NBS MONOGRAPH 161

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

# THE NICROSIL VERSUS NISIL THERMOCOUPLE: Properties and Thermoelectric Reference Data

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**The National Bureau of Standards was reorganized, effective April 9, 1978.**

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+ monograph . no. 161

Noel A. Burley

Materials Research Laboratories
Australian Department of Defence
Melbourne, Victoria 3032

Robert L. Powell

Institute for Basic Standards
National Bureau of Standards
Boulder, Colorado 80302

George W. Burns and
Margaret G. Scroger

Institute for Basic Standards
National Bureau of Standards
Washington, D.C. 20234

Sponsored by:

National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

and

Materials Research Laboratories
Australian Department of Defence
Melbourne, Victoria 3032, Australia

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Issued April 1978

**Library of Congress Cataloging in Publication Data**

Main entry under title:

The Nicrosil versus Nisil Thermocouple

(National Bureau of Standards Monograph: 161)
Supt. of Docs. No.: C13.44:161
1. Nickel alloys. 2. Thermocouples. I. Burley, Noel A. II. United States. National Bureau of Standards. III. Australia. Dept. of Defence. Materials Research Laboratories. IV. Series: United States. National Bureau of Standards. Monograph: 161.
QC100U556 No. 161 [TA480.N6] 602'.1s [669'.733] 77-14969

National Bureau of Standards Monograph 161
Nat. Bur. Stand. (U.S.), Mono. 161, 167 pages (Apr. 1978)
CODEN: NBSMA6

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1978

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For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Stock No. 003-003-01856-2. Price $3.50
(Add 25 percent additional for other than U.S. mailing).

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# THE NICROSIL VERSUS NISIL THERMOCOUPLE: Properties and Thermoelectric Reference Data

Noel A. Burley,* Robert L. Powell, George W. Burns, and Margaret G. Scroger

This monograph deals with the formulation and development of the new highly stable nickel-base thermocouple alloys *Nicrosil* (Ni–14.2Cr–1.4Si) and *Nisil* (Ni–4.4Si–0.1Mg) under the leadership of the Materials Research Laboratories (MRL) of the Australian Government Department of Defence, and their standardization by the National Bureau of Standards (NBS) of the U.S. Department of Commerce.

In the formulation of the new alloys, the main method was to use basic thermodynamic data to predict the conditions of solute concentration, temperature and oxygen pressure under which certain discrete oxide layers could form on the surface as highly efficacious passivating films. This work was the culmination of extensive research in which thermoelectric instability in existing nickel-base thermocouple alloys was correlated with their physical, chemical and metallurgical properties (section 2).

The basic thermoelectric properties of Nicrosil and Nisil more recently have been the subject of a joint research project between NBS and MRL. The aim of this project, which was conducted under the terms of an Arrangement under the U.S./Australia Agreement relating to Scientific and Technical Co-operation, was to establish a body of standard reference data on the thermoelectric and other properties of the new thermocouple alloys which could be recognized by various standards authorities around the world.

Descriptions of the prototype materials and experimental methods used in the joint research are given in sections 3 and 4, while the mathematical methods used to analyse the experimental results are described in section 5. The principal thermoelectric reference data for Nicrosil and Nisil, comprising tabular values of thermoelectric voltages, Seebeck coefficients and derivatives versus temperature, are given in section 7, while other material characteristics, in particular their highly stable thermoelectric properties, are summarized in section 6.

Key words: Calibration drift; chemical analyses; nickel-base alloys; nickel-chromium alloys; nickel-silicon alloys; oxidation; temperature; thermal electromotive force; thermocouples; thermocouple reference tables; thermoelements; thermometry.

## 1. Introduction

### 1.1 Thermoelectric Instability and Material Inhomogeneity

Ideally, a metallic thermocouple will comprise thermoelements which are homogeneous. In this case, which is hypothetical, the thermoelectromotive force output, or thermal emf, is a function only of the finite difference in the temperature of the thermojunctions, and it is dependent upon certain homogeneous characteristics of the individual thermoelements, principally solution composition and metallurgical state. It is thus possible to define thermoelectric properties of homogeneous metals in terms of a single parameter, $T$, temperature. For example, Mott and Jones [1936][1] have defined the reversible heat given up by a metallic conductor of unit cross-section, when an electric current $j$ flows through a temperature gradient $\delta T/\delta x$ along the conductor, as

$$-\mu j \frac{\delta T}{\delta x} \text{ per unit volume in unit time.}$$

The coefficient '$\mu$' defined in this way is known as the Thomson coefficient. The Thomson coefficient is used in simply defining a quantity, $S$, the absolute thermoelectric power of a homogeneous metal, as

$$S = \int_0^T \frac{\mu}{T} dT.$$

In reality, chemical, physical and metallurgical inhomogeneities are invariably generated in both the manufacture and subsequent usage of thermoalloys and, as a consequence, the thermal emf of a practical thermocouple is also a function of temperature distribution along the individual thermoelements. Mathematical treatments of the interaction of temperature-dependent inhomogeneities with longitudinal temperature gradients are not simple [see Fenton, 1969]. The 'inhomogeneity component' of the total thermal emf, which is sometimes called the 'spurious thermal emf', is a prime cause of uncertainty in thermoelectric thermometry. Not only can the spurious emf vary indeterminately with short-term temporal variations in the longitudinal temperature distribution, but it can also change in a gradual and insidious way as long-term environmental interactions produce cumulative changes in material composition.

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* Materials Research Laboratories, Australian Department of Defence, Melbourne, Victoria 3032.

[1] References cited are listed on page 100.

Thus it can be said that in the use of existing base-metal thermocouples, or in the development of new more stable varieties, inhomogeneities of various kinds must be obviated at all costs. This is easier said than done as the causes of inhomogeneity are many and varied. For example, compositional inhomogeneities include those caused by the local segregation of component or impurity elements in alloy manufacture, the absorption of materials from the environment by solution or by chemical combination, the loss of constituents by selective evaporation or chemical interaction, and the solution of elements produced by nuclear transmutation. Again, inhomogeneous metallurgical states can be caused by such phenomena as the thermal relief of residual internal stresses due to mechanical working, as well as structural ordering and recrystallization. Further, the effects of various physical phenomena such as magnetic fields and nuclear radiation cannot be ignored.

Of the base-metal thermocouples commonly used for temperature measurements up to about 1000 °C, the nickel-base alloy varieties presently designated 'Type K'[2] by the American National Standards Institute [ANSI, 1964] are the most versatile. Indeed, their use at the higher end of the temperature range is almost universal because they possess the best combination of such desirable properties as calibration accuracy and stability, oxidation resistance, high thermal emf, and reasonable cost. Type K alloys have been in widespread use for pyrometric measurement and control in scientific and industrial applications for well over half a century. Their thermoelectric stability in air at elevated temperatures has, over the years, been carefully studied by a number of workers, notably Dahl [1941], Hughes and Burley [1962], Potts and McElroy [1962], Starr and Wang [1963], Burley and Ackland [1967], Fenton [1969], and Burley [1969, 1970, 1972]. In complementary summary, their work provides cumulative evidence that the accuracy of thermocouples of Type K materials can be significantly impaired by two characteristic types of change which can occur in their temperature/thermoelectromotive force characteristics, namely

(i) a gradual and generally cumulative drift in thermal emf on long exposure at high temperatures; and

(ii) a short-term change in thermal emf on heating in the temperature range ca. 250 to 550 °C.

Burley [1969, 1972] has demonstrated that the long-term emf drifts are caused by the development of compositional inhomogeneities as reactive solutes are depleted chiefly by oxidation, in particular by internal oxidation. Fenton [1969] and Burley [1970] independently have adduced much circumstantial evidence in support of a hypothesis that the short-term emf changes are due to short-range ordering in the Ni–Cr atomic structure of the Type KP thermoelement.

## 1.2 Case for and Development of a New Base-Metal Thermocouple System

For some considerable time a justifiable case has existed for the development of a new base-metal thermocouple system having enhanced environmental, structural, and hence thermoelectrical stabilities. In science and industry, for example, temperature measurements above 1000 °C, especially in the range 1000 to 1300 °C, have become increasingly commonplace in recent times. On the other hand, informed but disinterested opinion [e.g. Bedford, 1964] has it that, for reliable and continuous thermocouple measurements of temperature above 1000 °C, one is restricted to the use of noble metals and alloys composed of them [see also Powell et al., 1974]. Again, for example, in the range of temperatures (250 to 550 °C) where the short-term structure-dependent drifts in the thermal emf of Type K thermocouples reach maximum magnitudes, tolerances on specified process temperatures in technological applications tend toward their most critical values. If the calibration stability, upper operating temperatures, and useful lives of base-metal thermocouple alloys could be significantly increased, considerable advantages would accrue. Not only would there be engendered a higher level of confidence in temperature measurement and control associated with various critical applications such as are found, for instance, in the aerospace, nuclear, and semi-conductor industries, but considerable scope would exist for cost reduction in industry in general, particularly where the maintenance, inspection, and calibration of thermocouple-actuated pyrometric installations are concerned.

It has been shown [Burley, 1972] that the long-term thermoelectric stability of nickel-base thermocouple alloys can in fact be significantly enhanced, particularly at temperatures above 1100 °C, by increasing alloy solute levels above those required to cause a transition from internal to external modes of oxidation, and by selecting solutes which preferentially oxidize to form impervious diffusion-barrier films. Furthermore, the short-term emf changes can virtually be eliminated by the choice of higher solute levels at which this structure-dependent effect is not evident. Based upon these considerations, and following an extensive program of research at the Defence Standards Laboratories of the Australian Government Department of Supply (now the Materials Research Laboratories of the Australian Government Department of Defence) in cooperation with major manufacturers of base-metal thermocouple alloys both in the U.S.A. and in Europe, two new nickel-base alloys for thermocouples have been developed. These alloys, at present called Nicrosil (Ni–14.2% Cr–1.4% Si) and Nisil (Ni–4.4% Si–0.1% Mg) are shown [Burley, 1972; and this Monograph] to be more resistant to

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[2] The compositions of typical examples of various Type K alloys at present available are given in Table 1.1.1. Alloy compositions quoted in this Monograph are expressed as percentages by weight, unless specifically noted as atomic percent (ao).

Table 1.1.1 *Typical compositions of various Type K alloys presently available [after Burley, 1972]*

| Alloy | Composition, wt.—%[a] | | | | | | | | | Variety |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cr | Mn | Al | Si | Co | Nb | Fe | Ni | Traces of Other Elements | |
| Positive (Type KP) | $9.2_0$ | T | ST | $0.2_5$ | P | | T | bal | Mg, Mo, Zn, Sn | Conventional (Lower Si) |
| | $9.3_4$ | T | T | $0.2_6$ | $0.2_0$ | ST | T | bal | Mg, Mo, Cu, Ca | |
| | $9.3_5$ | T | FT | $0.4_5$ | $0.1_5$ | ST | ST | bal | Mg, Cu, Ca, Zr | Conventional (Higher Si) |
| | $9.3_4$ | T | FT | $0.4_6$ | ST | | $0.1_7$ | bal | Mg, Mo, Cu, Ca, Zr | |
| | $9.3_1$ | ST | FT | $0.3_5$ | ST | $0.2_2$ | $0.3_5$ | bal | Mg, Mo, Cu, Ca, Zr | Special Conventional (Nb bearing) |
| Negative (Type KN) | ST | $2.8_7$ | $1.9_6$ | $1.1_5$ | $0.4_9$ | | T | bal | Mg, Cu, Ti, Pb | Conventional |
| | T | $2.7_8$ | $1.8_0$ | $1.0_2$ | P | | T | bal | Mg, Cu, Zn, Pb | |
| | ST | $1.6_7$ | $1.2_5$ | $1.5_6$ | $0.7_2$ | | T | bal | Mg, Mo, Cu, Ca, Pb | Modified Conventional (Mn and Al decreased) Si and Co increased) |
| | ST | $0.3_7$ | T | $2.3_0$ | $0.3_1$ | | ST | bal | Mg, Cu, Ca, Pb | |
| | ST | ST | FT | $2.5_0$ | $1.0_0$ | | $0.2_3$ | bal | (Cu-$2.2_2$) Mg, Ca | Special Conventional (Mn and Al eliminated, Si and Co increased) |
| | ST | FT | $0.1_3$ | $2.5_8$ | ST | | ST | bal | Mg, Ba, Cu, Ca, Pb | Special Conventional (Mn and Co eliminated, Al reduced, Si increased) |

[a] The numerals refer to chemical analysis and the symbols to spectrographic analysis as follows: P = 0.1–0.5%; ST = 0.05–0.1%; T = 0.01–0.05%; FT<0.01%.

air oxidation, to be usable at higher maximum temperatures, to be substantially freer of the effects of structural ordering and, as a consequence, to have much higher thermoelectromotive force stability than existing nickel-base thermocouple alloys.

## 1.3 Thermoelectric Reference Data for Nicrosil/Nisil: Joint NBS-DSL Research Program

Subsequent to the research and development work on Nicrosil and Nisil by the Defence Standards Laboratories, and to the presentation of a paper on the subject [Burley, 1972] to the Fifth Temperature Symposium held in Washington, D.C., in June, 1971, a collaborative research program between the Defence Standards Laboratories of the Australian Department of Supply and the National Bureau of Standards of the U.S. Department of Commerce was instigated. The purpose of this arrangement was to facilitate intensive studies of the thermoelectric and certain other properties of the new alloys, in particular the dependence of the thermoelectromotive force characteristics upon temperature and other factors such as solute concentration and structural state. The aim of the joint project, which was bilaterally sponsored by the Australian Department of Science and the U.S. National Science Foundation under the auspices of the U.S./Australia Agreement for Scientific and Technological Co-operation (1968), was to make possible the formulation of reference data on the thermoelectric and other properties of the new alloys which could be recognized by various standards authorities around the world. The venue for the experimental program concerned with temperatures from ambient up to 1300 °C was the Heat Division of the Institute for Basic Standards, National Bureau of Standards, Gaithersburg, Maryland, whilst the sub-ambient temperature work down to 4 K was carried out at the Cryogenics Division of the Institute, Boulder, Colorado. The results of the experimental program are largely embodied in the later sections of this Monograph, whose authors were the principal scientific collaborators in the joint project.

Various manufacturers of base-metal thermocouple alloys around the world played important roles in both the developmental and standardization phases of the Nicrosil/Nisil project, in particular, the Wilbur B. Driver Company made a significant contribution to the formulation of the negative alloy, Nisil (ref. section 2.2.3). Experimental and prototype alloys have been supplied at various times by—

Driver-Harris Company, Harrison, New Jersey
Hoskins Manufacturing Company, Detroit, Michigan
Wilbur B. Driver Company, Newark, New Jersey
British Driver-Harris Company, Stockport, Cheshire
Bulten-Kanthal A.B., Hallstahammar, Sweden

All these companies produced prototype alloys to rigid chemical specifications for the standardization phase of the project. These alloys, which were supplied in wire form, invariably were of excellent quality so that the data that emerged from the experimental program were of a most consistent nature.

Also of note is the significant interest in the project displayed by the American Society for Testing and Materials (ASTM) through its Committee E20 on Temperature Measurement. The E20 Sub-Committee concerned with Newer Thermocouple Materials has kept the development of Nicrosil and Nisil continually under review since 1971, both in its formal bi-annual meetings and through informal discussions with the scientists collaborating in the project.

## 2. Development of Nicrosil and Nisil Thermocouple Alloys

### 2.1 The Environmental, Structural and Physical Instabilities of Existing Nickel-Base Thermocouple Alloys

As mentioned in section 1, existing nickel-base thermocouple alloys of Type K possess the best combination of essential properties of all the standard base-metal thermocouple alloys. They do, nevertheless, have certain significant shortcomings related to environmental, structural, and physical instabilities that cause thermoelectric instability. The more important of these effects[3] are described in some detail in the following sub-sections.

#### 2.1.1 Oxidation

While existing nickel-base thermocouple alloys are prone to react deleteriously with a number of normal environmental substances, the chief deteriorative process whereby compositional inhomogeneities are produced is high-temperature air oxidation. Burley [1972] has described the general characteristics of the air oxidation of both the positive and negative conventional Type KP and KN alloys. These processes can be summarized briefly as follows—

On prolonged exposure in air at temperatures in the region of 800 to 1000 °C, several oxide layers of differing morphology are formed. This behavior is characterized in both alloys by the production of:

(i) an outer scale layer of nickelous oxide, NiO, which also appears in one or more of the intermediate layers, the innermost of which may be saturated with various solute ions and is porous. It forms principally at the scale/air interface as a result of the outward diffusion of nickel ions ($Ni^{2+}$) through vacancies in the defective cation sub-lattice of NiO;

(ii) an internally oxidized zone in which precipitates of oxides of the solute elements appear distributed in a solute-depleted alloy matrix. These precipitates are to some extent concentrated at the grain boundaries. This process arises from the dissolution of atomic oxygen at the metal/scale interface. In the positive alloy the internal oxide precipitates are predominantly $Cr_2O_3$, while in the negative alloy they are predominantly $MnO_2$ and $Al_2O_3$; and

(iii) ternary oxides of the spinel type $AB_2O_4$ which appear in the inner layers of the scale as the result of solid-state reactions between internal oxide precipitates and the NiO of the external scale. This occurs as the inner porous zone of the external scale advances inwards to take the place of the alloy matrix consumed in scale formation. In the Type KP alloy the spinel is $NiCr_2O_4$, while in the Type KN alloy it is predominantly $NiAl_2O_4$. In addition, small quantities of other complex spinel-type oxides of the several components of the Type KN alloy, e.g., $MnAl_2O_4$, $MnCo_2O_4$, as well as $Ni_2SiO_4$, form in the inner scales.

The existence of these zones of oxidation is clearly evidenced in figure 6.2.1. The most devastating of these three closely related oxidation processes, in producing compositional inhomogeneities in the underlying alloy, is internal oxidation. A more detailed examination of this process, in particular to show how it leads to thermal emf drift in Type K thermocouple alloys, is worthwhile.

The phenomenon of internal oxidation occurs in the oxidation of dilute solid-solution alloys composed of a base metal such as silver, copper, nickel or iron, and a small amount of one or more of less noble alloying elements such as indium, beryllium, chromium, manganese, silicon, aluminum, or zirconium. When such an alloy is exposed to an oxidizing atmosphere at high temperatures, particles of alloying element oxide are observed to precipitate at an advancing reaction front in a matrix of the base metal immediately below the external surface or an external scale. The conventional nickel-base thermocouple alloys of Type K are typical examples of such alloys, four of the solute elements mentioned above being major constituents.

Rapp [1965] has given an extensive review of the kinetics, microstructures and mechanisms of high-temperature internal oxidation in binary alloys. During the isothermal and isobaric oxidation of a binary alloy, the following criteria are considered necessary for the occurrence of internal oxidation—

(a) the free energy of formation (per mole of oxygen) for the solute metal oxide in the bulk alloy must be more negative than the cor-

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[3] When selecting for discussion the more important deteriorative effects that occur in the 'normal' use of Type K thermocouples, consideration was given to the restrictions placed on their use by ASTM [1974]. They should not be used in sulfurous, reducing, or alternately reducing and oxidizing atmospheres unless suitably protected with protecting tubes. They should not be used in vacuum (at high temperatures) for extended times because the chromium in the positive thermoelement vaporizes out of solution and alters the calibration. They should also not be used in atmospheres that promote the well known "green-rot" type of corrosion in chromium-bearing alloys (those with low, but not negligible, oxygen content).

responding energy of formation of the lowest oxide of the base metal;

(b) the free energy for the reaction of dissolved oxygen with solute to form the solute metal oxide in the solvent lattice must be negative;

(c) the pure solvent metal must exhibit a significant solubility and diffusivity for atomic oxygen in its lattice at the temperature of oxidation, if the required activity of dissolved oxygen at the reaction front is to be achieved;

(d) the solute metal content of the bulk alloy must be lower than that required to cause a transition from internal to external oxidation; and

(e) at the onset of oxidation any surface film, naturally or artificially produced, must not prevent the dissolution of oxygen in the base metal.

An examination of available data on free energies, diffusivities, etc. relevant to the conventional nickel-base thermocouple alloys confirms that in their case the above criteria are all met. Thermoelements made from these alloys will thus be prone to deterioration by internal oxidation during normal usage, and will hence exhibit a corresponding degree of thermal emf drift.

In the oxidation of binary alloys, Rapp and coworkers [e.g. Rapp, 1965; Rapp et al, 1966] have derived equations describing the kinetics for the simultaneous formation of an internal oxidation zone and an external scale. These equations predict the presence of substantial concentration gradients for both diffusing species, oxygen and solute metal, in the vicinity of the internal reaction front. From these it can be inferred that there will be substantial depletion of solutes, not only in the base-metal beneath the inner margin of the internally oxidized zone as components of the alloy diffuse outwards to the internal reaction front, but also within the internally oxidized zone itself. In relation to the former, Burley [1969] has quantitatively estimated the degree of solute depletion beneath the internally oxidized zone in Type K alloys using a coupled electron microprobe/computer technique. Typical concentration profiles of, for example, chromium in an oxidizing Type KP alloy are shown in figure 2.1.1.1. In relation to the latter, Rapp [1965] has calculated that for all dilute binary nickel-chromium alloys with mole fractions of chromium in the bulk alloy $< 0.1$ the concentration of chromium remaining in solution at the interface of the internally oxidized zone and the external scale should be approximately 1 in $10^8$, regardless of initial alloy content.

Some examples of the nature and magnitudes of thermal emf drifts caused by the depletion of solutes in oxidizing Type K thermocouple alloys are given in figures 2.1.1.2 and 2.1.1.3.

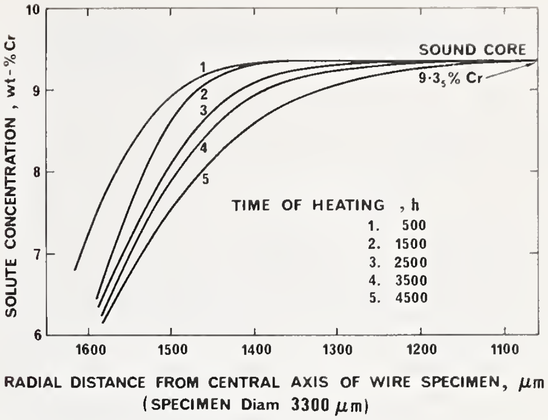

FIGURE 2.1.1.1 *Concentration profiles of chromium in the zone of solute depletion in a conventional Type KP thermoelement after heating in air at 950 °C for the indicated times.*

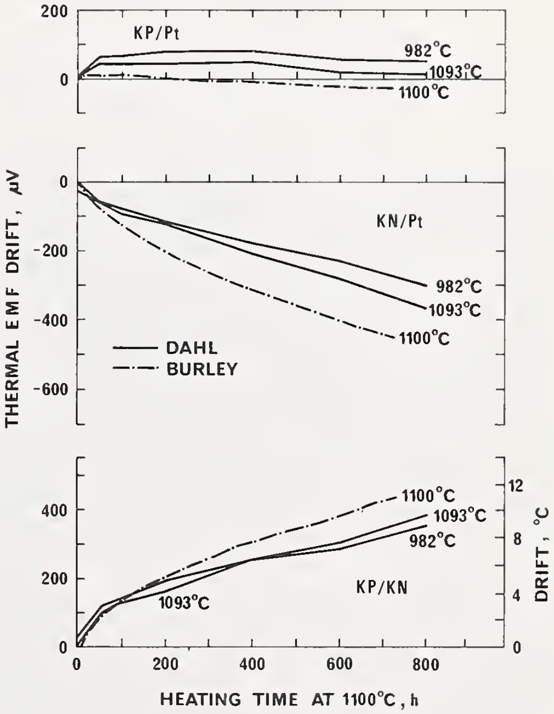

FIGURE 2.1.1.2 *Thermal emf drifts in conventional Type K thermocouples and in their* AWG 8 *thermoelements versus platinum on isothermal exposure in air at 1100 °C.*

Drift magnitudes are measured at the test-temperatures shown [after Dahl, 1941; and Burley, 1972].

### 2.1.2 Atomic Ordering

Little appears to be known about the basic cause of the anomalous thermal emf drifts of a short-term reversible nature, referred to in section 1.1, which occur in Type K alloys when heated in the temperature range ca. 250 to 550 °C. These emf changes, whose magnitude is dependent upon previous thermal history, and upon the time and the temperature of heating in this temperature range, can substantially increase the emf output of Type K thermocouples. On initial heat-

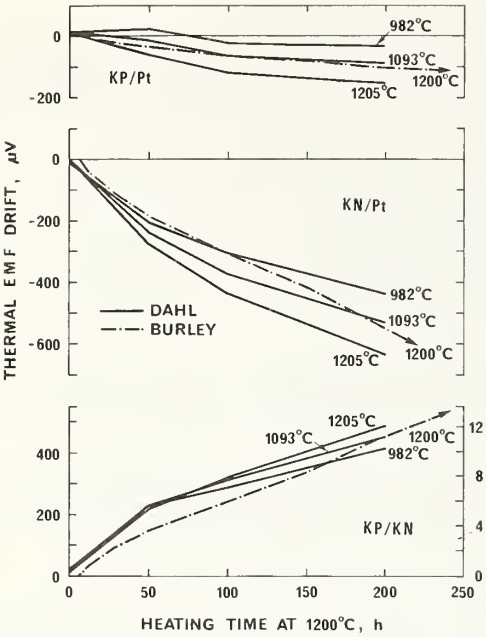

FIGURE 2.1.1.3 *Thermal emf drifts as in figure 2.1.1.2, but after exposure at 1200 °C.*

ing, 'as-received' Type K thermocouples commonly increase their thermal emf outputs by the equivalent of up to 3 °C; this increase is due almost entirely to a change in the emf of the Type KP thermoelement (see figure 2.1.2.1). Fenton [1969], for example, has observed an increase of about 0.6 $\mu$V $°C^{-1}$ in the thermoelectric power of a Type KP thermoelement as a result of heating for 30 days at 340 °C (see figure 2.1.2.2). This increase corresponds to a change in the thermocouple output equivalent to about 5 °C.

The alpha Ni–Cr alloys, which include the Type KP thermocouple alloys, are known to show anomalous deviations in physical and mechanical properties from those expected of a 'simple' solid solution. The weight of evidence seems to favor short-range ordering as the most likely common cause of these anomalous behaviors. Nordheim and Grant [1954], for instance, found that in the temperature range ca. 280 to 430 °C the electrical resistivity of Ni–10Cr increases toward an equilibrium value which is independent of thermal history. They contend that the absence of superstructure lines in their patterns of x-ray diffraction analysis and also the dependence of the magnitude of the effect upon temperature both support a theory of short-range order. Their conclusion is supported by Dehlinger [1962] who showed on theoretical grounds that the development of short-range order can cause a small increase in the resistivity of solid solutions. The development of long-range order in an alloy, on the other hand, is usually accompanied by a resistivity decrease [Schüle and Colella, 1969]. Again, Stansbury et al [1966] have shown that an anomalous increase of about 6 to 10 percent in specific heat occurs in Ni–10Cr and Ni–20Cr in the range 500 to 600 °C. They conclude that since the peak in the anomaly occurs at the same temperature for alloys of different chromium contents, short-range order is the cause. In long-range order, the temperature of the peak in the specific heat curve should decrease with a decrease in chromium content. The short-term cyclic anomalies in the thermal emf of Type KP alloys are consistent in nature and thermal dependence with the anomalies in electrical resistivity and specific heat in Ni–10Cr. It seems reasonable, therefore, to attribute these emf anomalies as well to short-range ordering.

Nordheim's and Grant's results [1954] can also be used to deduce the time-temperature dependences of the emf changes in Type KP alloys which are related to short-range order. Specifically, it is possible to obtain estimates of the times taken by Ni–10Cr to reach equilibrium resistivity values, at any temperature in the range 280 to 500 °C, after water-quenching from 980 °C. This is done by cross-plotting Nordheim's and Grant's results for Ni–11Cr, which are summarized in figure 2.1.2.3, to produce figure 2.1.2.4 which shows time-to-equilibrium resistivity as a function of the temperature for Ni–11Cr. Assuming that the equilibrium resistivity values relate to an equilibrium structural state of a particular degree of short-range order, figure 2.1.2.4 can also be used to estimate the times required for the thermal emfs of Type KP thermoelements to reach a stable value related to the same degree of short-range order. Values so derived are con-

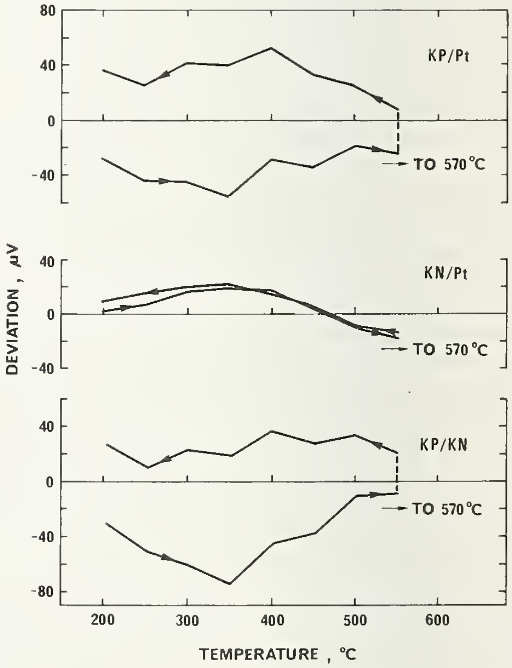

FIGURE 2.1.2.1 *Thermal emf deviations from standard tables for a typical conventional Type K thermocouple and for its AWG 8 thermoelements versus platinum, as measured during initial heating to 570 °C and during subsequent cooling to room temperature [after Burley, 1970].*

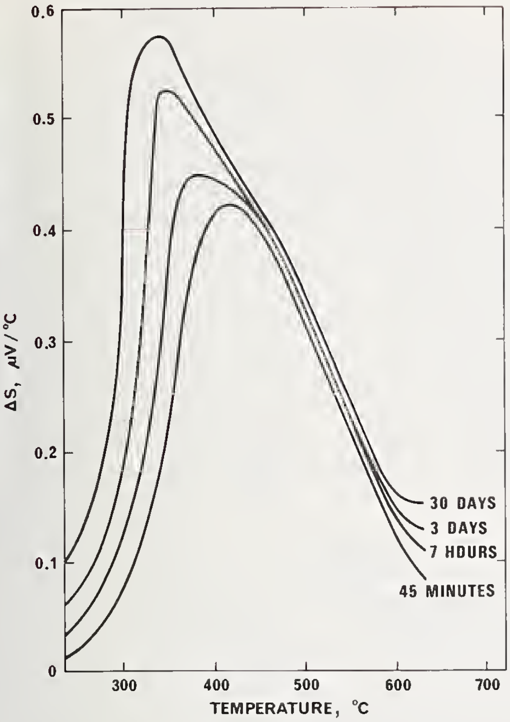

**Figure 2.1.2.2** *Changes in the thermoelectric power (ΔS) of a typical Type KP thermoelement versus platinum on initial heating, as a function of the aging temperature for the indicated times [after Fenton, 1969].*

sistent with the results of Fenton [1969], as summarized in figure 2.1.2.2, who measured corresponding changes in Type KP thermoelements directly.

The significance of these observations to the practical use of Type K thermocouples is worth examining. It can be seen that when a Type KP (Ni–9½Cr) thermoelement is heated so that any part of its length attains temperatures up to about 500 °C, it will experience time-temperature-dependent changes in thermal emf output whose net magnitude is a function of inhomogeneous change in the degree of short-range order existent in the 'initial' structure prior to heating. From figures 2.1.2.3 and 2.1.2.4, it may be inferred that the atomic structural changes which produce the resistivity and thermal emf changes in Type KP alloys are virtually time-independent in the temperature range 450 to 575 °C. The 'initial' degree of short-range order will thus be critically dependent upon the rate of cooling from some higher temperature through this virtually time-independent range. The maximum possible emf change will relate to a structural change from a disordered state to some temperature-dependent maximum degree of short-range order. The time required to establish this maximum order will depend only upon the aging temperature. In practice, a Type KP thermoelement operating in a temperature gradient could achieve a quasi-stable emf output in the first few hours, but additional insidious drifts in emf could occur over much longer periods due to the low rates of ordering characteristic of the lower temperatures in the gradient. Furthermore, if the relationship between the temperature gradient and the resultant ordering inhomogeneities was subsequently altered, for example by a change in the temperature or in the depth of immersion of the thermoelement, relative differences in emf output of a cyclic nature, up to the equivalent of about 3 °C, could result.

The exact nature of the atomic ordering processes alluded to in this section is yet to be determined. To this end a joint research program has been set up between the Materials Research Laboratories of the Australian Government Department of Defence and the Research Establishment of the Australian Atomic Energy Commission. Neutron diffraction techniques are being applied to polycrystalline samples of Type KP and Nicrosil-type alloys, and to their single-crystal counterparts of both naturally abundant and mono-isotopic composition, in an effort to elucidate the problem. The possibility that the short-range order in question is of magnetic origin is being investigated.

### 2.1.3 Magnetic Effects

The conventional negative thermoelement of the Type K thermocouple, the Ni–Mn–Al–Si–Co alloy known as KN of which examples are given in table 1.1.1, has a magnetic transformation which occurs at about 170 °C [Powell et al, 1974]. The actual transformation temperature, in the range 150 to 200 °C, depends upon composition. Since the composition of conventional Type KN thermoelements varies significantly from batch to batch, so does the transformation temperature. The magnetic transformation causes a measurable change in the Seebeck coefficient within about 200 °C of the transformation temperature. This perturbation in Seebeck coefficient was taken into account, however, in the recent revision of the NBS reference tables for Type K thermocouples [Powell et al, 1974], so that uncertainty in temperature measurement from this cause is minimized.

Of greater concern in the use of Type K thermocouples, therefore, is the limitation imposed by the effects produced when these devices are used in the presence of unavoidable magnetic fields. Little seems to be known about the basic influence of magnetic fields on the output thermovoltages of conventional Type K thermocouples, but the phenomenon cannot be ignored on that account. According to Loscoe and Mette [1962], for example, considerable errors in thermocouple measurements can occur in magnetic fields, and it is possible for the extraneous thermovoltages produced by the field to exceed those due to substantial differences in the temperatures of the thermojunctions.

Loscoe and Mette demonstrated that the extraneous 'thermomagnetovoltages' produced in the individual thermoelements, when they were exposed to temperature gradients in a magnetic field, were of two different kinds. The first is independent of the direction of the field while the other is dependent on field direc-

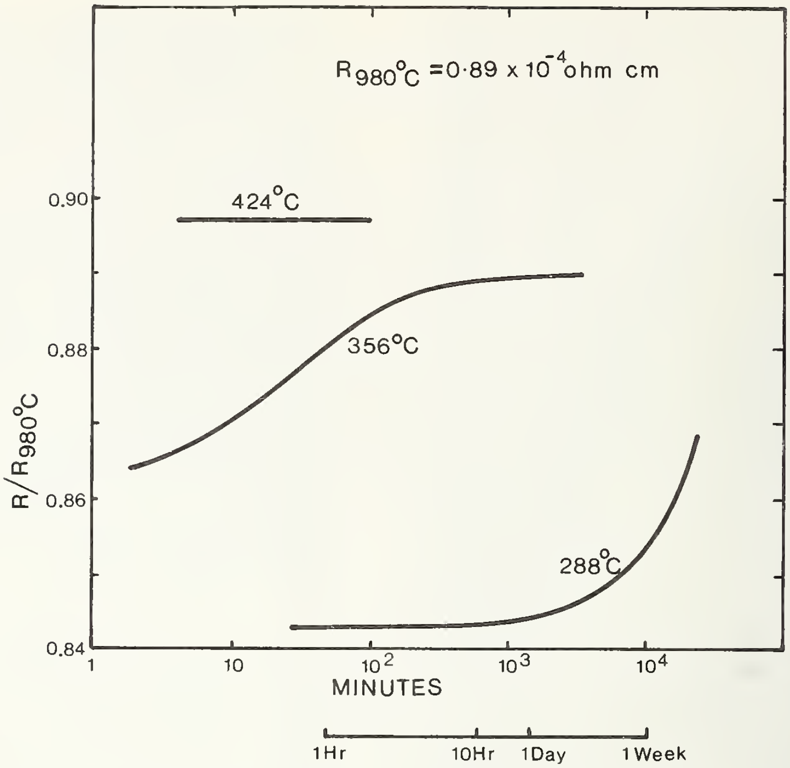

FIGURE 2.1.2.3 *Changes in electric resistivity of* Ni–10.9Cr *during isothermal aging at the indicated temperatures after water-quenching from 980 °C [after Nordheim and Grant, 1954].*

tion. In the first effect, a thermoelement in which a longitudinal temperature gradient exists exhibits an extraneous voltage component when exposed to a magnetic field. It is equivalent to a thermal emf generated in the same temperature gradient by a thermocouple comprising two identical thermoelements, one magnetized and the other not. The thermal emf is then equal to $S(a,a_m)\Delta T$ where $S(a,a_m)$ is the thermoelectric power between the magnetized and unmagnetized materials and $\Delta T$ is the temperature difference between the hottest and coldest points in the thermocouple in the magnetic field. In the second effect, with a magnetic field perpendicular to a diametral temperature gradient, a voltage appears at the ends of the thermoelement. This is equivalent to a Nernst effect with the magneto voltage equal to $B(\Delta T/\Delta y)Hb$, where $B$ is the Nernst coefficient, $\Delta T/\Delta y$ is the transverse temperature gradient in a wire sample of diameter $b$, and $H$ is the magnetic field strength.

In spite of its potentially large size, the first effect may be of little concern if it is possible to reverse the magnetic field; then the effect is eliminated provided the field strength is constant in either direction. On the other hand, the second effect is very difficult to eliminate because it reverses with the field. It can be minimized, however, by an appropriate choice of materials, namely those for which the ratio of their Nernst coefficient to their heat conductivity is small. Unfortunately, this implies a considerable limitation upon the use of Type K thermocouple materials in magnetic fields since, of the common base-metal thermoelements, the small-ratio condition appears to be least fulfilled by the Type KN alloys.

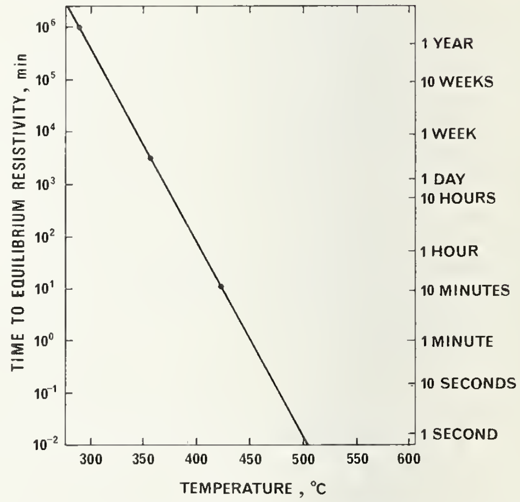

FIGURE 2.1.2.4 *Time-temperature dependence of equilibrium resistivity values in* Ni–10.9Cr *during isothermal aging after water-quenching from 980 °C [after Nordheim and Grant, 1954; and Burley, 1972].*

### 2.1.4 Nuclear Irradiation

Type K thermocouples are used extensively in nuclear reactors in applications where irradiation by neutrons is possible. The effects of neutron irradiation on thermocouple alloys have been studied in different ways by various workers. Browning and Miller [1962], for instance, have calculated radiation induced changes in composition (transmutations) in Type K thermocouple alloys, for irradiations in a thermal neutron flux of $1 \times 10^{14}$ n $cm^{-2}$ $s^{-1}$, for periods up to 20 years. Their results are summarized in figure 2.1.4.1, from which it can be inferred that the Type KP alloys apparently are stable in a neutron environment as neither nickel nor chromium undergoes significant radioactive decay. On the other hand the Type KN alloys appear to be inherently less stable in that they experience significant increases in their iron and copper contents, and decreases in their cobalt and manganese contents.

Since it is possible that the neutron flux will vary over the length of the thermocouple cable in an operating reactor, neutron-induced transmutations may produce chemical inhomogeneity, particularly in the negative thermoelement. The extent to which such compositional inhomogeneities cause cumulative calibration changes in Type K thermocouples in nuclear environments will depend on the nature of the temperature gradients in which they occur. Various workers [e.g. Kelley et al, 1962; Markina et al, 1971] have made quantitative observations of integral changes in the thermal emf of Type K thermocouples, which they ascribe to neutron-induced transmutations. Such changes in emf appear to reach several hundred microvolts.

Transmutations are only one of the possible effects of nuclear irradiation upon materials. There are also various solid-state effects [Billington, 1958] which could be expected to produce changes in materials which do not undergo transmutation. Markina et al [1971] have observed, for example, instantaneous variations in the thermal emf of Type K thermocouples upon neutron irradiation, which they ascribe to variations in electronic state of the materials at the moment of irradiation. These latter phenomena seem little understood and it is disconcerting that Markina et al have demonstrated that such effects can cause thermal emf changes in Type K thermocouples several times larger than those due to transmutations.

## 2.2 Formulation of the Nicrosil and Nisil Thermocouple Alloys

This section describes the conceptual and theoretical rationale for the formulations of Nicrosil and Nisil thermocouple alloys whose compositions are—

| | |
|---|---|
| Nicrosil (positive) : | Ni–14.2Cr–1.4Si |
| Nisil (negative) : | Ni–4.4Si–0.1Mg |

### 2.2.1 General

In the formulation of materials for a new base-metal thermocouple system which is required to show markedly enhanced thermoelectric stability in air, particularly at high temperatures, there are sound reasons for retaining nickel as the base metal for both the positive and negative alloys, and chromium and silicon as the major solutes.

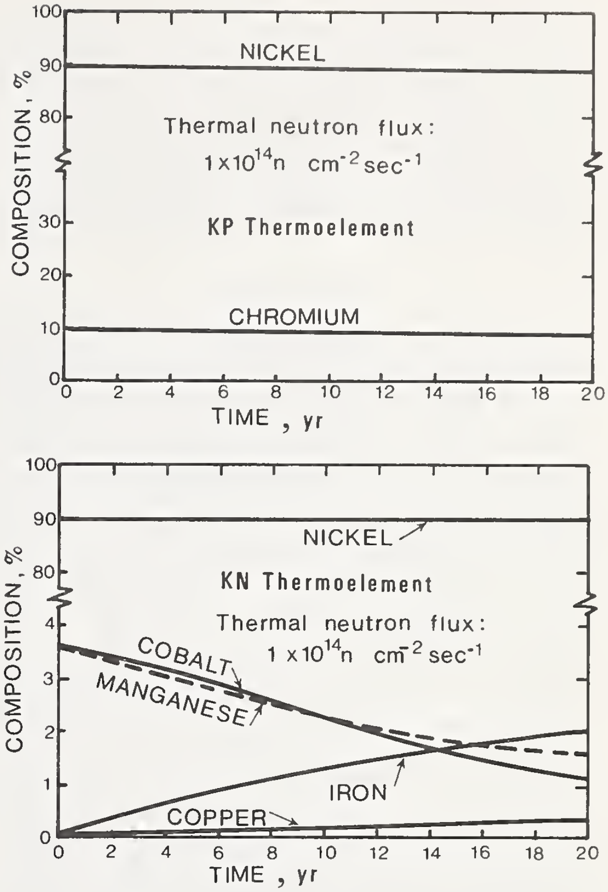

FIGURE 2.1.4.1 *Calculated composition changes in Type KP and KN thermoelements caused by neutron-induced transmutations [after Browning and Miller, 1962].*

Nickel and nickel-chromium alloys, in addition to their economic and metallurgical advantages, have most desirable thermoelectric properties. The addition of a Group VI transitional element such as chromium causes the absolute thermoelectric power of nickel, which is negative, to move strongly in the positive direction. In the case of chromium large positive emf maxima are reached in the compositional range of most interest. From the thermoelectric standpoint, therefore, certain of the alpha nickel-chromium alloys are inherently suitable as positive thermoelements. Furthermore, the ability of silicon to form stable, continuous, and impermeable oxide layers at the metal/scale interface in oxidizing nickel-chromium alloys is of considerable significance to their environmental and thermoelectrical stability. In such circumstances silicon alters the oxygen kinetics in such a way that the oxidation processes described in section 2.1.1 are retarded. The mechanisms involved do not appear to be completely understood, but scales in such alloys are observed to contain silica in the form of alpha cristobalite [Gil'dengorn and Rogel'berg, 1964; Lowell, 1973] with the main concentration occurring at the metal/scale interface. It seems likely that such films act to greatly hinder the diffusion mechanisms essential to the formation of the various oxide layers in nickel-chromium and, in particular, to inhibit internal oxidation.

### 2.2.2 Nicrosil

Whilst there are sound reasons for retaining both chromium and silicon as the major solute elements in a preferred nickel-base positive thermoelement, there are equally sound reasons for asserting that the concentrations (ca. 9½Cr, ½Si) of these elements in conventional Type KP thermoelements are by no means optimum. As shown in section 2.1, the environmental and structural instabilities of the conventional Type KP alloys are related primarily to their compositional characteristics. In what way, then, should the solute levels of chromium and silicon be changed?

At the outset it is important to note that, as shown by Burley [1970], the differences between thermal emf outputs corresponding to atomically ordered and disordered states in Ni–10Cr are of opposite algebraic sign to those in Ni–20Cr. An increase in the chromium content from 10 to 20 percent reverses the direction of emf change due to short-range ordering from positive to negative. Burley concluded that in this compositional range there is a 'neutral' alloy which is thermoelectrically stable from the atomic ordering point of view. He has further demonstrated [Burley, 1972], as shown in figure 2.2.2.1, that while the exact composition is temperature dependent this neutral alloy contains about 15½ percent chromium in binary solid solution. It is fortuitous that an increase in chromium content to, say, 15 percent would also significantly enhance the oxidation resistance of the alloy.

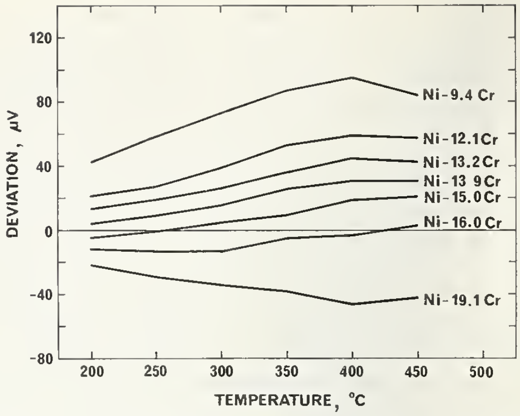

FIGURE 2.2.2.1 *Changes in the thermal emf's of several* Ni–Cr *alloys in the alpha range 9 to 20*Cr *during a heating (to 450 °C) and cooling cycle following water-quenching from 1050 °C.*
The changes are deviations in the emf's versus platinum on cooling from the values measured during heating [after Burley, 1972].

Recent studies of the composition dependence of the parabolic rate constants in the oxidation of Ni–Cr [e.g. Giggins and Pettit, 1969] have shown that in the temperature range 800 to 1100 °C the addition of chromium to nickel up to about two percent increases the rate constant, that this rate remains substantially the same with further chromium additions up to about ten percent, but that with additions beyond ten percent the rate is substantially reduced. These results are summarized in figure 2.2.2.2. Reference to the nickel-rich zone of the 1000 °C isothermal section of the Ni–Cr–O equilibrium diagram [Croll and Wallwork, 1969] suggests that about 10 percent chromium is the transition composition at which the spinel $NiCr_2O_4$ gives way to $Cr_2O_3$ as the stable oxide in Ni–Cr alloys. In alloys of 15 percent chromium, the tendency at these temperatures for $Cr_2O_3$ to form as a continuous passivating layer at the metal/scale interface, instead of as an internal oxide precipitate as in the lower-chromium alloys, has been proposed [Wood and Hodgkiess, 1966] as the major reason for their increased oxidation resistance. Since, as a rule, high-temperature parabolic oxidation signifies that a thermal diffusion process is rate-determining, the effectiveness of the $Cr_2O_3$ layer is presumably due to the low rate at which cations diffuse through a low concentration of chromium vacancies in the defective cation sublattice of this oxide, which is nearly stoichiometric.

In the conventional positive alloy the main cause of solute depletion and hence of thermal emf drift during oxidation in the temperature range 800 to 1000 °C is internal precipitation of $Cr_2O_3$ particles. It is therefore most desirable that an improved positive thermoelement should have a bulk chromium content that exceeds the critical value at which the transition from internal precipitate to external film type oxide formation occurs. It is not a simple matter, however, to determine theoretically the compositional range of chromium in Ni–Cr over which this temperature-dependent transition phenomenon occurs [Burley, 1972], and it is thus necessary to rely on empirically determined evidence. Giggins and Pettit [1969], for example, have shown that at temperatures between about 1050 and 1250 °C in 0.1 atm (10 kPa) pressure of oxygen, internal oxidation of chromium in Ni–Cr is not observed when the mole fraction of chromium exceeds about 0.15 (approximately 13 percent chromium). It is thus reasonable to suggest that the optimum chromium content of the preferred positive alloy should be that at which short-range order initiated thermal emf variations are not observed (approximately 14 percent chromium, as is seen below). For such an alloy, not only is the parabolic rate constant for oxidation significantly less than for the 10 percent chromium alloy in the temperature range of interest but also the rate at which the healing layer of $Cr_2O_3$ forms at the metal/scale interface increases markedly with increasing temperature [Wood and Hodgkiess, 1966].

There are several aspects of the oxidation mechanisms in Ni–14Cr, however, which require further

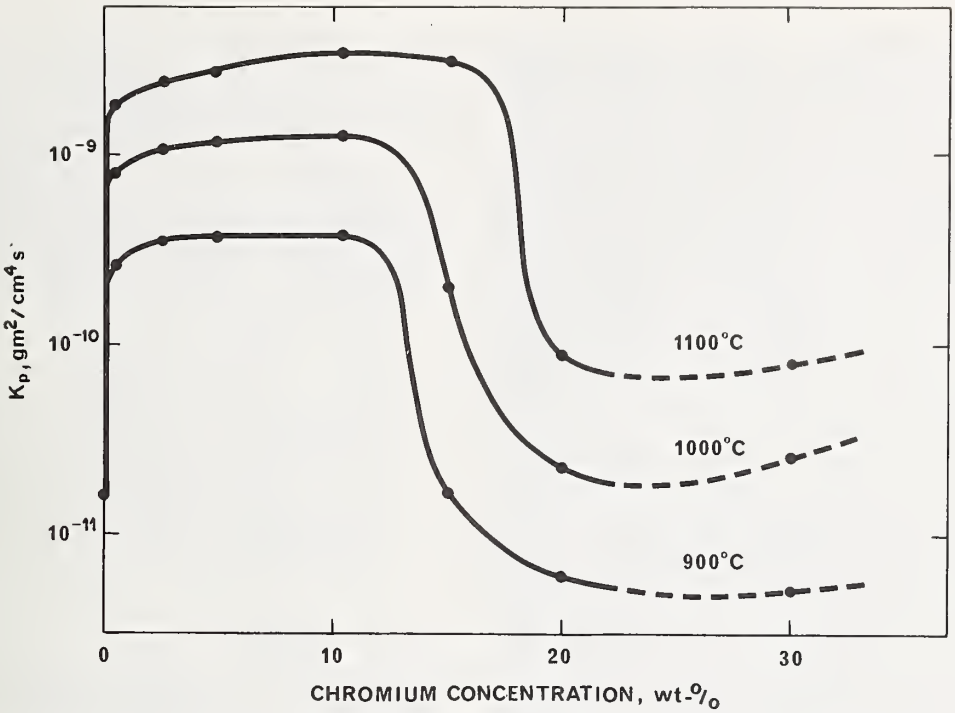

FIGURE 2.2.2.2 *Composition dependence of the parabolic rate constant* ($K_p$) *in the oxidation, in 10 kPa* $O_2$, *of alpha* Ni–Cr *alloys at 900, 1000, 1100 °C* [*after Giggins and Pettit, 1969*].

consideration. First, as the chromium concentration at the solute-depleting metal/scale interface falls during protracted heating at 1000 to 1200 °C, the tendency for $Cr_2O_3$ to form as a non-protective internal precipitate rather than as a protective external film will be increased. Secondly, when $Cr_2O_3$ is heated above about 1000 °C it tends to oxidize to $CrO_3$ [Kim and Belton, 1974], which is volatile at such temperatures. The evaporation of the higher oxide from any exposed regions of the healing oxide layer will tend to produce paralinear kinetics, and hence continuous chromium depletion and thermal emf drift. Thirdly, while the $Cr_2O_3$ film will inhibit outward cation diffusion to the extent that this process becomes the rate-limiting step in the oxidation process, the film could still thicken slowly by oxygen reactions at the metal/film interface. A second oxidation inhibiting mechanism is thus considered to be essential if the preferred positive alloy is to show maximum stability. The formation of a continuous silica film at the metal/scale interface, which occurs in oxidizing Ni–Cr alloys when a small quantity of silicon is present, appears to be such a mechanism. Since the solubility of most elements in $SiO_2$ is virtually nil, there will be very small chemical potential gradients across the film and hence very small driving forces for the diffusion of oxidation reactants such as nickel and chromium through it. Provided the $SiO_2$ film were to remain continuous this very low rate of diffusion could be the oxidation rate-controlling factor rather than the diffusion of chromium ions in $Cr_2O_3$.

Standard free energy data for the formation of the various oxides produced by a Ni–Cr–Si alloy at high temperatures suggest that $SiO_2$ will tend to form preferentially because it is the oxide with the largest negative free energy value. This factor alone, however, does not guarantee the formation of a complete healing layer of $SiO_2$; the composition of the bulk alloy must also be taken into account in determining whether this thermodynamically favoured oxide will eventually form a complete external layer or will merely appear as an internal precipitate. The presently available Type KP alloys have silicon contents which do not exceed about a half percent. There is strong evidence to suggest that this amount is significantly less than that required to produce a $SiO_2$ film of optimum diffusion inhibiting propensity.

Unpublished work [Burley, 1975] on the high-temperature air oxidation of various of the Type KP alloys of table 1.1.1 shows that, even though the differences in the silicon contents of these alloys are small (a range of from ¼ to ½ percent), the degree of chromium depletion in the metal beneath the scale is less in the higher silicon alloys than in the lower. Even so, chromium depletion and hence thermal emf drift in the ½ percent silicon alloys is substantial. Data on the effects of silicon in excess of ½ percent upon the oxidation characteristics of nickel-base alloys containing 10 percent chromium is meagre, but at least one study [Gil'dengorn and Rogel'berg, 1964], in which the influence of up to five percent silicon upon the growth kinetics of oxides formed on such alloys was investigated, is relevant. With oxidation in air in the range 1000 to 1200 °C, silicon additions reduce the oxidation rate of Ni–10Cr by an order or more, the drop being most marked after the addition of about 1 percent. The maximum effect appeared to be achieved at about 1½ to 2 percent. Of considerable significance to the present work is the result that in alloys containing 1 percent silicon or more an increase in isothermal aging temperature up to 1200 °C had negligible effect in increasing the oxidation rate. As shown later, in section 6.3.3, in Ni–Cr–Si alloys containing 14 to 15 percent chromium, maximum thermal emf stability in air at temperatures up to 1250 °C appears to result when the alloys contain about 1.4 percent silicon.

It seems reasonable to assume that the inner-layer diffusion barrier of SiO$_2$ in an oxidizing Ni–15Cr–1½Si alloy will be both persistent and tenacious. Although the rate at which silicon diffuses through nickel is such that high temperatures or long times, or both, would be required to replenish the SiO$_2$ component of the oxide layer, the diffusion coefficient exhibits the usual exponential temperature dependence in the range 1000 to 1200 °C, and the healing rate should increase significantly with increasing temperatures in this range. Furthermore if the diffusivity of oxygen in silica is low, as suggested in the next section, the concentration of oxygen at the metal/scale interface will fall markedly as the diffusion barrier film thickens. The film could thus be strengthened by secondary solid-state reactions which favour the Cr reduction of NiO and NiCr$_2$O$_4$, and also the Si reduction of Cr$_2$O$_3$.

It is not to be assumed that a Ni–Cr–1.4Si alloy will show minimal thermal emf variations due to atomic ordering at a chromium solute level of 15½ percent, the level at which these effects are minimal in the Ni–Cr binary alloy (see sect. 2.2.2). Burley [1974], in investigating the effects of silicon on the ordering phenomenon in these alloys, found that minimal structure-related emf variations occurred in Ni–Cr–1.4Si alloys when the chromium content reached 14 percent (ref. section 6.4).

The optimum formulation of Nicrosil thus appears to be Ni–14.2Cr–1.4Si.

### 2.2.3 Nisil

As discussed earlier in section 2.1.1, air oxidation of the conventional negative Type KN thermoelement (Ni–3Mn–2Al–1Si–½Co) causes substantial depletion of the reactive solutes manganese and aluminum in the vicinity of the internal oxidation reaction front. That this process produces substantial thermal emf drift is not surprising when one considers the shape of the curves (figure 2.2.3.1) relating the emf output of these alloys with their manganese and aluminum contents. Since the conventional negative alloy originally was developed primarily for sulfurous atmospheres, it can be argued that the readily oxidizable elements manganese and aluminum can be deleted from the formulation of a preferred negative alloy for use at high temperatures in air. Since cobalt is not required as an emf-modifying element, the formulation of such a preferred alloy can be developed from first principles. The virtue of nickel as the base for such an alloy has been established in earlier discussion, and there are several strong reasons for retaining silicon as the major solute.

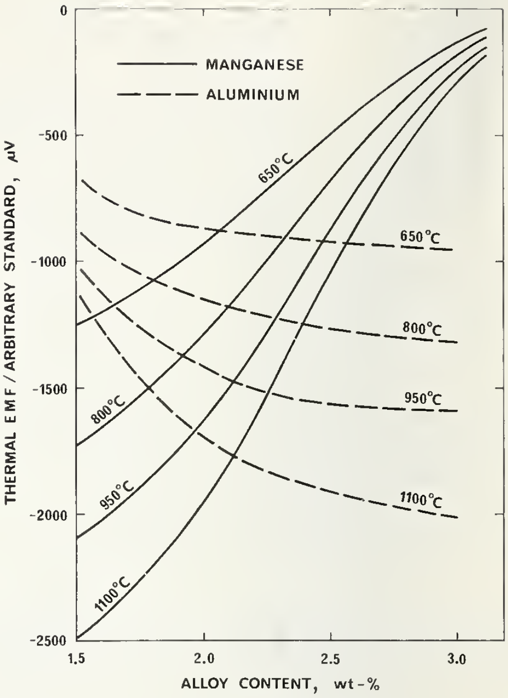

FIGURE 2.2.3.1 *Effects of manganese and aluminum in a conventional Type KN alloy on the deviation of thermal emf's from an arbitrary standard [after Starr and Wang, 1963].*

The absolute thermoelectric power ($S$) characteristics of Ni–Si are quite different from those of Ni–Cr. While silicon moves the $S$ of nickel in the positive direction as does chromium, the magnitude of the effect is relatively small. For example, the addition of 3.8 percent Si changes the $S$ of nickel from $-37$ to $-32$ $\mu$V °C$^{-1}$ at 1094 °C whereas a similar addition of Cr would move the $S$ of nickel to about $-17$ $\mu$V °C$^{-1}$ at this temperature [Wang et al, 1966]. A Ni–4Si alloy would therefore have the essential characteristic of being strongly thermonegative to Niscrosil.

The discussion in section 2.2.2 proposes that silicon can suppress solute depletion and consequent thermal emf drift in oxidizing Ni–Cr–Si alloys by forming a stable, continuous, and impermeable film of its oxide alpha-cristobalite, SiO$_2$, at the metal/scale interface. There is evidence [Potts and McElroy, 1962; Gil'dengorn and Rogel'berg, 1964] which suggests that silicon can perform a similar role in binary Ni–Si alloys. Prior to the development of Nisil, however, there were no published data on the stability of the temperature-thermoelectromotive force characteristics of Ni–Si in air at temperatures above 1000 °C. For silicon to have optimum stabilizing effect in Ni–Si its oxide would have to form as a continuous and impermeable layer, exclusively on the surface of the metal, which would persist indefinitely at high temperatures not only under isothermal conditions in air but also under conditions of very low oxygen pressure or rapid thermal cycling, or both.

On the assumption that a compact, pore-free oxide scale is formed, the theoretical critical concentration of binary solute ($B$) above which its oxide is formed exclusively on the surface is given by Wagner [1959, 1965] as—

$$N_B = \frac{V}{Z_B M_o} \cdot (\pi k_p / D)^{1/2}$$

where $V$ is the molar volume of the alloy,
$Z_B$ is the valence of the $B$ atoms,
$M_o$ is the atomic weight of oxygen,
$k_p$ is the parabolic rate constant for exclusive formation of $B$ oxide, and
$D$ is the diffusion coefficient of $B$ in the alloy.

In this equation, the values of $V$ and $Z_B$ are constant for a given alloy, so the value of the fraction $V/Z_B M_o$ is readily determined. Since it is known that the diffusion coefficient ($D$) of silicon in nickel exhibits the usual temperature dependence, values of $D$ at various temperatures can be calculated from the relationship—

$$D = D_o \exp[-Q/RT]$$

where $D_o$ is the frequency factor,
$Q$ is the activation energy,
$R$ is the gas constant, and
$T$ is the thermodynamic temperature.

Using values of $D_0 = 1.5$ cm$^2$ s$^{-1}$ and $Q = 61.7$ kcal g-atom$^{-1}$ [Swalin, 1957], or 258.2 kJ mol$^{-1}$,[4] as parameters for the diffusion of silicon in nickel, and R = 1.987 cal mol$^{-1}$ deg$^{-1}$, or 8.314 J mol$^{-1}$ K$^{-1}$, the values of $D(1100\ °\mathrm{C}) = 2.25 \times 10^{-10}$ cm$^2$ s$^{-1}$, or $22.5 \times 10^{-15}$ m$^2$ s$^{-1}$, and $D(1200\ °\mathrm{C}) = 10.5 \times 10^{-10}$ cm$^2$ s$^{-1}$, or $105 \times 10^{-15}$ m$^2$ s$^{-1}$ are obtained from the above equation. Data on oxidation rates in binary Ni–Si alloys are meagre but the relevant values that have been obtained [Gil'dengorn and Rogel'berg, 1964] appear to be reliable. These values are as follows:

$k_p$(Ni–3.6Si) = $1.2 \times 10^{-10}$ g$^2$ cm$^{-4}$ s$^{-1}$ at 1100 °C (or $12 \times 10^{-9}$ kg$^2$ m$^{-4}$ s$^{-1}$), and $5.4 \times 10^{-10}$ g$^2$ cm$^{-4}$ s$^{-1}$ at 1200 °C (or $54 \times 10^{-9}$ kg$^2$ m$^{-4}$ s$^{-1}$);

$k_p$(Ni–4.7Si) = $1.2 \times 10^{-11}$ g$^2$ cm$^{-4}$ s$^{-1}$ at 1100 °C (or $1.2 \times 10^{-9}$ kg$^2$ m$^{-4}$ s$^{-1}$), and $6.2 \times 10^{-11}$ g$^2$ cm$^{-4}$ s$^{-1}$ at 1200 °C (or $6.2 \times 10^{-9}$ kg$^2$ m$^{-4}$ s$^{-1}$).

Since the value of $k_p$ to be used in the above equation for determining $N_B$ is the value corresponding to the alloy whose mole fraction of silicon is equal to $N_B$, it is convenient to use an iterative method of solution with interpolated values of $k_p$. Such a method yields the values $N_B(1100\ °\mathrm{C}) = 0.089$ ($4.2_0$Si) and $N_B(1200\ °\mathrm{C}) = 0.090$($4.2_5$Si). These theoretical values of the minimum solute concentration required to give exclusive $SiO_2$ surface film formation in oxidizing alpha Ni–Si are consistent with the results of a fairly recent investigation [Wolf, 1965] in which the depth of internal oxide penetration in these alloys was measured as a function of silicon content. After heating for 200 hours in air at 980 °C, for example, the depth of penetration was found to be inversely proportional to solute content, the amount of internal precipitate being negligible when the concentration reached 4.0 percent silicon.

The degree to which a silica film on the surface of a Ni–Si alloy would inhibit diffusion is difficult to assess. Results of studies of oxygen transport in silica show large divergences in both diffusivities and activation energies, and the nature of oxygen defects in silica does not appear to be well understood. It can be reasoned from basic principles, however, that silica is highly impermeable to both oxygen and nickel. From Wagner theory the parabolic rate constant for oxidation is seen to be proportional to the electrical conductivity of an oxide which forms a continuous layer in which diffusion processes are rate-controlling. Hence the diffusion rates in $SiO_2$ should be much lower than in NiO, since the electrical conductivities of these oxides are $10^{-6}$ and $10^{-2}$ $\Omega^{-1}$ cm$^{-1}$, respectively. Thus a complete layer of $SiO_2$ on the surface of a Ni–Si alloy should greatly inhibit oxidation, and in particular it should prevent the silicon concentration at the metal/oxide interface from falling below the value critical to selective oxidation.

The long-term persistence of the silica surface film will be vital and this will be governed by a number of factors, in particular its volatility, reactivity, and spalling characteristics, which are considered in the following.

First, the formation of volatile silicon oxide molecules should not be a serious hindrance to the retention of silica as a protective diffusion barrier. Kellogg's [1966] treatment of relevant thermodynamic data has facilitated graphical representations describing the dependence of vapor pressure of a compound on the non-metal activity. Figure 2.2.3.2, which is derived from these treatments, shows the dependences on oxygen activity of the partial pressures of the volatile species Si(g) and SiO(g) over the condensed phases Si(s) and $SiO_2$(s) at 1225 °C. The four lines of the diagram were derived from the four vapor-forming reactions—

$$\begin{aligned}
&\mathrm{Si(s)} + \tfrac{1}{2}\mathrm{O_2} \rightarrow \mathrm{SiO(g)} \\
&\mathrm{Si(s)} \rightarrow \mathrm{Si(g)} \\
&\mathrm{SiO_2} \rightarrow \mathrm{SiO(g)} + \tfrac{1}{2}\mathrm{O_2} \\
&\mathrm{SiO_2} \rightarrow \mathrm{Si(g)} + \mathrm{O_2}
\end{aligned}$$

The slopes of the lines in figure 2.2.3.2, $d \log P_{\mathrm{SiO}} / d \log P_{\mathrm{O_2}}$ and $d \log P_{\mathrm{Si}} / d \log P_{\mathrm{O_2}}$, are derived by dif-

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[4] For some quantities quoted in this Monograph, preferred equivalents in terms of Système International d'Unités (SI Units) are also given.

ferentiating the logarithms of the equilibrium constants of the above vaporization equations. It can be seen from figure 2.2.3.2 that a $SiO_2$ scale at 1225 °C would exhibit negligible vapor losses in air and that SiO volatilization would be appreciable only in highly reducing gases.

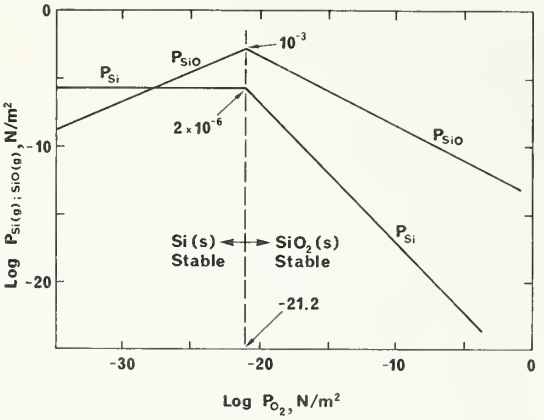


FIGURE 2.2.3.2 *Oxygen activity dependences of the partial pressures of the volatile species* Si(g) *and* SiO(g) *over the condensed phases* Si(s) *and* $SiO_2$(s) *at 1225 °C [after Kellogg, 1966; the value for* $P_{SiO}$ *at* Si–$SiO_2$ *co-existence is after Schäfer and Hörnle, 1950].*

Secondly, the reactivity of $SiO_2$ with nickel in the alloy to form $Ni_2SiO_4$ should likewise present little problem. The silicon content at which a binary Ni–Si alloy is in thermodynamic equilibrium with a mixture of $Ni_2SiO_4$ and $SiO_2$ can be calculated from the equation—

$$Ni_2SiO_4(s) + Si(alloy) = 2SiO_2(s) + 2Ni(alloy).$$

The equilibrium constant is—

$$RT \log_n K = RT \log_n a_{Ni}^2/a_{Si} = -\Delta G^\circ,$$

where $\Delta G^\circ = -87{,}660$ cal (1000 °C) [Saegusa, 1969]. Thus for $a_{Ni} = 1$, $a_{Si} = 1.1 \times 10^{-15}$, and $SiO_2$ will be more stable at the scale/metal interface when the silicon content exceeds this very low value.

Thirdly, the adhesion of the $SiO_2$ scale to the substrate in alpha Ni–Si is impossible to predict, but recent experience with thermoalloys of this type shows the mechanical persistence of its protective scale to be extremely good [Burley et al, 1975]. There is, furthermore, evidence [Gil'dengorn and Rogel'berg, 1964; Lowell, 1973] that adhesion increases with increasing temperatures and exposure times.

A compact and continuous scale-layer of silica on the surface of alpha Ni–Si is not assumed to be a perfect diffusion barrier, hence small quantities of oxygen may dissolve in the solid solution substrate at high temperatures. It would be desirable, therefore, to incorporate in the preferred negative thermoalloy a small amount of a highly reactive solute metal which would preferentially getter any such oxygen in forming its own oxide. In particular, this would suppress any tendency for silicon to oxidize internally and perhaps reduce any NiO which might form concurrently with $SiO_2$ in the early stages of oxidation. Magnesium has been found, at a concentration of 0.1 percent, to be a most suitable element for this role [Starr and Wang; 1967, 1976]. Standard free energy data suggest that its oxide will form preferentially to those of nickel and silicon, while the fact that its diffusion rate in nickel is considerably higher than that of silicon should ensure its replenishment at the metal/scale interface. This is not to suggest that the explanations given above for the proven beneficial effect of magnesium in alpha Ni–Si alloys are adequate. Numerous hypotheses have been advanced to explain how such trace additions affect the oxidation kinetics and scale adhesion in refractory alloys. The particular mechanisms by which magnesium improves the high-temperature oxidation resistance of alpha Ni–Si alloys is the subject of current research at the Australian Defence Materials Research Laboratories.

It can thus be deduced that the silicon content of a preferred binary Ni–Si negative thermoalloy should be between about 4¼ percent, which is the level of transition in these alloys from an internal to an external mode of oxidation in air at about 1200 °C, and 5 percent, which is the limit of binary solid solubility of silicon in nickel at room temperature. As will be shown later in section 6.1, there are sound thermoelectric reasons for a choice of 4.4 percent silicon in this range. In addition to achieving greatly improved thermal emf stability due to the enhanced oxidation resistance of Ni–4½Si–0.1Mg, the elimination of manganese, cobalt, and iron, present as alloying elements in the various conventional Type KN materials, from the preferred negative thermoalloy should also lead to improved stability in nuclear environments, since no neutron-induced transmutations of these elements can occur.

The optimum formulation of Nisil thus appears to be Ni–4.4Si–0.1Mg.

### 2.2.4 Thermal Passivation

In developing the formulations of Nicrosil and Nisil, in sections 2.2.2 and 2.2.3 above, basic thermodynamic data were used to relate the conditions of solute content, temperature and oxygen pressure under which certain discrete and continuous oxide layers could form exclusively on the alloy surface to produce highly effective diffusion barriers. Using such factors as the standard free energies of formation and the growth rates of the various oxides involved, the alloy inter-diffusion coefficients, and the solubility and diffusivity of atomic oxygen in the alloys, it was predicted that in the case of Nicrosil the barrier would comprise two predominant layers, namely a $Cr_2O_3$ film superimposed upon an insulating $SiO_2$ film located at the metal/scale interface, while in Nisil the barrier would consist of a single surface layer of $SiO_2$. That these diffusion-barrier oxide layers form as predicted, that they are highly efficient oxidation inhibitors and that, as a consequence, Nicrosil and Nisil show much enhanced environmental and thermoelectric stabilities, up to about 1300 °C in air, is established later in this Monograph.

It has been observed [Burley and Jones, 1975], however, that of the very small thermal emf drifts which do occur in Nicrosil/Nisil thermocouples at high temperatures in air, the greater part takes place in the very early stages of exposure and is due principally to the Nicrosil thermoelement. This suggests that once the oxide films on Nicrosil are established they greatly inhibit solute diffusion, but that in the early stages their formation can be relatively slow and may also be characterized by some departure from the theoretically predicted conditions of steady-state oxide growth.

Recent studies of transient or initial oxidation [Wood and Chattopadhyay, 1970] in certain binary nickel-base alloys, in one atm (100 kPa) oxygen at 600 °C, have shown that with Ni–Cr, Ni–Al, and Ni–Si, significant amounts of NiO are produced before the predicted steady-state healing layer of the particular less noble metal oxide is formed at the scale base. In the case of Ni–Cr, NiO was always the major oxide formed in the early stages of oxidation of Ni–5.6 and –11.1 ao Cr, with increasing amounts of $NiCr_2O_4$ forming as oxidation proceeded. The $Cr_2O_3$ healing layer did appear, however, fairly soon after exposure. The amount of $Cr_2O_3$ forming increased with chromium content and was detectable as early as 2 to 5 min with Ni–22.0 ao Cr. It is thus apparent that the high diffusion-inhibiting propensity of the $Cr_2O_3$ and $SiO_2$ films forming as steady-state passivating layers on Nicrosil could be deleteriously affected by the coformation of NiO and $NiCr_2O_4$ at the transient oxidation stage. This could account for the small initial thermal emf drift observed in this alloy.

It seems likely, however, that the transient formation of unwanted oxides, not only on Nicrosil but also on Nisil, could be suppressed by an initial thermal-treatment involving certain controlled conditions of temperature and of oxygen pressure which were favorable to the exclusive formation of $Cr_2O_3$ or $SiO_2$, or both. The theoretical basis of this proposition is outlined in the following.

If Ni–Cr–Si is heated in an abundant supply of air, the three components of the alloy will oxidize at different rates which are dependent initially upon the differences in the standard free energies of formation of their respective oxides. If, however, the oxygen potential of the reacting gas is progressively lowered, say by reducing its total pressure or by changing its composition, the selective oxidation of chromium with respect to nickel, and of silicon with respect to both chromium and nickel, is enhanced. This means that the oxidation of nickel can be suppressed while that of chromium and silicon continues, next the oxidation of nickel and chromium can be suppressed while that of silicon continues, and finally the oxidation of all three alloy components can be suppressed. Such a lowering of the oxygen pressure will also lead, successively, to the dissociation of any NiO, $NiCr_2O_4$, $Cr_2O_3$, and $SiO_2$ already formed. Figure 2.2.4.1, which has been calculated from heats of decomposition and entropy data, shows the partial pressure of oxygen in equilibrium with the relevant oxides of nickel, chromium and silicon, at temperatures up to about 1000 °C. If the partial pressure of oxygen and the temperature are such that conditions correspond to the area marked A, the atmosphere will be oxidizing to all three reactions. If, however, the condition lies around B it will be seen that the oxygen partial pressure has fallen below the equilibrium pressure for the reaction—

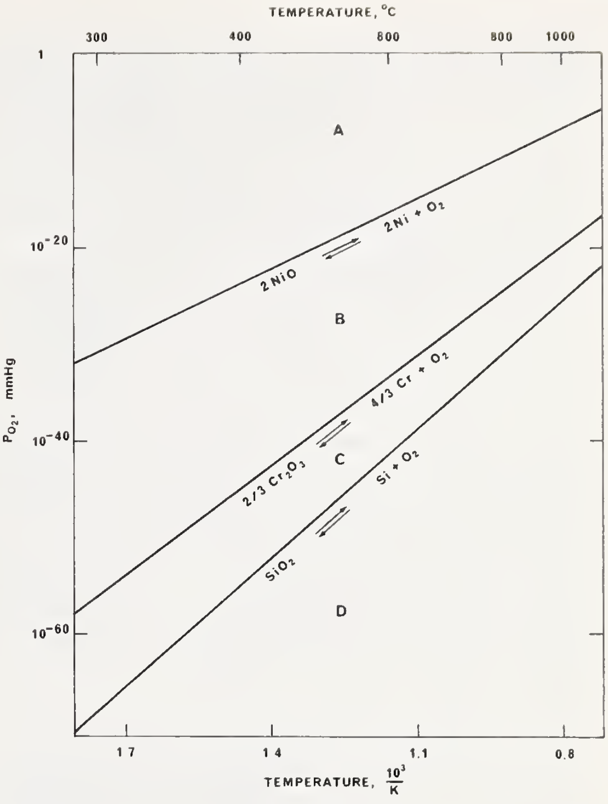


Figure 2.2.4.1 *Reaction equilibrium: relation between* $P_{O_2}$ *and temperature (1 mmHg=133.3 Pa). For areas A to D, see text [after Burley, 1972b].*

$$2NiO \rightleftharpoons 2Ni + O_2$$

and thus the equilibrium

$$K = C[Ni] \times P_{O_2}/C[NiO]$$

is disturbed by a lowering of $P_{O_2}$ and a decrease in $C$ [NiO] will occur to restore the equilibrium, i.e. the reaction will go to the right and no oxidation of nickel will occur. The oxygen partial pressure is, however, greater than the equilibrium value for the reactions—

$$\tfrac{2}{3}Cr_2O_3 \rightleftharpoons \tfrac{4}{3}Cr + O_2, \text{ and}$$

$$SiO_2 \rightleftharpoons Si + O_2,$$

both of which will accordingly go to the left and the oxidation of chromium and silicon only will take place. When the condition lies around C both the nickel and chromium reactions will go to the right and the exclusive oxidation of silicon will take place. When the condition lies around D all three reactions will go to the right and the surface will remain bright. From figure 2.2.4.1, it will further be seen that at any given partial pressure, increasing the temperature brings the condition closer to the equilibrium state and thus tends toward the suppression of one reaction and the enhancement of the selective effect.

Thus, in theory, the deleterious effects of the initial formation of NiO and $NiCr_2O_4$ in the transient oxidation of Ni–Cr–Si and Ni–Si can be eliminated by preliminary thermal-treatments at controlled temperatures and pressures in which the exclusive formation of $Cr_2O_3$ or $SiO_2$, or both, would occur. This could involve lowering the oxygen pressure to around D in figure 2.2.4.1, at some suitable temperature, and raising it again to around C or B, as appropriate. To achieve the very low oxygen pressure implied would require the use of special atmospheres.

The concept of thermal passivation, particularly as it relates to Nicrosil and Nisil, has been the subject of research at the Australian Defence Materials Research Laboratories since early 1972.

### 2.3 Tests on Developed Alloys

Subsequent to the work involved in the theoretical formulation of Nicrosil and Nisil which is summarized in section 2.2, prototype samples of the new alloys were obtained from various of the world's leading manufacturers of base-metal thermocouple alloys (refer section 1.3). These samples were subjected to rigorous and exhaustive tests of various kinds, the purpose of which was to gather a body of qualitative and quantitative data on the thermoelectric, metallurgical and physical properties of these alloys. This process would not only test the validity of the predictions made for their greatly enhanced thermoelectric stability, but would also establish the relevant property characteristics of these materials for future reference, in particular for the purposes of standardization.

Predominant among these tests, which were carried out mainly at the Australian Defence Materials Research Laboratories, and also at the U.S. National Bureau of Standards and the Australian National Measurement Laboratory, were those aimed at establishing the degrees of environmental, structural and thermoelectrical stability exhibited by Nicrosil and Nisil. The results of these tests, which are summarized in section 6, show that the new alloys are, in fact, much more resistant to air oxidation, usable at higher maximum temperatures, and substantially freer of the effects of structural ordering than existing alloys of Type K. As a consequence, Nicrosil and Nisil are possessed of much higher thermoelectromotive force stability than any existing base-metal thermocouple alloys.

### 2.4 Recommended Thermocouple System

In section 2.2 a new thermocouple system is implied which comprises the new nickel-base thermoalloys Nicrosil and Nisil. The compositions of these alloys, whose prototype names are derived from the first syllables of their respective major component elements are

Nicrosil (positive) : Ni–14.2Cr–1.4Si, and
Nisil (negative) : Ni–4.4Si–0.1Mg;

these formulations are quoted as percentages by weight.

In determining compositional tolerance limits about the solute levels quoted above it is necessary to take into account a number of factors, some of which are conflicting. For example, from the standpoint of the manufacturer it is desirable to work to compositional tolerances which are as wide as practicable. There is an obligation on the part of the manufacturer, however, to produce materials whose thermal emf outputs lie within specified tolerance limits, and this imposes compositional bounds because of the sensitivity of the thermal emfs of the alloys to variations in solute content. It would seem desirable that the emf tolerances on Nicrosil/Nisil imposed in manufacture should be the same as, or close to, those specified for Type K thermocouples by the American National Standards Institute, the American Society for Testing and Materials, and the Instrument Society of America. These tolerances are the thermal emf equivalents of ±2¼ °C, or ±¾ percent of the temperature, whichever is the greater (ASTM, 1974).

The sensitivity of the thermal emf's of Nicrosil and Nisil to variations in solute concentration are set out below. The figures in column 3 are emf's versus Pt–67 at 1000 °C.

| Alloy | Component | Emf Sensitivity (mV per 0.1 wt.−%) | Reference |
|---|---|---|---|
| Nicrosil | Cr | −0.085 | section 6.1.2 |
| | Si | −0.242 | section 6.1.2 |
| Nisil | Si | +0.010 | section 6.1.3 |
| | Mg | +0.106 | Starr and Wang [1976] |
| | Fe | +0.220 | Wang [1976] |
| | Cr | ca. +0.900 | Burley [1975] |

From these data it can be seen that the thermal emf of Nicrosil is much more sensitive to variations in its silicon content than it is to variations in its chromium content. Nisil, on the other hand, is virtually insensitive to variations in its silicon content, but is most sensitive to variations in its iron.

Tolerance limits for chromium (in Nicrosil), silicon, magnesium and iron can be estimated from the thermal emf-composition relationships summarized above. In the case of carbon and chromium in Nisil, other factors must be taken into account. Carbon was found to exert a considerable influence upon the linearity of the temperature-emf characteristics in Nisil, while its emf is extremely sensitive to chromium in trace quantities. It is therefore necessary to set the lowest practicable limit on the presence of these elements in the negative alloy.

The thermal emfs of the prototype alloys, particularly the Nisils, were found to be very sensitive to iron. Since the iron content of the prototype alloys differed by up to 0.13 wt.−% over the range (0.04 to 0.17) wt.−% (see table 3.1.2), it was decided to set the iron level at 0.1 wt.−%, even though this implied the need for some manufacturers to add iron to their melts in order to supplement the initial 'impurity' levels of this element.

With such factors in mind, it is suggested that the compositional tolerances for the main alloying constituents of Nicrosil and Nisil should be as follows (percentages by weight)—

| Nicrosil | | Nisil |
|---|---|---|
| 14.2±0.15 | Cr | 0.02 max |
| 1.4±0.05 | Si | 4.4±0.2 |
| 0.1±0.03 | Fe | 0.1±0.03 |
| 0.03 max | C | 0.03 max |
| | Mg | 0.1±0.05 |

## 3. Prototype Materials and Test Specimens

### 3.1 Acquisition of Prototype Materials for Thermoelectric Reference Data

Prototype alloy melt batches of Nicrosil and Nisil were acquired from each of the base-metal thermocouple alloy manufacturers mentioned in section 1.3, specifically for establishing the thermoelectric reference data. It was specified that the alloys should be manufactured in accordance with close compositional tolerance limits for the main alloying constituents, similar to those given in section 2.4. In this Monograph the thermocouple alloy manufacturers are individually identified by the letters A, B, C, D and E, which were assigned in a quite arbitrary and random way. The number of melt batches obtained from each of these manufacturers is given in table 3.1.1. Altogether, 15 melt batches of Nicrosil and 16 melt batches of Nisil were procured. Samples of each alloy, in the form of both 1.63 and 0.32 (or 0.25) mm diameter wires (AWG 14 and 28 (or 30), respectively) were drawn down and supplied by the particular manufacturer from each melt batch. All the prototype materials were received at NBS by January, 1974.

The chemical compositions of the individual prototype alloy melt batches are given in table 3.1.2. The elemental analyses were performed by the Metals Analysis Group of MRL using specimens taken from near the mid-point of the coils of 1.63 mm diameter wire. The concentrations of all the elements listed, except carbon, were estimated by conventional wet-way methods after preliminary spectrographic analysis. The carbon values were determined by a combustion-conductimetric method. The specimens were also examined by x-ray fluorescence spectroscopy. All the manufacturers furnished compositional data for their alloys, and the agreement with the MRL data presented in table 3.1.2 is generally very good. Table 3.1.2 shows that the majority of the prototype alloy melt batches were in compliance with the specified compositional tolerances referred to above.

Table 3.1.1 *Number of prototype alloy melt batches acquired from various manufacturers*

| Manufacturer | Number of melt batches | |
|---|---|---|
| | Nicrosil | Nisil |
| A | 2 | 2 |
| B | 2 | 1 |
| C | 4 | 6 |
| D | 3 | 4 |
| E | 4 | 3 |

Tables 3.1.2 also gives values of the thermal emfs of the prototype alloy melt batches against Pt–67 at 1000 °C. These data were obtained during preliminary tests. The samples for these tests, and for the final calibration tests in the high temperature range, were also taken from near the mid-point of the coils of 1.63 mm diameter wire, adjacent to the samples for chemical analysis. They were electrically annealed in air for one hour, the Nicrosils at 950 °C and the Nisils at 850 °C, prior to testing at 100 °C intervals from 100 to 1100 °C using the calibration methods and equipment described in section 4.2.

Finally, table 3.1.2 shows the laboratory identification numbers and the manufacturers' melt numbers assigned to the prototype alloys, and indicates the final calibrations performed on them. The methods used in the various temperature ranges for the final calibrations are summarized in section 4.

### 3.2 Experimental Alloys for Other Property Data

In addition to supplying the prototype alloy melt batches for establishing the thermoelectric reference data, various of the manufacturers mentioned in section 1.3, and one other producer, fabricated groups of alloys in suitable wire form for use in studies (see section 6) of certain physical, chemical, and metallurgical properties of the new thermoalloys. Some of the prototype alloy samples were also used in the section 6 studies. The groups of alloys specially prepared for this work are described in the following.

First, a group of six binary alpha Ni–Si alloys of very high purity, having silicon contents ranging up to five percent, were obtained from the Development and Research Department of the International Nickel Company, Birmingham, U.K. These were used to study the effect of silicon upon the thermal emf of the alpha Ni–Si alloys in general and Nisil in particular. Details of these alloys, including chemical compositions, NBS–MRL identification numbers, and manufacturer numbers, are given in table 3.2.1.

Secondly, a group of eight pure ternary Ni–Cr–Si alloys, having chromium contents spanning a range of values near the 14.2 percent level of Nicrosil and silicon contents fixed at about the Nicrosil level of

TABLE 3.1.2 *Compositions and calibrations of prototype alloy melt batches.*

| Alloy | Manufacturer | NBS–MRL Identification number | Manufacturer's melt number | Chemical Composition [a] | | | | | Calibrations performed | | | EMF against Pt–67 at 1000 °C[b] (mV) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cr | Si | Fe | C | Mg | High temperature range (100 to 1300 °C) | Overlap temperature range (−75 to 450 °C) | Cryogenic temperature range (−269 to 7 °C) | |
| Nicrosil | A | 150 | BR1/3 | 14.01 | 1.58 | 0.09 | 0.030 | | Yes | No | Yes | 25.987 |
| | A | 151 | BR1/4 | 14.08 | 1.39 | .09 | .029 | | No | No | No | 26.440 |
| | B | 160 | 96140 | 13.92 | 1.54 | .05 | .13 | | No | No | No | 26.700 |
| | B | 161 | 96141 | 13.92 | 1.52 | .04 | .14 | | No | No | No | 26.696 |
| | C | 170 | 73007 | 14.34 | 1.51 | .05 | .042 | | Yes | Yes | Yes | 25.961 |
| | C | 171 | 73008 | 14.34 | 1.51 | .04 | .045 | | Yes | No | Yes | 26.030 |
| | C | 172 | 73009 | 14.34 | 1.51 | .04 | .055 | | No | No | No | 26.047 |
| | C | 173 | 73010 | 14.31 | 1.50 | .05 | .050 | | Yes | Yes | No | 26.116 |
| | D | 180 | 3095 | 14.21 | 1.46 | .10 | .006 | | Yes | Yes | Yes | 26.112 |
| | D | 181 | 3096 | 14.25 | 1.48 | .05 | .009 | | Yes | Yes | Yes | 26.976 |
| | D | 182 | 3097 | 14.19 | 1.41 | .05 | .004 | | Yes | No | Yes | 26.040 |
| | E | 190 | 52272/1 | 14.27 | 1.44 | .09 | .014 | | Yes | No | Yes | 26.101 |
| | E | 191 | 52272/2 | 14.24 | 1.47 | .11 | .016 | | Yes | Yes | Yes | 26.050 |
| | E | 192 | 52272/4 | 14.27 | 1.47 | .09 | .026 | | No | No | No | 26.144 |
| | E | 193 | 52272/3 | 14.18 | 1.46 | .09 | .015 | | Yes | Yes | Yes | 26.124 |
| Nisil | A | 200 | BR2/3 | | 4.18 | .04 | .008 | 0.10 | No | No | No | −10.671 |
| | A | 201 | BR2/4 | | 4.36 | .04 | .006 | .11 | Yes | No | Yes | −10.660 |
| | B | 210 | 96461 | | 4.24 | .14 | .019 | .04 | Yes | Yes | Yes | −10.165 |
| | C | 220 | 73019 | | 4.46 | .04 | .030 | .11 | Yes | No | Yes | −10.381 |
| | C | 221 | 73020 | | 4.58 | .04 | .020 | .09 | Yes | Yes | No | −10.332 |
| | C | 222 | 73021 | | [c] 4.23 | | [c] .12 | [c] .09 | No | No | No | −10.099 |
| | C | 223 | 73022 | | [c] 4.23 | | [c] .12 | [c] .09 | No | No | No | −10.102 |
| | C | 224 | 73023 | | 4.38 | .04 | .003 | .08 | Yes | Yes | Yes | −10.543 |
| | C | 225 | 73024 | | 4.54 | .04 | .005 | .07 | No | No | No | −10.520 |
| | D | 230 | 3155 | | 4.22 | .17 | .006 | .09 | No | No | No | −9.263 |
| | D | 231 | 3157 | | 4.25 | .06 | .007 | .10 | Yes | Yes | Yes | −10.213 |
| | D | 232 | 3168 | | 4.20 | .08 | .004 | .11 | Yes | Yes | Yes | −10.134 |
| | D | 233 | 3255 | | 4.17 | .07 | .008 | .07 | No | No | No | −9.772 |
| | E | 240 | 52272/5 | | 4.18 | .09 | .002 | .21 | Yes | Yes | Yes | −10.213 |
| | E | 241 | 52272/6 | | 4.19 | .04 | .005 | .21 | Yes | No | Yes | −10.511 |
| | E | 242 | 52272/7 | | 4.22 | .04 | .006 | .22 | Yes | Yes | Yes | −10.532 |

[a] Balance is nickel; all alloy compositions are expressed as percentages by weight. Some specimens showed traces of Co, Mn and/or Zn.

[b] Values are based on reference junctions at 0 °C and were obtained during preliminary tests on 1.63 mm diameter test specimens that were annealed for one hour in air by electric resistance heating, the Nicrosils at 950 °C and the Nisils at 850 °C.

[c] Data furnished by manufacturer.

Table 3.2.1 *Compositions of alpha* Ni–Si *alloys*

| Alloy (nominal) | NBS–MRL Identification number | Manufacturer's melt number | Chemical composition [a] | | | | |
|---|---|---|---|---|---|---|---|
| | | | Si | Fe | Mg | Cr | C |
| Ni–0Si | 33 | Pure nickel | 0.001 | 0.012 | <0.005 | <0.01 | 0.022 |
| Ni–1Si | 6 | MESL | 1.06 | .04 | <0.001 | <0.01 | .001 |
| Ni–2Si | 7 | MESJ | 2.00 | .04 | <0.001 | <0.01 | .001 |
| Ni–3Si | 8 | MESK | 3.00 | .05 | <0.001 | <0.01 | .001 |
| Ni–4Si | 9 | MESM | 4.03 | .06 | <0.001 | <0.01 | .001 |
| Ni–5Si | 10 | MESO | 5.08 | .08 | <0.001 | <0.01 | .001 |

[a] Percentage by weight; balance is nickel.

Table 3.2.2 *Compositions of the* Ni–Cr–1½Si *alloys*

| Alloy (nominal) | NBS–MRL Identification number | Manufacturer's melt number | Chemical composition [a] | | | | |
|---|---|---|---|---|---|---|---|
| | | | Cr | Si | Fe | Mg | C |
| Ni–12Cr–1½Si | 96 | 73026 | 12.04 | 1.44 | 0.04 | 0.02 | 0.013 |
| Ni–12½Cr–1½Si | 97 | 73027 | 12.50 | 1.44 | .04 | .02 | .016 |
| Ni–13Cr–1½Si | 98 | 73028 | 12.98 | 1.45 | .03 | .01 | .016 |
| Ni–13½Cr–1½Si | 99 | 73029 | 13.60 | 1.47 | .10 | .02 | .021 |
| Ni–15¼Cr–1½Si | 92 | 71005 | 15.37 | 1.47 | .06 | .03 | [b] .06 |
| Ni–15¾Cr–1½Si | 93 | 71006 | 15.79 | 1.49 | .06 | .03 | [b] .06 |
| Ni–16¼Cr–1½Si | 94 | 71016 | 16.26 | 1.49 | .05 | .03 | [b] .06 |
| Ni–16¾Cr–1½Si | 95 | 71017 | 16.88 | 1.50 | .05 | .02 | [b] .06 |

[a] Percentage by weight; balance is nickel.
[b] From manufacturer's data.

Table 3.2.3 *Compositions of the* Ni–14¼Cr–Si *alloys*

| Alloy (nominal) | NBS–MRL Identification number | Manufacturer's melt number | Chemical composition [a] | | | | |
|---|---|---|---|---|---|---|---|
| | | | Cr | Si | Fe | Mg | C |
| Ni–14¼Cr–½Si | 55 | 3126 | 14.16 | 0.61 | 0.05 | 0.09 | 0.012 |
| Ni–14¼Cr–1Si | 56 | 3127 | 14.25 | 1.09 | .04 | .08 | .012 |
| Ni–14¼Cr–2Si | 57 | 3128 | 14.21 | 2.08 | .07 | .07 | .007 |
| Ni–14¼Cr–2½Si | 58 | 3129 | 14.28 | 2.60 | .08 | .08 | .007 |
| Ni–14¼Cr–3Si | 59 | 3130 | 14.26 | 3.04 | .06 | ,07 | .008 |

[a] Percentage by weight; balance is nickel.

1.4 percent, were fabricated by manufacturer C. These were used to study the effect of chromium upon the thermal emf of Nicrosil. Details of these alloys are given in table 3.2.2.

Thirdly, a group of five pure ternary Ni–Cr–Si alloys, having silicon contents spanning a range of values near the 1.4 percent level of Nicrosil and chromium contents fixed at about the Nicrosil level of 14.2 percent, were fabricated by manufacturer D. These were used to study the effect of silicon upon the thermal emf of Nicrosil. Details of these alloys are given in table 3.2.3.

All chemical analyses referred to in this section were carried out by the Metals Analysis Group of MRL.

## 3.3 Alloy Samples Selected for Establishment of Thermoelectric Reference Data

The selection of a final small group of alloy samples of Nicrosil and Nisil for intensive and critical final calibration leading to the establishment of the thermoelectric reference data proceeded in several successive steps.

On receipt of the various prototype alloy batches from their respective manufacturers, each one was calibrated over the range 100 to 1100 °C (as described in section 3.1) to obtain preliminary data on their individual temperature versus thermal emf characteristics. Using these calibration data, from which values at 1000 °C are quoted in table 3.1.2, and the compositional data presented in the same table, a selection of nine individual batches of Nicrosil and nine batches of Nisil was chosen from the original 31 batches for further calibration. In this first reduction the principal criteria which were taken into account in eliminating various of the original alloy batches from further consideration were that—

(i) deviations in elemental solute levels from the nominal compositions quoted in section 2.2 should be minimal,

(ii) deviations in thermal emfs from the mean values of the preliminary calibrations should be minimal, and

(iii) at least one batch of Nicrosil and one of Nisil from each manufacturer should be included.

Using optimum selection techniques based on these criteria, the following alloy batches were nominated for further calibration studies—

| Nicrosils | | | | Nisils | | | | |
|---|---|---|---|---|---|---|---|---|
| 150 | 170 | 180 | 190 | 201 | 210 | 220 | 231 | 240 |
| | 171 | 181 | 191 | | | 224 | 232 | 241 |
| | | 182 | 193 | | | | | 242 |

Samples from these batches were then calibrated in the high-temperature range 100 to 1300 °C using techniques described in section 4.2, also in the cryogenic range −269 to 7 °C using techniques described in section 4.4, and the majority of them (as detailed in table 3.1.2) in an overlap range −75 to 450 °C using techniques described in section 4.3. It is to be noted that all calibration data obtained relevant to batches 150 and 151 suggest that these batches were almost certainly incorrectly labelled in reverse by their manufacturer. It would seem reasonable, therefore, to read 151 for 150 where the latter alloy is referred to subsequently in this Monograph.

Alloys 173 and 221 were also calibrated in the high-temperature range, but the data were not used in the final analysis.

It was this body of calibration data, utilized in the reduction, analysis, and fitting techniques described in section 5, which led to the production of the thermoelectric reference data for Nicrosil and Nisil presented in section 7.

Principal reliance was placed in the final data analysis on three batches of Nicrosil (171, 182 and 191) and on three batches of Nisil (224, 231 and 240). Nicrosil 191 and Nisil 240 were selected for the generation of the final functions and tables. The rationale of this choice is developed in section 7.1.

## 4. Experimental Methods for Establishment of Thermoelectric Reference Data

### 4.1 General

Detailed calibrations were carried out in the range −269 °C to 1300 °C using calibration equipment located in laboratories of NBS at Boulder, Colorado and Gaithersburg, Maryland. Calibrations of the smaller diameter wires were made in the range −269 °C to 7 °C in the Cryogenics Division at Boulder. In the Heat Division at Gaithersburg, the larger diameter wires were calibrated in the high temperature range 100 °C to 1300 °C; in addition, calibrations of the smaller diameter wires were made in an overlapping temperature range −75 °C to 450 °C. The calibration methods employed for these three temperature ranges are summarized in the following subsections. This phase of the project was undertaken during the period July, 1973 through August, 1974 and the experimental work at Gaithersburg was done, for the most part, prior to that at Boulder.

### 4.2 High Temperature Range (100 to 1300 °C)

In this range the thermal emf's of 1.63 mm diameter Nicrosil and Nisil wire samples were measured at 50 °C intervals against platinum reference-wires whose values of thermal emf were known relative to Pt–67. Standard Pt–10%Rh/Pt thermocouples were used to determine the temperature of the measuring junctions of the test wires, and the platinum thermoelement of the thermocouples served as the reference wire. Testing was done in laboratory tube furnaces. The nickel-chromium tube furnace described in NBS Circular 590 [Roeser and Lonberger, 1958] was used between 100 and 1000 °C and a furnace with a tubular silicon carbide heater [Burns and Gallagher, 1966] was used between 800 and 1300 °C.

A number of the nickel-base alloy wires, usually six, were tested at the same time. Before any test-thermocouples were made up, the wire samples were electrically annealed in air for a half hour, the Nicrosils at 850 °C and the Nisils at 800 °C. They were first assembled in multi-bore sintered alumina tubing and welded together with an oxygen-gas torch to form a common junction. The measuring junction of a standard thermocouple was then welded to the common junction with an electric spot welder. So as to minimize contamination of the standard thermocouple during these tests, it was protected by a double-bore alumina insulating tube and an outer silica glass tube to within a few millimeters of the measuring junction, and the ends of the tubes were sealed to the thermocouple by a small amount of borosilicate glass. The test-wires and standard thermocouple were inserted directly into the nickel-chromium tube furnace, but in the higher temperature furnace they were protected by a closed-end recrystallized alumina tube that was positioned inside the silicon carbide heater so as not to be in contact with it. The temperature was regulated by manually controlling the power to the furnaces with adjustable transformers. The thermal emf of the standard thermocouple and that of the nickel-base alloy wires versus the platinum reference wire were measured simultaneously by the two-potentiometer method [Roeser and Lonberger, 1958]. All calibration runs were taken with increasing temperature and the reference junctions of the test-wires and standard thermocouple were maintained at 0 °C in ice baths.

As indicated in table 3.1.2, twenty of the prototype alloy melt batches were tested by this method, ten of Nicrosil and ten of Nisil. Altogether, corresponding values of emf and temperature were obtained for 18 Nicrosil wires and 20 Nisil wires. With a few exceptions, two samples of wire were used from each melt batch.

For the tests described in this section, the emf measurements were made with calibrated K–3 type potentiometers. The K–3 potentiometers were calibrated in our laboratory (NBS) by intercomparison with a calibrated six-dial laboratory potentiometer having a resolution of 0.01 μV and a limit of error not exceeding ±(0.002% of voltage measured+0.1 μV). A history of such calibrations indicated that voltages could be measured with these K–3 potentiometers with an uncertainty of not more than ±(0.005% of voltage measured+0.3 μV) between 0 and 16 mV and ±(0.005% of voltage measured+2 μV) between 16 and 40 mV.

The Pt–10%Rh/Pt thermocouples employed in these tests were calibrated in our laboratory by the fixed point method [Roeser and Lonberger, 1958], at the outset of the project, and met the requirements of the IPTS–68 for standard thermocouples [CIPM, 1976]. They were tested at the freezing points of zinc, antimony, silver, and gold where the calibrating temperatures were realized in metal freezing-point cells that were essentially the same in design as those described by Evans and Wood [1971]. Corresponding values of emf and temperature for the standard thermocouples in the range 630.74 °C to the gold point (1064.43 °C) were obtained according to the IPTS–68 [CIPM, 1969]. Values outside of this range were interpolated or extrapolated by using the new international reference table for the Pt–10%Rh/Pt thermocouple [Bedford et al., 1972] in conjunction with a deviation curve constructed from the calibration data. Above the gold point, the deviation curve was linearly extrapolated , while below 630.74 °C, it was represented by a quadratic equation fitted to the deviations at the zinc point and at 630.74 °C and constrained to produce 0 μV at 0 °C. The uncertainties in the values are estimated not to exceed 0.3 °C in the range 0 to 1064 °C and then increase to not more than 1.5 °C at 1300 °C. The standard thermocouples were checked periodically for changes in their calibrations by intercomparing them with other, less frequently used, Pt–10%Rh/Pt thermocouples. These checks were performed in the same furnaces, at the same immersions, with the same measuring instruments, and by the same general measurement techniques as those used for testing the nickel-base alloy wires.

### 4.3 Overlap Temperature Range (−75 to 450 °C)

The thermal emfs of 0.32 (or 0.25) mm diameter Nicrosil and Nisil wires versus platinum reference-wires, whose values of thermal emf were known relative to Pt–67, were measured at 25 °C intervals from −75 to 100 °C and then at 50 °C intervals from 100 to 450 °C. For these measurements, a standard platinum resistance thermometer (SPRT) was used to determine the temperatures of the measuring junctions. A cryostat (below 0 °C), together with a series of stirred liquid baths (above 0 °C), provided the uniform temperature media for this purpose. A stirred water bath was used from 25 to 75 °C. Two different oil baths were used above 75 °C; one between 100 and 200 °C and the second between 200 and 300 °C. Above 300 °C, a stirred molten-tin bath was used. The tin bath has eleven 9 mm i.d. thermometer wells of cold rolled steel equally spaced on a 6.5 cm diameter circle. The salient features of these calibration baths are described in NBS Monograph 150 [Wise, 1976].

The wire samples used in both this temperature range and the cryogenic temperature range were taken from the inside ends of 20-meter lengths of annealed wire which had been removed from the start and finish of the wires on the spools furnished by the various manufacturers.

Prior to the tests in this range, the wire samples were annealed in air for a half hour at 650 °C. For testing, three of the nickel-base alloy wires were assembled with a platinum reference-wire in a four-bore alumina insulating tube. A common measuring junction was formed between the wires by using the welding procedures described in the previous section. The insulated wires were then placed in a closed-end Pyrex glass protecting tube of 6 mm o.d. and 4 mm i.d. Up to four such wire assemblies were tested at a time. In the water, oil, and molten-tin baths, the wire assemblies and the SPRT were immersed about 40 cm below the surface of the bath liquid. The wire assemblies were positioned so that their measuring junctions were at about the same depth as the mid-point of the thermometer resistor. The distance between any assembly and the SPRT was less than 6 cm. In the cryostat, the wire assemblies and the SPRT were equally spaced on a 3 cm diameter circle and were immersed about 25 cm in the bath liquid. The temperature uniformity in each bath was checked by probing the working area with three SPRT's. These checks indicated that under the conditions of test, the measuring junctions of the wires and the thermometer resistor could be expected to be at the same temperature to within about 10 mK in the cryostat, the water bath, and the oil bath used to 200 °C; to within 30 mK in the oil bath used above 200 °C; and to within 75 mK in the tin bath.

The calibration points were taken in order of increasing temperature during these tests, and the reference junctions of the wires were maintained at 0 °C in ice baths. The resistance of the SPRT was determined at the triple point of water [Riddle et al., 1973] both before and after use in each of the calibration baths. G–2 type Mueller bridges, which were calibrated in our laboratory by the method described in Appendix H of NBS Monograph 126 [Riddle et al., 1973], were used to measure all SPRT resistances. The values of thermal emf were measured with a six-dial laboratory potentiometer that had a resolution of 0.01 μV and a limit of error of not more than ± (0.002% of voltage measured +0.1 μV).

The SPRT's used in this work were calibrated by the NBS Resistance Thermometer Calibration Laboratory. The uncertainties of the calibrations of the SPRT's are estimated not to exceed 3 mK in the range −75 to 400 °C. The calibration methods employed, as well as the equipment and the measurement uncertainties, are discussed in detail in NBS Monograph 126 [Riddle et al., 1973].

By the method described in this section, corresponding values of emf and temperature were obtained for 14 Nicrosil wires and 16 Nisil wires. At least two samples of wire were tested from each of thirteen melt batches denoted in table 3.1.2.

### 4.4 Cryogenic Range (−269 to 7 °C)

The apparatus was essentially the same as that used earlier for cryogenic calibrations [Sparks et al., 1972]; the main modifications were in the external wiring and instrumentation. The apparatus has been described in detail previously, so that the discussion below is a modified review.

A schematic diagram of the cryostat used to determine the thermal voltage for temperatures between 4 and 280 K (−269 to 7 °C) is shown in figure 4.3.1. The principal parts are labelled UPPER CHAMBER and LOWER CHAMBER. The two chambers are connected by a thermal stand-off tube which serves as a wire duct and allows gas transfer from the lower to the upper chambers. During operation the lower chamber contains the cryogenic liquid. The cryogen serves as the reference junction bath for the thermocouples, provides a source of refrigeration for the upper chamber, and serves as a heat sink for all wires that are in the upper chamber. The upper chamber contains a heavy (∼ 10 kg) copper block. The measuring junctions of the thermocouples are thermally anchored to this block. A stable temperature gradient is established between the reference junctions and the measuring junctions by balancing the refrigerator power from the boiling reference cryogen with the power supplied to a heater coil wound on the copper block.

The upper and lower cryostats are completely contained in a vacuum chamber. The vacuum chamber is, in turn, totally immersed in liquid nitrogen. In addition to the vacuum insulation and liquid nitrogen shield, radiation shields have been wrapped on the upper and lower chambers and on the inner surface of the vacuum chamber. The radiation shields consist of layers of aluminum foil separated by balsa wood strips. The insulating vacuum is maintained at approximately 700 μPa by a 20 L/s diffusion pump. All vacuum seals are made using a low melting point solder in the flange and trough arrangement. The outer vacuum chamber seal is effective at ∼76 K, while the seals on the two inner cryostats are used down to 4 K. Seals of this sort require no heavy flange and are made at low enough temperatures that there is little danger of overheating nearby primary thermometers.

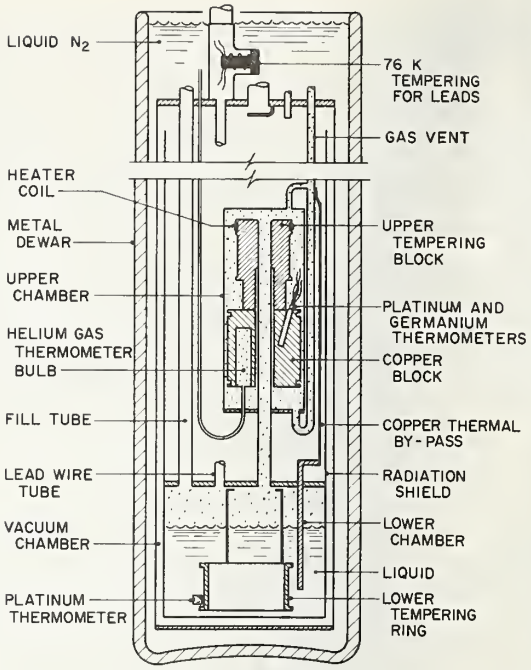


FIGURE 4.3.1 *Schematic diagram of cryogenic thermocouple calibration apparatus.*

It is imperative that the upper chamber be isothermal; temperature fluctuations of the measuring junctions of the thermocouples have to be minimized, since approximately twenty minutes is required to make the necessary measurements at each temperature gradient. Energy flow into the upper chamber is controlled as follows:

(i) All wires coming into the system are first brought to 76 K by thermal attachment to the liquid nitrogen shield. They are then thermally anchored in the reference liquid before going into the upper chamber.
(ii) The gas vent line for the inner chambers is in the proximity of the upper chamber. Since the vent line is in contact with the liquid nitrogen shield, it could be warm relative to the temperature of the upper chamber. A heavy copper thermal bypass was installed to transfer any excess energy to the reference liquid in the lower chamber without coming near the upper chamber.
(iii) Radiative heat transfer to the copper block is essentially eliminated by placing a concentric thermal shield between the block and the walls of the upper cryostat. The temperature of the shield is regulated by supplying current to a heater coil on the upper chamber walls. The temperature difference between the block and shield was never greater than 0.05 K while taking the data reported in this Monograph.

The temperatures of the measuring junction block and of the thermal shield surrounding the block are controlled automatically. The controllers used are solid-state devices designed specifically for low power (10 W maximum), high stability applications. For the block heater, either a platinum or germanium resistance thermometer is used as a sensor. A bucking voltage corresponding to the desired thermometer resistance is set on a potentiometer; the controller senses the misbalance between the potentiometer setting and the thermometer voltage and supplies power to the block heater until a null situation is achieved. The temperature drift of the block during a one hour run is nominally between 3 and 5 mK. A separate power supply is used for the shield heater; its control sensor is a four-junction differential thermopile installed between the block and the shield.

The pressure above the reference cryogen is manostatically controlled when using liquid nitrogen. Pressure control is such that the temperature drift of the reference liquid is less than 3 mK/h, as determined from readings of a calibrated platinum resistance thermometer in the reference liquid. This temperature stability corresponds to less than 65 Pa pressure drift during the one hour runs. When liquid helium is used as the reference liquid, the system is opened to atmospheric pressure and the temperature is determined by reading the barometric pressure. The maximum pressure variations observed during a single testing period of one hour are usually less than 120 Pa, which corresponds to a temperature change of 1.4 mK in the liquid helium reference bath.

Two types of resistance thermometer are used to determine the temperature of the measuring junctions of the thermocouples. Capsule type platinum resistance thermometers are used between 20 and 280 K; germanium resistance thermometers are used below 20 K. For this research, one thermometer of each type was calibrated at NBS, Gaithersburg. The ice-point resistance, $R_0$, for the platinum thermometer was subsequently monitored by measurement at the triple point of water. The remaining thermometers are used as sensors for the heater control system. The thermal resistance between the thermometers and the block is reduced by wrapping each thermometer with layers of 25 $\mu$m thick aluminum foil and then removing one layer of foil at a time until a snug fit is obtained between the thermometers and the thermometer wells.

The room temperature segments of the copper wires which connect the measurement system to the voltage sensing devices enter the system through a wax seal. The temperature of these wires is subsequently reduced to liquid nitrogen temperature by wrapping them on an 11 mm diameter copper rod which is in intimate contact with the liquid nitrogen shield. The wires are then drawn into the reference liquid in the lower chamber. Approximately one meter of each wire is wrapped on the copper cylinder below the reference cryogen level in the lower chamber. This is done to ensure that the wires are at the temperature of the reference cryogen before being taken into the upper chamber. The wires are then taken into the upper chamber via the thermal stand-off tube connecting the chambers. Approximately one meter of each wire is wrapped on the upper tempering block, which is made of copper. Each of the 21 thermocouple test wires installed in the apparatus for a calibration run is similarly anchored to the copper block in the upper chamber and to the copper cylinder in the reference liquid in the lower chamber. All of the test wires are brought together to form a common measuring junction that is thermally tied to the copper block, but is electrically isolated from it. The thermocouple reference junctions, which are made by soldering the copper extension wires to the test wires, are electrically insulated from one another and are in good thermal contact with the reference liquid. It is important to note that thermal gradients across the junctions (both measuring and reference) are minimized by carefully bringing all wires to the same temperature as far back from the junctions as possible.

As mentioned above, the wires were thermally anchored over a length of about one meter. A thermal analysis indicated that this length is more than should be necessary even under more unfavorable temperature conditions. However, since our thermocouple test wires had various diameters, thermal conductivities, and insulations, we used a conservatively calculated length.

For these experiments, the potentiometer and resistance bridge used previously was replaced by a '5½' digit electronic multimeter. It worked extremely well, being both more convenient and much more rapid than the previous setup. After calibration, and taking care when changing ranges to not overload the input, it was more accurate, by a very slight amount, than the thermoelectric system itself. Its precision was slightly less than 0.1 $\mu$V, sufficient for these measurements.

## 5. Mathematical Methods and Data Analysis

### 5.1 Graph Theory Representation

Our method of data acquisition at cryogenic temperatures was designed to take advantage of the large amount of partially redundant information available. The common junction allows many different combinations to be measured. Concepts derived by analogy from the connectivity of paths in graph theory are used to determine optimum experimental procedures. As a simple illustration of how graph theory is applied, consider the situation where one is to intercompare some property of two different objects where two other intermediate objects are also available. Graphically this situation can be represented as in figure 5.1.1. In this figure, the objects are represented by the vertices and the comparison of some property between objects is represented by the connecting lines. For example, the comparison '*d*' might represent the difference in weight between objects *A* and *D*. In applying graph theory to thermoelectric measurements, the vertices represent the thermocouple test wires and the connecting lines represent the thermal voltages generated by a given temperature gradient. The thermoelectric voltage between $A$ and $C$ in figure 5.1.1 would be determined by (1) measuring $c$, that is, a direct measurement of the desired voltage, (2) measuring the thermal voltages $a$ and $b$ and combining these data algebraically, and (3) measuring the thermal voltages $d$ and $e$ and similarly combining these data. The algebraic combination of $a+b$ and $d+e$ yield two independent determinations of the desired voltage, equivalent to $c$. The final determination of the voltage (A−C) is given by

$$e_{\text{calc}} = (A-C) = [2c + (a+b) + (d+e)]/4.$$

The measurement $c$ is given a weight of 2, since it involves only one experimental determination, whereas the other two measurement paths both require two readings. The estimate of the standard deviation for $(A-C)$ is given by

$$S^2 = \{2(e_{\text{calc}} - c)^2 + [e_{\text{calc}} - (a+b)]^2 + [e_{\text{calc}} - (e+d)]^2\}/3.$$

The advantages of taking data in this way are that measuring instrument errors are randomized, any subconscious operator prejudice is eliminated, and spurious voltages in the lead wires are randomized. Since the magnitudes of $a$, $b$, $c$, $d$, and $e$ usually vary considerably, the readings or the dial settings of the measuring instrument would also be considerably different. Thus, any dial errors which exist are randomized by this method. These random errors would then appear as scatter in the data and would be accounted for in the variance calculated from the above equation.

Since the potentiometer dial or multimeter readings vary a great deal and the order of readings may be random, the chance for subconscious operator prejudice is minimized. In order to influence the readings in a systematic way, the operator would have to algebraically combine very different numbers which are not necessarily taken in adjacent readings. This is not done subconsciously, even on the simple four object system being considered here. On the other hand, if multiple readings are taken of the same quantity, there is a strong tendency to produce data which are biased in a systematic way.

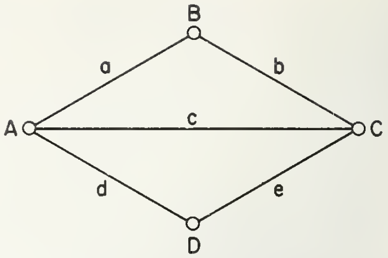


FIGURE 5.1.1 *Four-object measurement graph.*

Spurious voltages in the extension wires are also randomized by using the graph theory method. Consider a three wire system such as that which would result if the $D$ wire were eliminated from figure 5.1.1. Assume the number we actually want is $(B-C)$. This is the thermoelectric voltage generated by the thermocouple made from materials $B$ and $C$ when a thermal gradient, $\Delta T = T_1 - T_2$, exists. The number which is actually measured is $b$ which includes the spurious voltages generated in the extension wires to both $B$ and $C$. If the spurious voltages $\delta_{Bi}$ and $\delta_{Ci}$ are zero or are at least known, then the true value of $(B-C)$ may be determined. The voltages $\delta_{Bi}$ and $\delta_{Ci}$ can be determined by an isothermal test where $T_1 = T_2$. When $T_1 = T_2$, $(B-C) = 0$ and $b = (B-C) + \delta_{Bi} + \delta_{Ci} = \delta_{Bi} + \delta_{Ci}$. However, this determination of the spurious voltages is valid only when the thermal gradients in the system are the same as when the isothermal test was made. In many experimental situations this approach to the spurious voltage problem is not practical. The only other solution is to randomize these voltages so that they appear as scatter in the experimental data and are therefore included in the estimate of the variance, $S^2$. The graph theory approach does allow these voltages to be randomized. Suppose, for instance, that we wish to determine $(B-C)$ in figure 5.1.1. The voltages $a$, $b$, and $c$ would then be measured.

$$a = (B-A) + \delta_{A1} + \delta_{B1}$$

$$b = (B-C) + \delta_{B2} + \delta_{C1}$$

$$c = (A-C) + \delta_{A2} + \delta_{C2}$$

$$b_{\text{calc}} = [b + \tfrac{1}{2}(a+c)]/3/2 = \frac{2b+a+c}{3}$$

$$b_{\text{calc}} = \frac{[2(B-C) + (B-A) + (A-C)]}{3} + \frac{\delta_{A1} + \delta_{A2} + \delta_{B1} + 2\delta_{B2} + 2\delta_{C1} + \delta_{C2}}{3}$$

If the spurious conditions are stable, i.e., the measurements are made rapidly enough to ensure that the system gradients haven't changed,

then $\delta_A = \delta_{A1} = \delta_{A2}$, $\delta_B = \delta_{B1} = \delta_{B2}$, and $\delta_C = \delta_{C1} = \delta_{C2}$

and $$b_{\text{calc}} = \frac{[2(B-C) + (B-A) + (A-C)]}{3} + \tfrac{2}{3}\delta_A + \delta_B + \delta_C.$$

If the more common procedure of multiple readings of $b$ were used, $b$ would be measured, say, 3 times:

$$b_1 = (B-C)_1 + \delta_B + \delta_C,$$

$$b_2 = (B-C)_2 + \delta_{B1} + \delta_{C1},$$

$$b_3 = (B-C)_3 + \delta_{B2} + \delta_{C2}, \text{ and}$$

$$b_{\text{calc}} = \frac{[(B-C)_1 + (B-C)_2 + (B-C)_3]}{3} + \frac{\delta_B + \delta_C + \delta_{B1} + \delta_{C1} + \delta_{B2} + \delta_{C2}}{3}.$$

Again, assume stable spurious conditions for the time required to determine $b$ three times. Then $\delta_B = \delta_{B1} = \delta_{B2}$, $\delta_C = \delta_{C1} = \delta_{C2}$, and $b_{\text{calc}} = \overline{(B-C)}_{1,2,3} + \delta_B + \delta_C$.

The tendency to randomize dial errors and to eliminate operator prejudice is illustrated by comparing $b_{\mathrm{calc}}$ from the graph theory method and from the multiple readings method. More dials are probably changed in determining $(B-C)$, $(B-A)$, and $(A-C)$ than are changed in determining $(B-C)$ three times. The subconscious operator prejudice is reduced by having to combine the two readings $(B-A)$ and $(A-C)$ to get the independent determination of $(B-C)$.

The third and perhaps the most important advantage of the graph theory approach to the measurement of thermocouple outputs is the randomization of spurious voltages in the extension wires. These errors would not be accounted for, i.e., they would be systematic, if the multiple reading approach is utilized. This is shown in the calculation of the estimate of variance for the two methods:

Graph theory:

$$b_{\mathrm{calc}}=\frac{[2(B-C)+(B-A)+(A-C)]}{3}+\frac{\delta_{A1}+\delta_{A2}+\delta_{B1}+2\delta_{B2}+2\delta_{C1}+\delta_{C2}}{3}$$

$$S^{2}{}_{b_{\mathrm{calc}}}=\{2(b_{\mathrm{calc}}-b)^{2}+[b_{\mathrm{calc}}-(a+c)]^{2}\}/2;$$

now assume that the only cause of variation is the spurious voltages

$$S^{2}{}_{b_{\mathrm{calc}}}=1/3(\delta_{A'}+\delta_{B'}-\delta_{C'})^{2}$$

where $\delta_{A'}\equiv\delta_{A1}+\delta_{A2}$,

$\delta_{B'}\equiv\delta_{B1}-\delta_{B2}$, and

$\delta_{C'}\equiv\delta_{C1}-\delta_{C2}$.

If spurious conditions are constant, $\delta_{B'}=0$, $\delta_{C'}=0$ and $S^{2}{}_{b_{\mathrm{calc}}}=1/3(\delta_{A'})^{2}$.

Multiple measurements:

$$b_{\mathrm{calc}}=\frac{[(B-C)_{1}+(B-C)_{2}+(B-C)_{3}]}{3}+\frac{\delta_{B}+\delta_{C}+\delta_{B1}+\delta_{C1}+\delta_{B2}+\delta_{C2}}{3};$$

$$S^{2}{}_{b_{\mathrm{calc}}}=\{(b_{\mathrm{calc}}-b_{1})^{2}+(b_{\mathrm{calc}}-b_{2})^{2}+(b_{\mathrm{calc}}-b_{3})^{2}\}/2$$

again assuming all scatter is due to spurious voltages, i.e.,

$$(B-C)_{1}=(B-C)_{2}=(B-C)_{3},\ \text{then}$$

$$\begin{aligned}18\ S^{2}{}_{b_{\mathrm{calc}}}=&[-2(\delta_{B}+\delta_{C})+\delta_{B1}+\delta_{C1}+\delta_{B2}+\delta_{C2}]^{2}\\&+[-2(\delta_{B1}+\delta_{C1})+\delta_{B}+\delta_{C}+\delta_{B2}+\delta_{C2}]^{2}\\&+[-2(\delta_{B2}+\delta_{C2})+\delta_{B}+\delta_{C}+\delta_{B1}+\delta_{C1}]^{2}.\end{aligned}$$

Now if the spurious conditions are constant $\delta_{B}=\delta_{B1}=\delta_{B2}$, $\delta_{C}=\delta_{C1}=\delta_{C2}$, and $S^{2}{}_{b_{\mathrm{calc}}}=0$.

The spurious voltages do not appear in the estimate of the standard deviation when the multiple measurement method is used. They are present but unaccounted for until some estimate of systematic error is introduced.

The graph used to represent the measurements made on the present thermocouple materials is given in figure 5.1.2. The terminology discussed earlier in this section applies to this figure, i.e., materials are represented by the vertices and thermovoltage measurements are represented by lines.

The high temperature data were obtained in the more conventional manner of experimental data design. The lack of graph circuit redundancy was rectified by making measurements on adjacent wires and by carrying out a carefully planned set of statistical imprecision experiments as described below.

Many sources of error can contribute to the inaccuracies in high-temperature calibration of thermocouples. Some general ones include:

operator memory or bias,
instrumental imprecision and inaccuracy,
temporal changes—time of day, week, or time since beginning of experiment, etc.

Other specific sources of errors for these experiments include:

short range inhomogeneities in alloys,
temperature gradients in furnace test zones, and
variations between different furnaces.

Each of the above sources of error was separately tested.

The three general sources were found to be insignificant, or immeasurably small for these tests, about 0.1 to 0.2 μV or less. The three specific sources of error were analyzed at three different temperatures, 425 °C, 825 °C (for both furnaces), and 1225 °C. The latter two sources, though significant (up to 1 μV for some specimens), were overwhelmed by the main source of error, inhomogeneities in the alloys. The voltage variations caused by those inhomogeneities were found to be strongly temperature dependent, with values ranging from about 1 μV near room temperature to almost 5 μV near 1200 °C. These values, though high with respect to the system inaccuracies, are low compared to the thermoelectric instabilities of most

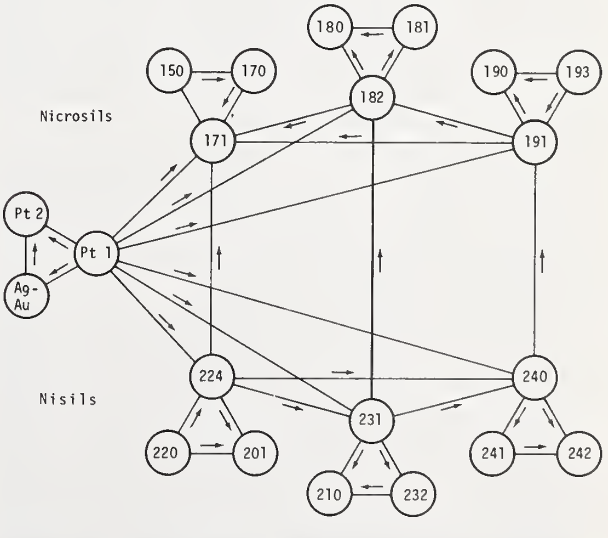


FIGURE 5.1.2 *Measurement graph network for Nicrosil-Nisil thermocouple calibrations.*

thermocouples operated at high temperatures. As discussed in section 7, the experimental data were weighted statistically in order to reflect the wide variations in imprecision.

### 5.2 Data Analysis

Two major steps were needed to transform the experimental data from their original form into their final form. The first operation involved making minor adjustments to the data and forming the desired thermocouple combinations using graph theory considerations. The second step consisted of finding the best analytical representation of the adjusted data and calculating statistical quantities.

The first operation on the data was to apply potentiometer or multimeter dial corrections to all voltage and resistance data.

A calibrated germanium resistance thermometer was used to determine measuring junction temperatures in the range from 4 K to 20 K. The thermometer current was determined by measuring the voltage across a standard resistor which was in series with the thermometer. Corrected voltages from the thermometer and from the standard resistor were used to determine the resistance of the thermometer. A power series representation of $T=f(R)$ for our thermometer was used to determine the temperature. The germanium thermometer had been calibrated by members of the Cryogenic Physics Section in NBS–Washington.

For each calibration run, the time sequence of primary temperature determinations and thermocouple readings was known. Using this information, it was possible to estimate the variable and reference temperatures which actually existed at the time the individual thermocouple voltages were measured. However, in order to take advantage of the graph theory approach to data acquisition, it was necessary that all combinations have the same reference junction temperature and have the same measuring junction temperature. Linear interpolation in the $E_i$ versus $T_i$ data for each thermocouple combination was used to adjust the measuring junction temperature of each thermocouple to the average of the values which were taken for each temperature gradient.

The data obtained at the upper cryogenic and higher temperatures were easier to analyze for temperatures. The cryogenic data above 20 K utilized calibrated platinum resistance thermometers; while the data above 0 °C utilized calibrated platinum-rhodium versus platinum thermocouples.

After these corrections and adjustments had been made, the data represented the thermoelectric voltages of the desired thermocouple combinations with identical reference junction temperatures and identical measuring junction temperatures. For the cryogenic data, graph theory manipulations were then performed with these data to obtain multiple indirect determinations of a given thermal voltage. The general procedure for calculation of thermal voltages is similar to that given in the previous discussion of graph theory. For the high temperature data, graph theory methods were not possible because of the lack of connecting measurement links. Statistical redundancy was obtained by averaging the results on adjacent wires.

The next major step in the data analysis for the high temperature data was to fit the experimental data in order to provide a continuous $E=f(T)$ relationship for each thermocouple combination. The method used to represent the data is a modified Gram-Schmidt approximation. The calculated values for the voltages of each thermocouple combination were approximated by a series of orthonormal polynomials in the $L_2$ norm (least squares), that is,

$$E(T)=\sum_{n=1}^{L} A_n F_n(T)$$

where

$E(T)$ = thermocouple voltage;

$T$ = temperature of the thermocouple measuring junction;

$L$ = the highest order fit—an order high enough to represent the data with no loss of precision, but not so high as to introduce mathematical oscillations;

$A_n$ = constants to be determined by the fitting approximations; and

$F_n(T)$ = orthonormal polynomials, orthonormal on the data points over the range of variation of the independent variable, $T$.

The orthonormal polynomials are taken to be the truncated power series

$$F_n(T)=\sum_{j=1}^{n} C_{nj}\,T^j$$

where the $C_{nj}$ are determined from the orthonormality conditions at the measured temperatures. It should be stressed that the $F_n$ are determined by the values of the independent variable $T$ only. The $F_n(T)$ are therefore the same for all thermocouple combinations which are based on the same set of temperatures.

A common problem in the numerical analysis of data fitting by polynomials is selection of the proper order—an order high enough to represent the data with no loss of precision, but not so high as to introduce mathematical oscillations. This problem is well solved by the method of fitting with orthonormal polynomials. The absolute values of the coefficients $A_n$ decrease with increasing $n$ as long as they are larger than the noise level. However, when the noise level is reached the coefficients are random valued. An inspection of a graph of $|A_n|$ versus number of terms $(n)$ shows the noise level and the probable maximum value of $n$ that is significant. In figure 5.2.1 $|A_n|$ versus $n$ is shown for Nicrosil thermoelement 191X. Incidentally that particular graph is for a cryogenic set of data, but typical high temperature graphs had the same appearance. It is clearly seen that, for that set of data, the sixth and higher order terms were

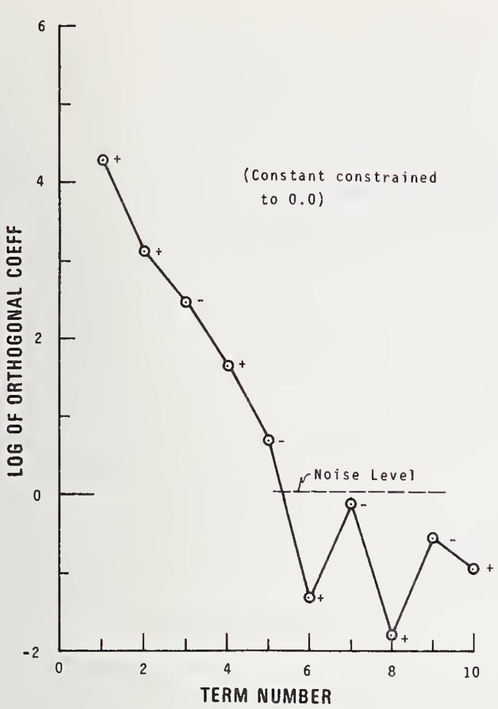


FIGURE 5.2.1 *Convergence of orthogonal coefficients for function fit to measured emf-temperature values for Nicrosil 191X versus platinum,* Pt–67.

random in magnitude, whereas the first five terms decreased rapidly in magnitude. All such representations of well-taken data had that same appearance.

Because of the widely varying reference junction temperatures, the cryogenic data were much more complex to analyze. The method used was based on the following transformation of experimental values. If one assumes that the absolute thermoelectric power $S$ can be represented as

$$S=\sum_{i=1}^{N} A_i T^{i-1}$$

then the total voltage observed between two temperatures will be

$$\Delta E=\int_{T_1}^{T_2} S dT=\sum_{i=1}^{N} A_i \frac{(T_2{}^i-T_1{}^i)}{i} .$$

The cryogenic experimental data were $\Delta E$, $T_1$, and $T_2$ for each run. The basis set for computing a least squares fit was

$$\frac{T_2{}^i-T_1{}^i}{i}$$

rather than $T^i$ as it was for high temperature (and most other) data. After that transformation the data analysis for cryogenic temperatures followed the same lines as it did for the high temperature data.

Another advantage of the orthonormal polynomial representation is that the function may be simplified by lowering the order of the fit without having to determine new $A_n$.

As a convenience to users who wish to use the highest order—and therefore highest precision—fit for a particular thermocouple combination, the orthonormal polynomials and coefficients have been combined to give simple power series coefficients. The power series method of generating the standard data is more straightforward to program for a computer, since it involves only one summation. Using the power series coefficient, the $E=f(T)$ relationships are given by

$$E=\sum_{j=0}^{L} B_j T^j.$$

It should be stressed that the full array of coefficients must be used in the power series method, whereas in the orthogonal representation each order is independent.

## 6. Material Characteristics

In the joint NBS–MRL research program, in addition to the establishment of thermoelectric reference data in the form of temperature versus thermal emf relationships for Nicrosil/Nisil, various studies of quantitative aspects of certain of their physical, chemical and metallurgical properties were also deemed necessary. Selected for study were those properties which are of most practical significance to the manufacturer and the user. The results of these studies are presented in the following.

### 6.1 Solute Sensitivity

#### 6.1.1 General

It has been shown [Wang et al, 1966] that the absolute thermoelectric power, $S$, of binary alloys of nickel is dependent upon the $(s+d)$ electron concentration of the alloy. If the addition of a transition solute atom causes an increase in electron concentration when compared to the matrix nickel, the $S$ of the alloy becomes more negative than that of nickel. On the other hand, if the addition of the transition solute atom causes a decrease in electron concentration, the $S$ of the alloy becomes more positive than that of nickel.

In the case of the Group VI transition elements, which include chromium, the addition of any one of these elements to nickel causes the $S$ to change in the positive direction. The positive maxima of $S$ in such alloys occur at a common electron concentration of about 9.6 $(s+d)$ electrons per atom, the exact value being dependent upon temperature. In the specific case of chromium, a typical value for $S_{\max}$ for Ni–Cr is $+15\ \mu V\ °C^{-1}$ at 800 °C. This value occurs when the electron concentration is 9.66 $(s+d)$ electrons per atom which corresponds to an atomic percentage of chromium of 12.0 and a weight percentage of 10.6.

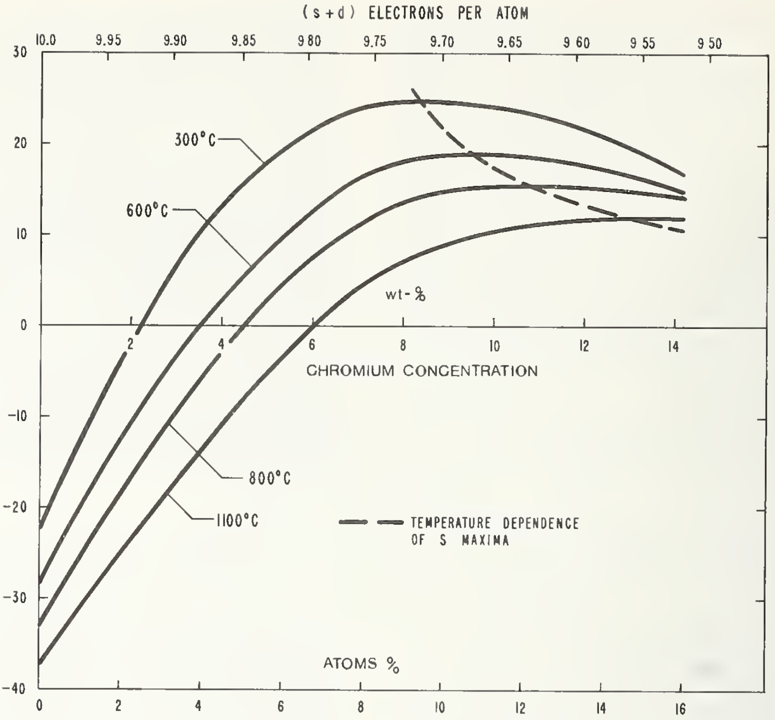


FIGURE 6.1.1.1 *Absolute thermoelectric power (S) of binary nickel-chromium alloys [after Wang et al, 1966].*

Thus, when the $(s+d)$ electron concentration in Ni–Cr increases above a value of about 9.6 electrons per atom, $S$ will change in a negative direction. At a chromium concentration corresponding to the composition of Nicrosil (14.2 wt.−%) it would be expected that the $S$ of Nicrosil, which in addition contains 1.4 percent Si, would be inversely proportional to chromium content. These relationships are summarized in figure 6.1.1.1.

The $S$ characteristics of Ni–Si are quite different from those of Ni–Cr. The first addition of silicon to nickel drives the $S$ of nickel positive, but the effect is much less than that of chromium. The relative effects of chromium and silicon on the $S$ of nickel are shown in figure 6.1.1.2. The addition of 1.4 percent Si to the binary Ni–14¼Cr alloy to form Nicrosil would be expected to drive the $S$ of the binary alloy negative again. The more complex effect of silicon with increasing binary concentration, as in Nisil, can perhaps be attributed to the Curie transformation in Ni–Si.

The effects of both chromium and silicon upon the thermoelectric properties of Nicrosil, and of silicon upon those of Nisil, have been determined in the present project. The principal results of these studies are presented in the following.

### 6.1.2 Nicrosil

From section 6.1.1 it can be seen that the thermoelectromotive force of Nicrosil is inversely proportional to its chromium content. The sensitivity of the thermal emf of Nicrosil to variation in its chromium content was investigated by determining the emf's of Ni–Cr–1½Si alloys of various chromium contents versus Pt–67 in the temperature range 600 to 1300 °C. The compositions of the alloys used are listed in table 3.2.2. The calibration techniques used in these tests were the same as those used in the establishment of the thermoelectric reference data in the high temperature range (ref. section 4.2). It will be seen that the alloys of table 3.2.2 comprise two groups. Alloys 92 to 95, inclusive, have chromium contents greater than the 14.2 wt.−% of Nicrosil, while alloys 96 to 99, inclusive, have chromium contents less than 14.2 percent. The salient results of the measurements on both these groups of alloys are expressed graphically in figure 6.1.2.1.

Using experimental data upon which figure 6.1.2.1 is based, it is possible to estimate the dependence of the thermal emf of Nicrosil upon its chromium content. To a first approximation this can be done, with reference to alloys 92 and 93, by expressing the mean change in thermal emf per 0.1 percent Cr as—

$$[(E_{93}-E_{92})_t/(\mathrm{Cr}_{93}-\mathrm{Cr}_{92})]\times 10^{-1}\mathrm{mV},$$

where $E_{92,93}$ are the thermal emf's in mV of alloys 92 and 93 versus Pt–67 at temperature $t$, and

$\mathrm{Cr}_{92,93}$ are the chromium contents in wt.−% of alloys 92 and 93.

From this expression, the following values are derived—

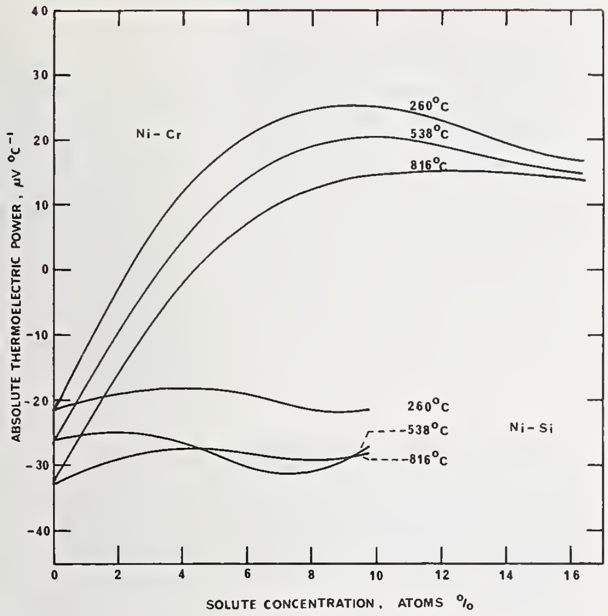


FIGURE 6.1.1.2 *Absolute thermoelectric power* (S) *of binary alloys of nickel with chromium and silicon* [*after Wang et al, 1966*].

| | |
|---|---|
| 700 °C | −0.075 mV/+0.1 percent Cr |
| 800 | −0.080 |
| 900 | −0.086 |
| 1000 | −0.088 |
| 1100 | −0.089 |
| 1200 | −0.088 |
| 1300 | −0.084 |

For a second approximation, reference can also be made to the alloys 98 and 99. By a similar process further values are derived as follows—

| | |
|---|---|
| 800 °C | −0.080 mV/+0.1 percent Cr |
| 900 | −0.082 |
| 1000 | −0.082 |
| 1100 | −0.079 |
| 1200 | −0.076 |

By averaging the two sets of values given above, which cover a range of 13 to 15.8 percent Cr, a further set of values are obtained which can be regarded as the change in thermal emf of the Nicrosil alloy versus Pt-67 corresponding to a variation of 0.1 percent in its chromium content with its silicon content fixed at 1.47 percent.

| | |
|---|---|
| 800 °C | −0.080 mV/+0.1 percent Cr |
| 900 | −0.084 |
| 1000 | −0.085 |
| 1100 | −0.084 |
| 1200 | −0.082 |

The sensitivity of the thermal emf of Nicrosil to variations in its silicon content were investigated by determining the emf's of Ni–14¼Cr–Si alloys of various silicon contents versus Pt–67 in the temperature range 800 to 1200 °C. The compositions of the alloys used are listed in table 3.2.3. The same calibration techniques were used as are mentioned above. The results are expressed graphically in figure 6.1.2.2.

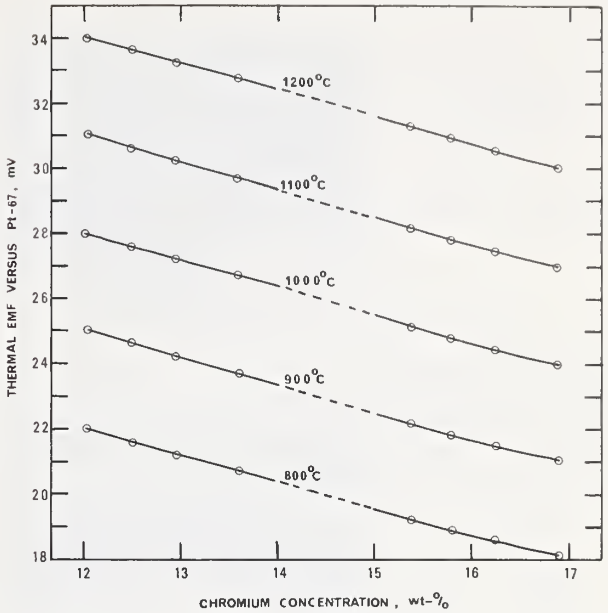


FIGURE 6.1.2.1 *Thermal emf's of* Ni–Cr–1½Si *alloys* (*ref. table 3.2.2*) *of different* Cr *contents versus platinum*, Pt–67.

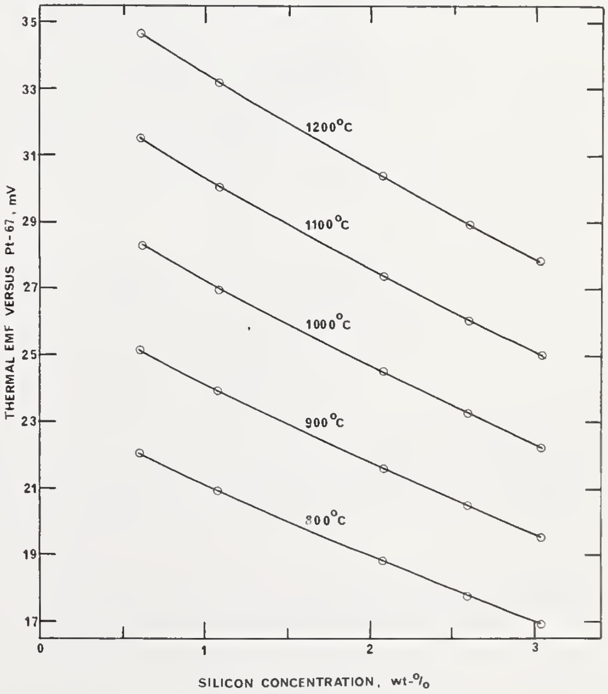


FIGURE 6.1.2.2 *Thermal emf's of* Ni–14¼Cr–Si *alloys* (*ref. table 3.2.3*) *of different* Si *contents versus platinum*, Pt–67.

Using the experimental data upon which figure 6.1.2.2 is based, it is possible to estimate the dependence of the thermal emf of Nicrosil upon its silicon content. This is done by reference to alloys 56 and 57. The change in the emf of Nicrosil per 0.1 percent silicon is given by—

$$[E_{57}-E_{56})_t/(\mathrm{Si}_{57}-\mathrm{Si}_{56})]\times 10^{-1}\ \mathrm{mV}$$

where $E_{56,57}$ in mV are the thermal emf's of alloys 56 and 57 versus Pt–67 at temperature $t$, and

$\mathrm{Si}_{56,57}$ are the silicon contents in wt.–% of alloys 56 and 57.

From this expression, the following values for the change in the thermal emf of the Nicrosil alloy versus Pt–67, corresponding to a variation of 0.1 percent in its silicon content with its chromium content fixed at 14.23 percent, are derived—

| | |
|---|---|
| 800 °C | −0.203 mV/+0.1 percent Si |
| 900 | −0.223 |
| 1000 | −0.242 |
| 1100 | −0.259 |
| 1200 | −0.274 |

### 6.1.3 Nisil

The sensitivity of the thermal emf of Nisil to variation in its silicon content was investigated by determining the thermal emf's of the Ni–Si alloys listed in table 3.2.1 versus Pt–67 in the range 400 to 1200 °C. The same calibration techniques were used as are mentioned above. The results of these studies are expressed graphically in figure 6.1.3.1.

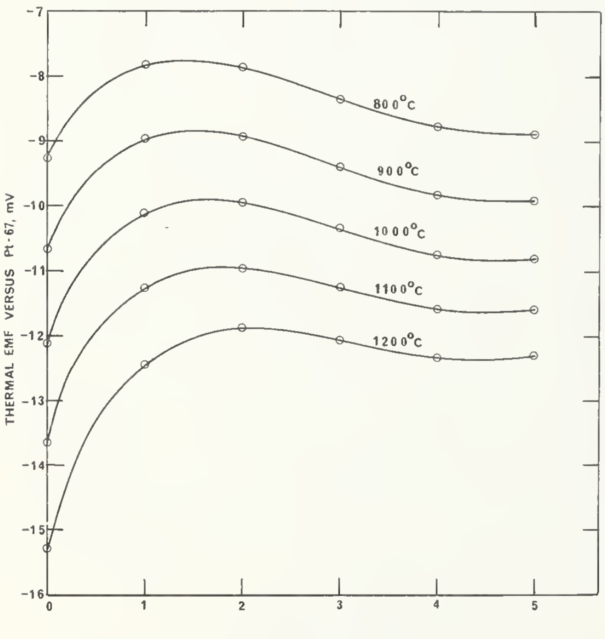


FIGURE 6.1.3.1 *Thermal emf's of alpha* Ni–Si *alloys (ref. table 3.2.1) versus platinum,* Pt–67.

The curves of figure 6.1.3.1 show a series of maxima near a value of 1½ percent Si and a series of minima near a value of 4½ percent Si. For compositions near these values, which appear to be somewhat temperature dependent, the thermal emf's of Ni–Si alloys are relatively insensitive to variations in silicon content. As was proposed in section 2.2.3, the preferred silicon content of Nisil lies between 4¼ percent, which is the level of transition in these alloys from an internal to an external mode of oxidation in air at about 1200 °C, and 5 percent, which is the limit of binary solid solubility of silicon in nickel at room temperature. It is clear from figure 6.1.3.1 that the specific silicon content of Nisil should be 4.4 percent, the mean value of the minima referred to above.

## 6.2 Oxidation Resistance

It is not proposed in this Monograph to present a qualitative description of the mechanisms and microstructures which characterize the oxidation behaviors of Nicrosil and Nisil. The intention in section 6 is to deal only in quantitative terms with those properties chosen for discussion.

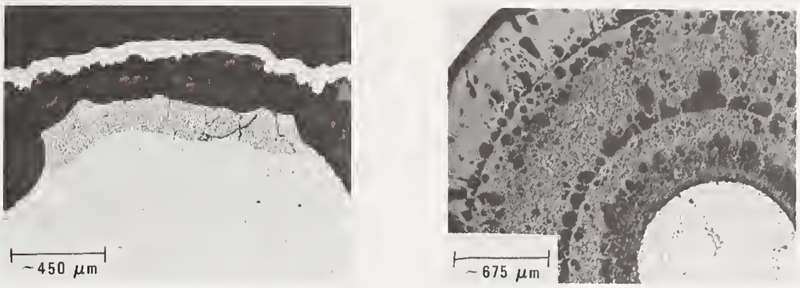
Nevertheless, since the aim in the formulation of the new thermoelements was to develop a thermocouple system which would show greatly enhanced oxidation resistance in air at high temperatures, sufficient evidence is presented here to establish that this aim has been most satisfactorily achieved.

In section 2.1.1 the general characteristics of the air oxidation of both the positive and negative conventional Type K thermcouple alloys are described. In summary, this process results in the formation of—

(i) an outer scale layer of nickelous oxide, NiO,
(ii) an internally oxidized zone in which precipitates of oxides of the solute elements appear in a solute depleted alloy matrix, and
(iii) ternary oxides of the spinel type $AB_2O_4$ which result from solid-state reactions between the NiO and the internal oxides and which appear in the inner layers of the external scale.

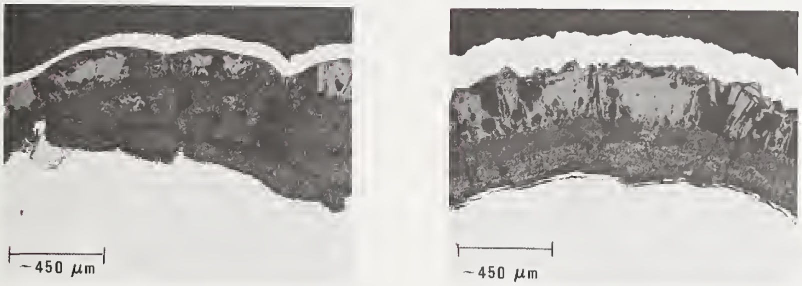
These structures are illustrated in figure 6.2.1.

In section 1.2 it is proposed that the air oxidation resistance of nickel-base thermocouple alloys can be significantly enhanced, particularly at temperatures above 1100 °C, by increasing alloy solute levels above those required to cause a transition from internal to external modes of oxidation, and by selecting solutes which preferentially oxidize to form impervious diffusion-barrier films. It was further suggested that the application of these proposals in the formulation of Nicrosil and Nisil would produce alloys in which the oxidation mechanisms summarized above would be substantially retarded and in which internal oxidation would not occur at all. Figure 6.2.1 shows that Nicrosil and Nisil are thermocouple alloys of such a kind, and that their oxidation resistance is markedly superior to that of the existing Type K thermocouple alloys.



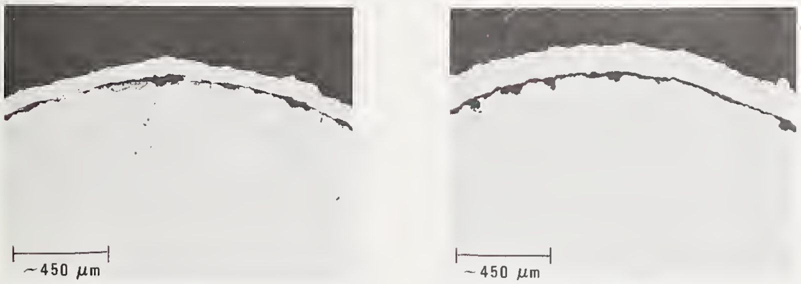
CONVENTIONAL KP (lower Si)

CONVENTIONAL KN



CONVENTIONAL KP (higher Si)

MODIFIED KN



NICROSIL TYPE

NISIL TYPE

FIGURE 6.2.1 *Oxide structures in conventional and modified conventional Type K thermocouple alloys (ref. table 1.1.1) and in Nicrosil and Nisil type alloys.*

The structures result from constant-temperature exposure in air for 800 hours at 1200 °C. The outer white annular zone is a layer of electrodeposited copper [Burley and Dale, 1962] which is applied to support the fragile oxides.

From figure 6.2.1 it can be seen that the internal and external oxide layers which form in the commercial Type K alloys are, in fact, virtually absent from Nicrosil and Nisil. Of particular note is that, for this group of alloys, the least oxide occurs in Nisil at 1200 °C, a temperature at which the conventional Type KN alloy was oxidized right through after about 700 hours. Studies using a coupled electron-probe/computer technique [Burley, 1969] have shown that solute depletion in Nisil, even after very long times of exposure at 1200 °C, is negligible, while depletions in Nicrosil are considerably less than in the conventional positive alloys.

Studies of oxidation mechanisms and kinetics in Nicrosil and Nisil, and of the effects of thermal passivation treatments (ref. section 2.2.4.) on these behaviors, are continuing at MRL.

## 6.3 Thermoelectromotive Force Stability Related to Oxidation Resistance

### 6.3.1 General

In the optimization of the formulations of Nicrosil and Nisil (ref. section 2.2), a main aim was to design positive and negative thermoelements which would be more resistant to air oxidation, and hence show much higher long-term thermal emf stabilities, than existing nickel-base thermocouple alloys. Exhaustive laboratory tests have now been carried out to show whether this aim has been realized. These tests were carried out mainly at the Australian Defence Materials Research Laboratories (MRL), and also at the Australian National Measurement Laboratory (NML).

### 6.3.2 Methods of Test

Two types of experiment were carried out to test the thermal emf stability of Nicrosil and Nisil thermoelements related to their oxidation resistance in air. The initial calibration stability has been determined at NML [Burley and Jones, 1975] by successive calibration runs on prototype samples (ref. section 3.1). The long-term thermal emf stability has been investigated at MRL by measuring thermal emf drifts in similar samples on long exposure in air at constant temperatures up to 1250 °C.

The investigation of the thermoelectric changes occurring during initial heating of the thermocouples utilized a rapid computerized calibration system [Jones and Egan, 1975], and a special aging furnace [Burley and Jones, 1975]. In this automatic system, test thermocouples are compared with a standard noble-metal thermocouple in a programmed furnace [Jones and Egan, 1975] whose temperature is raised to the test temperature and lowered to ambient at rates which allow the thermocouple measuring junctions to remain above 700 °C for only two hours. Successive calibrations in this equipment were used to show changes in the thermal emf outputs of the test thermocouples, and of their positive and negative thermoelements versus platinum, during the initial hours of their use. The calibration runs were alternated with periods of heating at a selected test temperature in the special aging furnace. During aging, the test thermocouples were located at fixed immersion in a specific temperature profile or were totally immersed for isothermal heating. Identical heating of all the elements of the test assemblies, comprising Nicrosil/Nisil and Type K thermocouple wires supplied by Manufacturer A (ref. section 3.1), was ensured by welding their measuring junctions into a common bead into which was peened the measuring junction of a standard noble-metal thermocouple.

The investigation of the long-term drifts in the thermal emf's of Nicrosil and Nisil involved prolonged exposure of 3.3 mm diameter test thermocouples in air at constant high temperatures in a special furnace [Burley and Jones, 1975] in which temperature profiles were readily controlled. The test assemblies comprised prototype Nicrosil/Nisil, Type K, and standard noble-metal reference thermocouples. These assemblies were similar to those used in the initial calibration stability investigation described above, except that the base metal alloys were obtained from a number of different manufacturers. The thermal emf's of all the thermocouples, and of their positive and negative thermoelements versus platinum, were measured initially and at various times during the prolonged high temperature exposure. Two principal aging temperatures are considered here, namely 1000 °C and 1250 °C. The emf measuring systems for both the short-term and long-term tests, and the uncertainty of the measurements involved, are discussed by Burley and Jones [1975].

Prior to the adoption of the final formulation of Nicrosil, long-term stability tests of the type described above were carried out on a group of seven 'Nicrosil-type' alloys having silicon contents ranging from 0.6 to 3.6 percent. The results of the tests on these alloys, which were specially fabricated for the purpose by Manufacturer B (ref. section 3.1), were used to estimate the optimum silicon content of Nicrosil.

In these tests, the Type K thermocouples were found to be quite unstable at 1250 °C, so results for them are presented at an upper test temperature of 1200 °C.

### 6.3.3 Nicrosil versus Platinum

Typical short-term variations with time in the thermal emf outputs of 3.3 mm diameter Nicrosil and Type KP thermoelements versus platinum, on aging in a fixed temperature profile with a maximum of 1250 °C, are summarized graphically in figure 6.3.3.1. It can be seen that the initial emf drift of Type KP thermoelements in this test was about 5 times greater than that of Nicrosil.

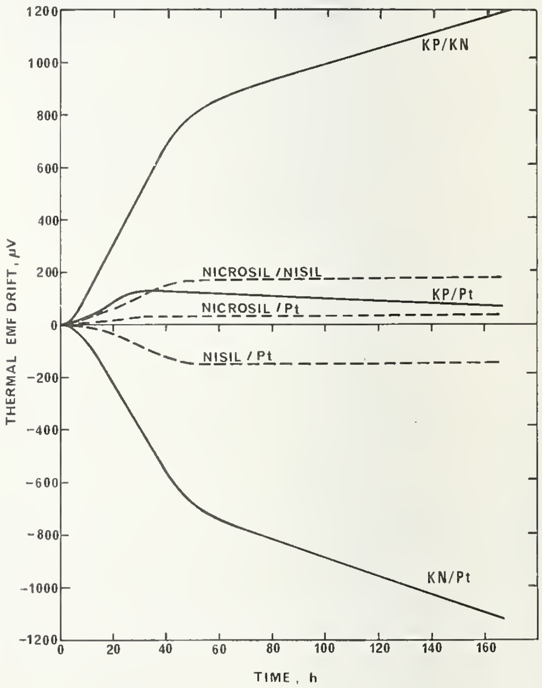
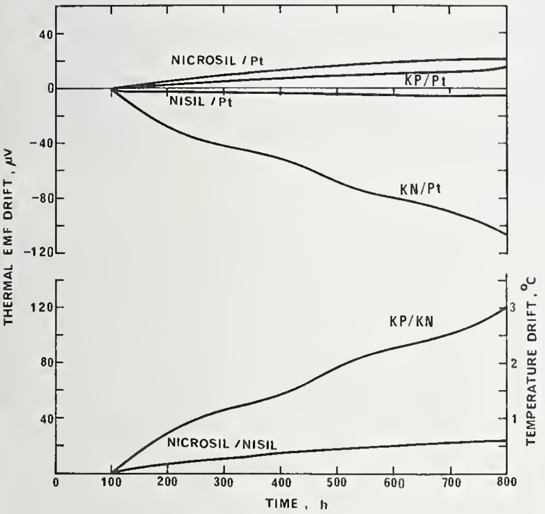


Figure 6.3.3.1 *Short-term changes in the thermal emf outputs of 3.3 mm diameter Nicrosil/Nisil and Type K thermocouples and of their individual thermoelements versus platinum on exposure in air at 1250 °C [after Burley and Jones, 1975].*

Typical long-term drifts in the thermal emf outputs of Nicrosil and Type KP thermoelements versus platinum on long exposure in air are presented graphically in figure 6.3.3.2 (1000 °C) and in figure 6.3.3.3 (1200 °C and 1250 °C). The results are given in terms of deviations of thermal emf's from 'original' values as functions of time at the particular temperature. The 'original' value is taken as the thermal emf output after 100 hours of heating so as to effectively separate long-term emf drifts from short-term calibration changes.



IGURE 6.3.3.2 *Long-term thermal emf drifts in 3.3 mm diameter Nicrosil/Nisil and Type K thermocouples and in their individual thermoelements versus platinum on exposure in air at 1000 °C.*
The drifts are changes from emf output values existent after 100 hours of constant-temperature (1000 °C) exposure in air.

It can be seen that, on long-term exposure at 000 °C in these tests, Type KP and Nicrosil showed little difference in emf stability, but at the higher temperatures Nicrosil (at 1250 °C) was about 20 times more stable than Type KP (at 1200 °C).

The results for the 'modified Nicrosil' alloys containing different amounts of silicon are expressed graphically in figure 6.3.3.4. The dotted curve, which is the mean of the results for the 1.09 and 1.66 percent Si curves, represents virtually ideal isothermal behavior. The maximum positive deviation for this hypothetical case, about 30 μV, occurs after 750 hours of exposure, and the deviation returns to zero after 1600 hours. This curve corresponds to a silicon content of 1.4 percent, which can thus be considered optimum for Nicrosil. The excellent stability of a series of experimental Nicrosil alloys (pre-prototype) containing 1.4 percent silicon is shown in figure 6.3.3.5.

### 6.3.4 Nisil versus Platinum

The short-term variations with time in the thermal emf outputs of the 3.3 mm diameter Nisil and Type KN

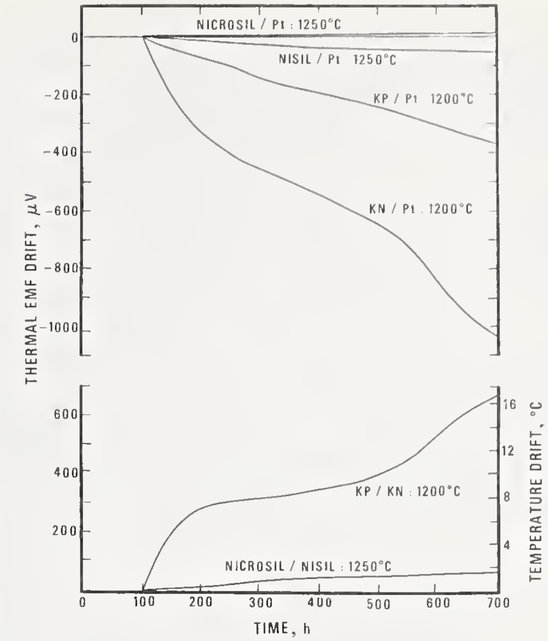


FIGURE 6.3.3.3 *Long-term thermal emf drifts as in figure 6.3.3.2, but on exposure at 1200 °C (Type K) and 1250 °C (Nicrosil/Nisil).*

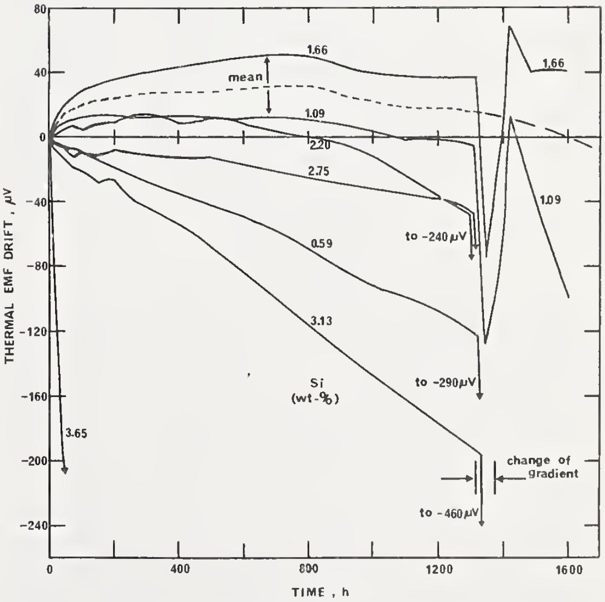


FIGURE 6.3.3.4 *Long-term thermal emf drifts in 2 mm diameter wires of* Ni–16Cr–Si *alloys of various silicon contents versus platinum on exposure in air at 1250 °C.*
The change of gradient is a temporary change to a much steeper temperature profile from the smooth parabolic profile which obtained throughout the 1600-hour test. The significance of the mean curve is described in the text.

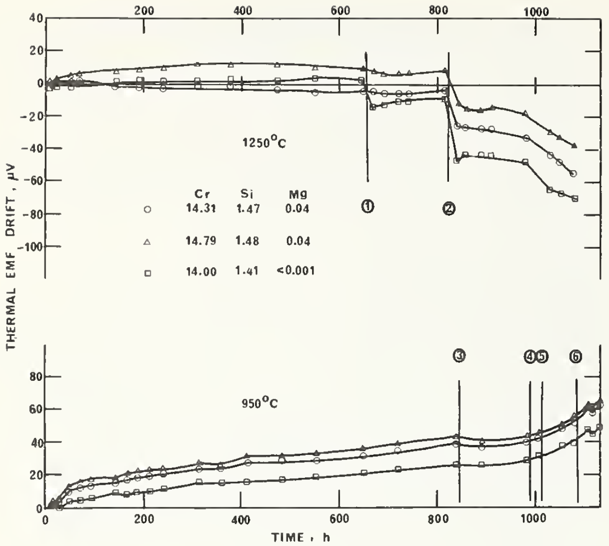


FIGURE 6.3.3.5 *Long-term thermal emf drifts in 3.3 mm diameter experimental Nicrosil-type thermoelements of indicated composition versus platinum on exposure in air at 950 °C and 1250 ° C.*

The number annotations refer to short-term temperature excursions from the test-temperature as follows—

| | | | |
|---|---|---|---|
| (1) | to 1000 °C | (2) | to 800 °C |
| (3) | to 850 °C | (4) | to 600 °C |
| (5) | to 400 °C | (6) | to ambient |

thermoelements versus platinum at 1250 °C are summarized graphically in figure 6.3.3.1. It can be seen that, at the conclusion of the test, Type KN had drifted about 8 times more than Nisil.

Typical long-term drifts in the thermal emf's of the Nisil and Type KN thermoelements versus platinum are presented graphically in figures 6.3.3.2 (1000 °C) and 6.3.3.3 (1200 °C and 1250 °C). In these tests Nisil was about 25 times more stable than Type KN at 1000 °C, whereas Nisil at 1250 °C was about 20 times more stable than Type KN at 1200 °C.

### 6.3.5 Nicrosil versus Nisil

The short-term variations and long-term drifts in the thermal emf outputs of the Nicrosil/Nisil and Type K thermocouples are also presented in figures 6.3.3.1, 6.3.3.2 and 6.3.3.3.

It will be seen that the initial calibration stability of the Nicrosil/Nisil thermocouples in these tests was about 7 times greater than that of the Type K thermocouples.

It will be seen that, on long-term exposure at 1000 °C in these tests, Nicrosil versus Nisil thermocouples were about 5 times as stable as Type K thermocouples. A typical deviation of the Nicrosil/Nisil system at 700 hours was about +25 µV (≅0.6 °C) whereas that of the Type K thermocouples was about +120 µV (≅3 °C). While both the Nicrosil and Nisil thermoelements were stable at 1000 °C, the relative instability of the Type K thermocouples was predominantly due to substantial emf drift in their negative thermoelements.

On exposure at 1250 °C, the emf outputs of the Type K thermocouples in these tests were quite unstable, drifting continuously at the rate of about 2 µV per hour. On the other hand, at 1250 °C the deviation of the Nicrosil/Nisil thermocouples at 700 hours was about +60 µV (≅1.5 °C). By way of further contrast at 1200 °C the emf of the Type K thermocouples had drifted by about +650 µV (≅16 °C) at 700 hours. It is also to be noted that, whereas the positive thermoelements of the Type K thermocouples drifted by more than −350 µV at 1200 °C, the Nicrosil elements at 1250 °C were virtually inert and showed negligible emf changes. Were it not for the fact that the emf drifts in the individual thermoelements of the Type K thermocouples were in the same direction, the net thermocouple drifts would have been even greater, e.g. at 700 hours of exposure at 1200 °C, a −360 µV drift in Type KP and a −1020 µV drift in Type KN resulted in a net +660 µV drift in the combination.

It is also to be noted that the thermoelectric stability of Nicrosil/Nisil thermocouples on long exposure in air at 1250 °C compares favorably with that of noble-metal thermocouples of Type R exposed under the same conditions [Burley and Jones, 1975].

## 6.4 Thermoelectromotive Force Stability Related to Atomic Ordering

### 6.4.1 General

In section 2.1.2 the discussion embodies circumstantial evidence which exists to support a hypothesis that the short-term variations in the thermal emf of Type K thermocouples, which occur in the temperature range ca. 250 to 550 °C, are due to short-range ordering in their Type KP thermoelements.

In the optimization of the formulation of Nicrosil, in section 2.2.2., a complementary aim was to select a solute level of chromium at which thermal emf variations related to atomic ordering were minimal. It was concluded that, in the case of binary alloys of nickel and chromium, this level was about 15½ percent, but when silicon (1.4%) was added to the binary alloy to form Nicrosil, minimal structure related emf variations occurred when the chromium concentration was about 14 percent.

Experiments aimed at determining the susceptibility of Nicrosil to emf instability related to atomic ordering were carried out at NBS during the joint project. The salient results of these tests are presented in this section.

### 6.4.2 Methods of Test

First, a series of tests was carried out to determine the characteristic magnitudes of the short-term order-related variations in the thermal emf of Nicrosil. Alloy wire samples (1.63 mm diam., 14 AWG) of Nicrosil, and also of Type KP for direct and simultaneous comparison, were made up into test assemblies incorporating noble-metal standard thermocouples, similar to those described in section 4.2 for use in the establishment of the thermoelectric reference data. The Nicrosil samples were of prototype alloys supplied by manufacturers A and D (ref. section 3.1). The Type KP alloy, which was a commercial sample selected at random from recently procured stocks of the product of manufacturer A, had virtually the same composition as that of the high-silicon conventional type positive alloy listed in table 1.1.1.

Several samples of each alloy, each of which had different thermal histories, were calibrated in the range 200 to 500 °C using the calibration methods described in section 4.2. The four different thermal histories involved were:

(A) 'As-received': The samples were cut from rolls of wire as-received from the manufacturer: their thermal history was thus related to a manufacturing production heat-treatment which was a brief anneal at high temperature—

(i) "about 30 seconds at 1080 °C" in the case of manufacturer A.
(ii) "a few seconds at 950 °C" in the case of manufacturer D.

Since both of these anneals were followed by a fairly rapid cool to room temperature, some degree of atomic order would have been produced in the Type KP samples. This degree of order would increase on subsequent heating during calibration to some higher time-temperature-dependent degree, and the thermal emf of the Type KP samples would increase correspondingly as a consequence.

(B) 'Metastable': As-received samples were annealed in air for six hours at 1050 °C, and then were drastically water-quenched. It was assumed that the high-temperature anneal would produce a state of quasi-random disorder. The extremely rapid cooling produced by the drastic water-quench ought therefore to retain a metastable quasi-disordered structure in both Nicrosil and Type KP alloys. Subsequent reheating of these samples during calibration would produce large changes in the degree of order in the Type KP alloys and correspondingly large changes in thermal emf.

(C) 'Stabilized by slow-cool': As-received samples were annealed at 1050 °C as in (B), but were very slowly cooled to room temperature in the annealing furnace. While such samples would also develop a quasi-disordered structure during the high temperature anneal, on slow cooling the Type KP samples would assume some temperature-dependent high degree of atomic order as they passed through the virtually time-independent ordering range 575 to 450 °C (referred to in section 2.1.2).

(D) 'Stabilized by aging': As-received samples were annealed and water-quenched as in (B), but were then isothermally aged in air at 480 °C for one hour. As implied in section 2.1.2, this aging treatment generates about the maximum degree of short-range order attainable in alloys of Type KP in a relatively short period of time. It can further be inferred that, even though relatively large increases in thermal emf would occur in the Type KP samples during the aging period, any further variations in emf during subsequent heatings would be quite small provided the aging temperature was not significantly exceeded. This would appear to be the most stable state for Type KP alloys.

In addition to the tests on the thermally-treated samples of Type KP and Nicrosil, a further series of tests was carried out to determine the sensitivity of order-related thermal emf variations in Nicrosil to variations in the solute concentration of its major alloying component, chromium. This was done by calibrating, in the manner described above, the range of Ni–Cr–1½Si alloys of various chromium contents which are listed in table 3.2.2, plus the Nicrosil prototype No. 180 which has a Si content close to the average of the alloys in the table. Samples of each of these alloys were thermally treated by a procedure of the type (B) described above, i.e. a high-temperature anneal and water-quench, in this case at 1000 °C for three hours. This procedure ensured that any short-range order which might develop in these alloys on subsequent heating during calibration, and thus any corresponding variation from initial thermal emf values, would initiate from a ground state of quasi-disorder.

### 6.4.3 Results of Tests

The results of the calibration of samples of thermal history (A), i.e. the 'as-received' samples, are given in figure 6.4.3.1 in terms of the deviation of the calibration values obtained during the cooling portion of the calibration cycle from those obtained during the heating portion. It can be seen that, in comparison with Type KP$_A$, in which order-related changes in emf output up to about 70 $\mu$V occurred, Nicrosil$_A$ was stable within 6 $\mu$V and Nicrosil$_D$ was stable within 10 $\mu$V during the calibration cycle to 550 °C.

The results of the calibration of samples of thermal history (B), i.e. the high-temperature anneal and water-quench, are also given in figure 6.4.3.1. It can be seen that when the quasi-disordered (quenched) samples were heated in a calibration cycle to 550 °C, the consequent development of a high degree of time-temperature-dependent order in Type KP$_A$ produced changes in emf output up to about 60 $\mu$V. On the other hand, identical treatment produced changes in Nicrosil$_D$ not exceeding 10 $\mu$V.

While the type (B) thermal treatment is of little practical significance, in that operating thermocouples are almost never water-quenched, it is of considerable scientific relevance in that it facilitates a determination of the magnitudes of the changes in the thermal emf outputs of Type KP thermoelements corresponding to the development of maximal degrees of short-range order from the quasi-disordered state. It is of considerable significance that, in these tests, such emf changes were of the same order of magnitude as those occurring during the calibration of the as-received samples, a practical procedure of considerable importance.

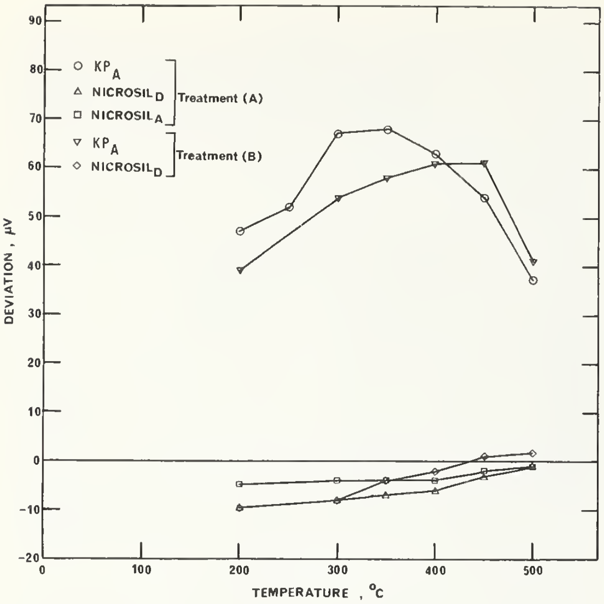


FIGURE 6.4.3.1 *Changes in the calibrations of Type KP and Nicrosil thermoelements versus platinum,* Pt–67, *of thermal histories (A) and (B) (see text), in terms of deviations of the calibration values obtained during the cooling portion of the calibration cycle from those obtained during the heating portion.*

The samples were held at 500 °C (KPA) and 550 °C (Nicrosils) for one hour before cooling them to room temperature.

The results of the calibration of samples of thermal history (C), i.e. high-temperature anneal and very slow cool, are not summarized in graphical form, nor are those for thermal history (D), i.e. the isothermal aging. This is because these treatments allow the development of maximal degrees of short-range order in thermoalloys of Type KP and, since there is little further change in this state of ordering during subsequent heating to 550 °C, the initial calibration remained reasonably stable. For example, the emf differences between the heating and cooling portions of the calibration cycle for the Type $KP_A$ thermoelements did not exceed 5 μV; corresponding differences for Nicrosil thermoelements did not exceed 1 μV. Similar results accrued when the aging treatments were carried out in the temperature profile (maximum value 480 °C) of the calibrating furnace.

It is to be noted that the stability of Type KP thermoelements 'stabilized' by the slow cooling or by aging treatments described above will persist only until such thermoelements are again heated above about 600 °C. When this occurs, further thermal emf variations will accompany subsequent disorder-order reactions as the Type KP alloys are thermally cycled above and below this temperature. On the other hand, all the experimental evidence presented in this section shows that none of the thermal treatments applied produces any appreciable changes in the emf output of Nicrosil when calibrated in the temperature range of interest. This very high degree of structure-related emf stability, furthermore, is not reduced by subsequent thermal cycling above 600 °C. It is concluded, therefore, that Nicrosil is virtually immune from the instabilities of calibration of the kind related to atomic ordering which so plague the Type KP thermoelements.

The results of the experiment to determine the sensitivity of order-related emf variations in Nicrosil to variations in its chromium content are summarized graphically in figure 6.4.3.2. Since the magnitude of emf shift due to ordering is a function not only of chromium solute level but also of temperature and time of calibration, there are a number of different values of shift for each chromium level. The data of figure 6.4.3.2 therefore are shown in the form of an envelope of values with upper and lower bounds defining the maximum and minimum shifts observed for each chromium level. From this graph it can be seen that the optimum chromium content of Nicrosil should be about 14 wt.–%.

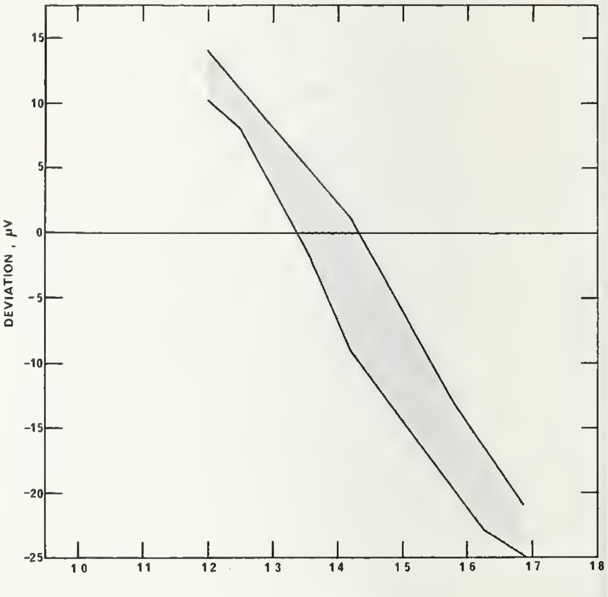


FIGURE 6.4.3.2 *Changes in the calibrations of Nicrosil-type thermoelements of different chromium contents versus platinum,* Pt–67, *(ref. table 3.2.2) as in figure 6.4.3.1.*

The significance of the envelop of values is described in the text.

A similar experiment, using the alloys listed in table 3.2.3 was carried out to estimate the sensitivity of the order-related emf changes in Nicrosil to variations in its silicon content. It was concluded that the sensitivity of such emf changes to variation in silicon content was virtually the same as that for chromium.

## 6.5 Thermoelectromotive Force Stability Related to Plastic Deformation and Annealing

### 6.5.1 General

The thermoelectric properties of metallic materials are affected by plastic deformation. Of considerable practical significance is the deformation produced by the mechanical working of thermoalloys during manufacture, and the change in thermal emf output which this process causes. Of equal significance are the effects on thermal emf produced during subsequent heating by such phenomena as recovery, ordering, recrystallization and grain growth in the crystal structure of the alloy.

Practically all base-metal thermocouple wires are annealed at high temperature as a final stage of manufacture. Such heat-treatments, some examples of which are given in section 6.4.2, are generally considered to stabilize thermal emf's and, according to the ASTM [1974], it is seldom found advisable to anneal wires further before testing and use. Potts and McElroy [1962], however, found that commercial nickel-base thermocouple wires, in the as-received state, were residually cold-worked to the extent of 2 to 5 percent and that, as a consequence, errors of measurement up to one percent could occur. They further found that a major part of this emf shift could be removed by thermal treatments aimed at bringing about recovery and recrystallization, which they state occur in nickel-base thermoalloys in the ranges 250 to 450 °C and 500 to 750 °C, respectively.

No definitive studies of the complex effects of deformation and annealing upon the thermoelectric properties of Nicrosil and Nisil were possible in the time available for the joint NBS–MRL project, but sufficient testing was done to gain preliminary knowledge of the sensitivity of the thermal emf's of the new alloys to these effects.

### 6.5.2 Methods of Test

Two different kinds of experiment were carried out using 1.63 mm (14 AWG) and 0.32 mm (28 AWG) diameter wire samples of prototype alloys from manufacturers A and D, respectively. In the first experiment, several 'as-received' (ref. section 6.4.2) wire samples were strained in tension by different amounts by stretching them in the Tinius-Olsen tensile testing machine located in the Mechanical Properties Section of the Metallurgy Division, NBS Gaithersburg. The strained samples were then calibrated in the range 50 to 450 °C using the calibration techniques described in section 4.2. This was done to determine what effect the tensile plastic deformation had upon the thermal emf's of the wire samples. In the second experiment similar samples were strained in the above manner by elongating them 10 percent (0.32 mm diam. Nicrosil), 15 percent (0.32 mm diam. Nisil), 20 percent (1.63 mm diam. Nicrosil), and 25 percent (1.63 mm diam. Nisil). Each strained sample was then isothermally annealed in air for 30 minutes. The temperatures at which the various samples were annealed ranged from 150 to 950 °C. After they were annealed, the samples were calibrated in the range 50 to 500 °C by the techniques described in section 4.2 to determine what effect high-temperature annealing had upon thermal emf's corresponding to the 'as-strained' condition.

### 6.5.3 Results of Tests

The results of the low temperature calibration of the 1.63 mm diam. 'as-received' samples of both Nicrosil and Nisil, strained by various amounts, are summarized in figure 6.5.3.1. In these tests, the thermal emf of Nicrosil decreased proportionally with strain and temperature up to test maxima of 20 percent and 450 °C, respectively, where the change was −56 μV. Up to this temperature there was no change from this proportionality, indicating that no significant metallurgical recovery had taken place. With Nisil, on the other hand, 20 percent strain produced a maximum increase in emf of only 17 μV at 150 °C, above which temperatures the emf decreased again indicating a quite low-temperature recovery process. Very similar effects were observed in the case of the finer wires of 0.32 mm diameter.

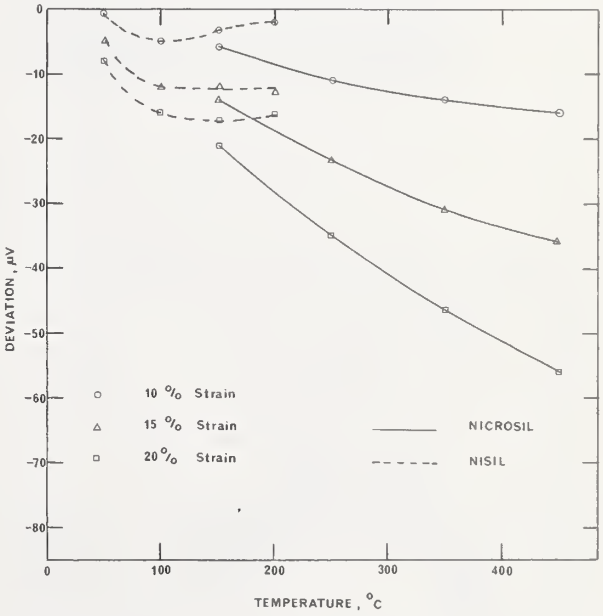


FIGURE 6.5.3.1 *Changes in the calibrations of (1.63 mm diam.) Nicrosil and Nisil thermoelements versus platinum,* Pt–67, *due to tensional plastic deformation.*

The results of the calibration of the strained and annealed samples are given in figures 6.5.3.2 (Nicrosil) and 6.5.3.3 (Nisil). It is to be noted that these graphs are expressed in a different mode from most of those in previous figures. In figures 6.5.3.2 and 6.5.3.3 the abscissas are annealing temperatures, not cali-

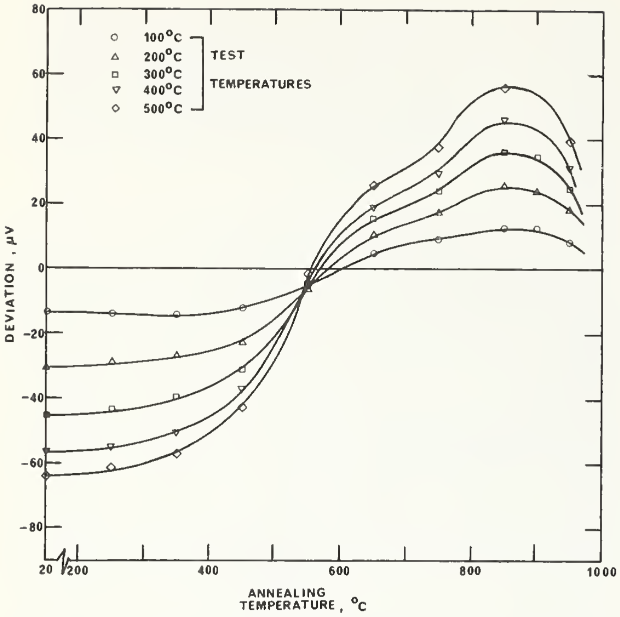


FIGURE 6.5.3.2 *Changes in the calibrations of (1.63 mm diam.) Nicrosil thermoelements versus platinum,* Pt–67, *due to annealing for 30 minutes in air at various temperatures between 150 and 950 °C after tensional plastic deformation to 20 percent strain.*

The values at 20 °C on the abscissa represent the changes in thermal emf on straining from 'as-received values.'

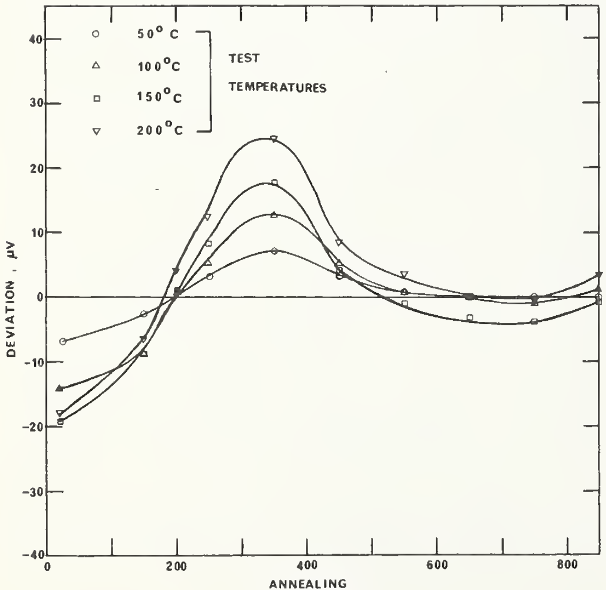


FIGURE 6.5.3.3 *Changes in the calibrations of Nisil thermoelements, as in figure 6.5.3.2, but after 25 percent strain.*

bration temperatures which are represented by the different curves. It will be seen that when Nicrosil was annealed at about 550 °C, its thermal emf's returned to 'as-received' values, namely those which obtained, before straining 20 percent produced decreases up to 63 μV. It seems that the maxima in emf deviations after annealing at 850 °C correspond to the recrystallization phenomenon in Nicrosil. Similar conclusions, with different corresponding temperatures, can be drawn for Nisil. Similar conclusions for both alloys can also be drawn from the results of the tests on the 0.32 mm diam. wires.

## 6.6 Other Physical Properties

In addition to the various thermoelectric properties of Nicrosil and Nisil quantitatively investigated during the joint NBS–MRL project, several other physical property measurements on these alloys have been made independently by other authorities. Of particular interest are those which have been made at Oak Ridge National Laboratory (ORNL), Tennessee, USA. Moore and associates of the Metals and Ceramics Division and the Instrumentation and Controls Division at ORNL have presented the results of their measurements of thermal conductivity, electrical resistivity, and mean coefficient of thermal expansion, on two alloys near the nominal compositions of Nicrosil and Nisil, to the 14th International Thermal Conductivity Conference (Moore et al, 1975). Their results, together with some of the associated discussion, are summarized in this section. All properties are differentiated, as between the Nicrosil- and Nisil-type alloys, with the symbols (+) and (−), respectively.

### 6.6.1 Thermal Expansion (α)

All the ORNL experimental data for α are within ± 3 percent of—

$$\alpha(+) = \left(9.44 + 0.00633T + \frac{815}{T}\right) \times 10^{-6}\ (\mathrm{K}^{-1}) \qquad 400 < T < 1100\ \mathrm{K, and}$$

$$\alpha(-) = (12.2 + 0.0034T) \times 10^{-6}\ (\mathrm{K}^{-1}) \qquad 400 < T < 1100\ \mathrm{K.}$$

Both $\alpha(+)$ and $\alpha(-)$ are about 15 percent below $\alpha$ of Type 304 stainless steel [Touloukian, 1967a], facts which Moore et al attribute as the cause of reduced mechanical compatibility between Nicrosil/Nisil conductors and stainless steel sheathing in mineral-insulated integrally-sheathed thermocouple cable. As a way of overcoming this problem, they advocate the use of sheathing materials with $\alpha$ values near $\alpha(+)$ and $\alpha(-)$. The authors of this Monograph suggest that Nicrosil and/or Nisil themselves might prove to be adequate sheathing alloys for such cables.

### 6.6.2 Electrical Resistivity (ρ)

The ORNL experimental values of $\rho(+)$ and $\rho(-)$, corrected for thermal expansion, are shown in figure 6.6.2.1 as well as those for pure nickel. Since the

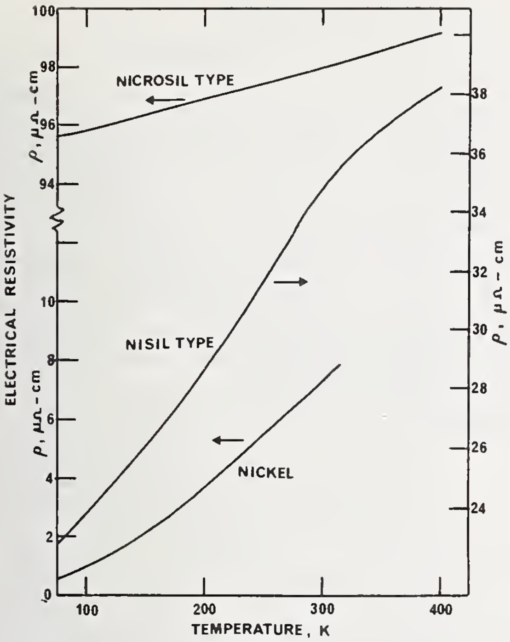


FIGURE 6.6.2.1 *Electrical resistivity of Nicrosil- and Nisil-type alloys compared with pure nickel [after Moore et al, 1975].*
Note scale changes.

values of $\rho(+)$, $\rho(-)$ and $\rho(\mathrm{Ni})$ differ appreciably, the scale of figure 6.6.2.1 is different for each material. The electrical resistivity, $\rho(+)$, of Nicrosil increases smoothly with increasing temperature, $T$, from 80 to 400 K and all data are within ±0.05 percent of

$$\rho(+)=94.79+0.010732T$$

The electrical resistivity of Nisil is a factor of three or four below that of Nicrosil but the slope $d\rho(-)/dT$ is greater than $d\rho(+)/dT$.

It is to be noted that the electrical resistivity of a ferromagnetic, antiferromagnetic, or paramagnetic metal is due to scattering of conduction electrons by several mechanisms. The localized spin model would give

$$\rho(T)=\rho_i+\rho_p(T)+\rho_s(T)$$

where $\rho_i$, $\rho_p(T)$, and $\rho_s(T)$ are due to electron scattering by impurities, lattice vibrations, and disordered spins, respectively. Nicrosil is paramagnetic and, qualitatively, its resistivity can be interpreted as that of a paramagnetic metal where $\rho_s$ is approximately constant and where there is a large $\rho_i$ due mostly to the high chromium content (14¼%). On the localized spin model, $\rho_s$ and $\rho_i$ of Nicrosil should be constant over the measurement range 80 to 400 K since there are no transformations over this range.

The electrical resistivity-temperature dependence of Nisil is similar to that of nickel (ref. figure 6.6.2.1) except that the Curie temperature, $T_c$, is lowered from about 630 K for nickel to about 290 K for Nisil by the addition of silicon (to 4½%). From 80 K to about 290 K, $\rho(-)$ increases rapidly with increasing temperature as the aligned electron spins are thermally disordered. Above $T_c$ the slope of $\rho(-)$ is lower and nearly constant at about 0.035 $\mu\Omega$ cm $K^{-1}$, which is close to the slope of 0.036 $\mu\Omega$ cm $K^{-1}$ for paramagnetic Ni [Touloukian, 1967b].

### 6.6.3 Thermal Conductivity (λ)

The ORNL experimental data for thermal conductivity of Nicrosil and Nisil are presented graphically in figure 6.6.3.1. This figure shows that $\lambda(+)$ is low but relatively uniform from 80 to 400 K, whereas $\lambda(-)$ is much higher and has a distinct break near 300 K. very near the $T_c$ for Nisil.

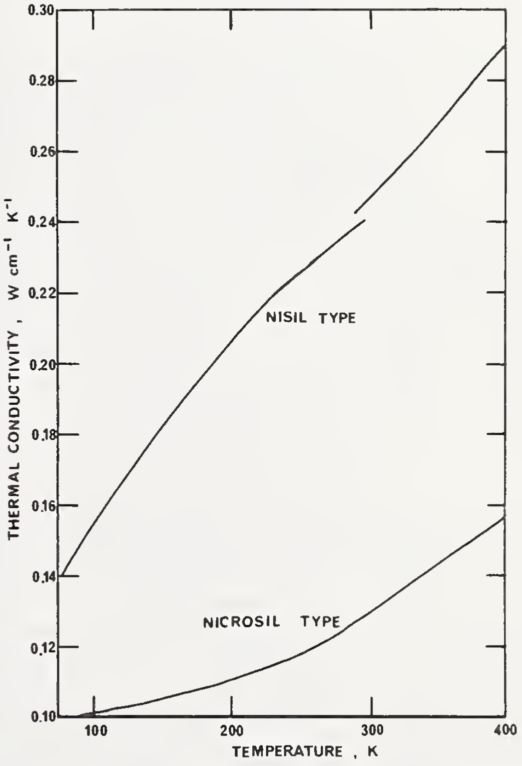


FIGURE 6.6.3.1 *Thermal conductivity of Nicrosil- and Nisil-type alloys from 80 to 400 K [after Moore et al, 1975].*

## 6.7 Size Dependence and Inhomogeneity

For reasons discussed in section 2, and which largely devolve around a small degree of solute depletion in Nicrosil and Nisil on the formation of passive oxide films, the surface layers of wires of these alloys will differ slightly in composition from that of the bulk. Furthermore, there will be a greater concentration of structural imperfections near the surface layers as a result of non-uniform plastic deformation during manufacture. For both these reasons the ratio of disturbed (inhomogeneous) sub-surface volume to bulk volume will be greater in the smaller diameter wires than in the larger. As a consequence, the two wires of different diameter used in the joint project were expected to show different thermoelectric properties. These differences are exemplified for the Nicrosil and Nisil wires in figures 6.7.1 and 6.7.2. The values plotted in these figures were obtained by making direct intercomparisons between *AWG 28* thermoelements and *AWG 14* thermoelements, rather than by calculating them from the less precise calibration data for the thermoelements versus platinum. Similar differences are observed for all base-metal thermocouple wires.

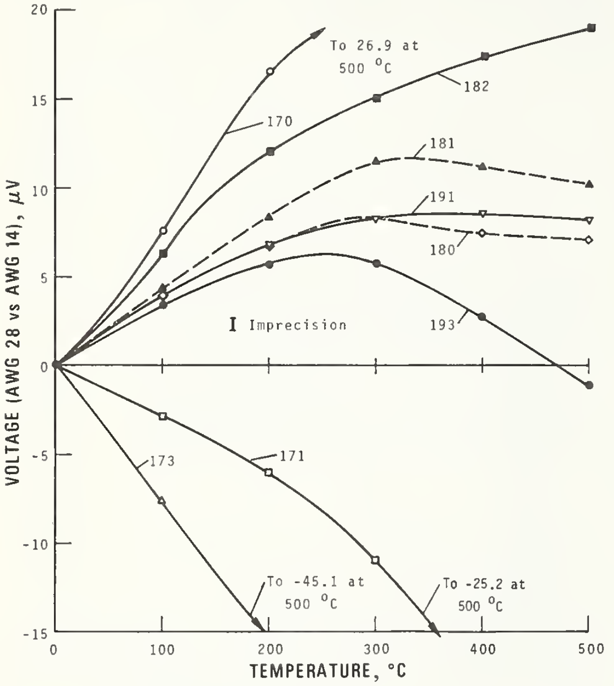


FIGURE 6.7.1 *Effect of size differences for Nicrosil thermoelements.*

It is well known that commercial thermocouple alloys normally have slightly different compositions and imperfections in different lengths from a given coil or spool when received from the manufacturer, and that wires from different melt batches, coils or spools may differ much more. These differences also are represented by different thermoelectric voltages. For the Nicrosil and Nisil prototype alloys, many of these deviations are shown graphically in section 7.2.

## 7. Nicrosil versus Nisil Reference Data

Section 7 is organized as follows: The procedures for selecting and analyzing the experimental data are outlined in section 7.1. The resultant deviations between different specimens are given in the section following that. The heart of the reference data is incorporated in section 7.3, 7.4 and 7.5 for Nicrosil versus Nisil thermocouples, for Nicrosil thermoelements versus platinum, Pt–67, and for platinum, Pt–67, versus Nisil thermoelements, respectively.

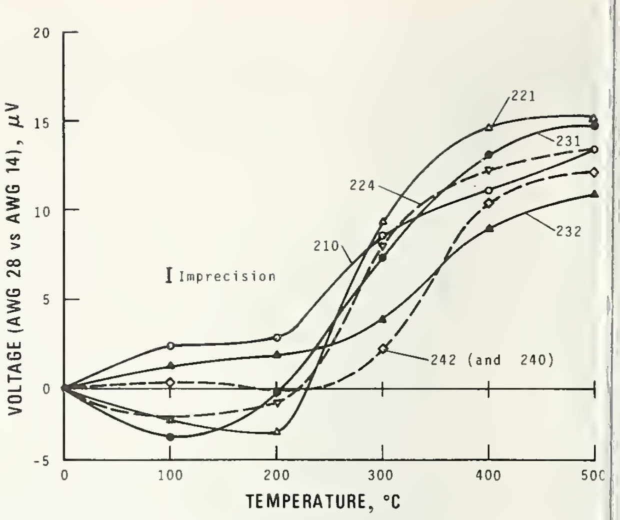


FIGURE 6.7.2 *Effect of size differences for Nisil thermoelements.*

### 7.1 Data Selection and Analysis

The fitting functions for Nicrosil versus Nisil thermocouples (and for each thermoelement versus platinum) are based on four main sets of experimental data, two each for the *AWG 28* and *AWG 14* wires. For the smaller, *AWG 28*, wire there were cryogenic data between −269 and 7 °C generated in NBS Boulder and overlap data between −75 and 450 °C generated in NBS Gaithersburg. All the data on *AWG 14* wires were obtained in Gaithersburg. As described in section 4, two different furnace systems were used, one from 0 to 1000 °C, the other from 800 to 1300 °C. For both size wires, and for both wide temperature ranges, there were data, overlapping in temperatures, from two different apparatuses. Fortunately, therefore, there were data available for both high- and low-temperature calibrations for material produced at the same time by the same manufacturer. This is quite unlike our previous standardization program that was reported in NBS Monograph 125. The real voltage differences caused by different mechanical and thermal treatments and by different ratios of surface area to volume could be clearly observed. Those differences are undoubtedly present, but not reported for all base-metal thermocouple systems. All temperatures[5] were

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[5] Below 20 K, temperatures were actually measured on the National Bureau of Standards acoustical temperature scale, NBS P 2–20 (1965), described by Plumb and Cataland [1965 a,b; 1966]. However, the difference between this temperature scale and the IPTS–68 in the range of overlap (13.81 to 20 K) is substantially less than the experimental imprecision in the measured thermocouple data.

In this Monograph the symbol $T$ is used to denote all temperatures. Values of temperature on the IPTS–68 are expressed in either kelvins (symbol K) or degrees Celsius (symbol °C). In a few instances the symbol $T$ also is used to denote thermodynamic temperature. The distinction is either explicitly stated or evident from context. The symbolism customarily used to distinguish between

Table 7.1.1 *Characteristics of principal alloys chosen for final analysis*

| Identification number | | Chemical composition[a] | | | | | EMF against Pt–67 at 1000 °C[b] | |
|---|---|---|---|---|---|---|---|---|
| Element | | Cr | Si | Fe | C | Mg | (μV) | |
| | | 14.2 | 1.4 | 0.1 | 0.03 max | | 26040 | ←Nominal value |
| | | Deviation from nominal value | | | | | | |
| NICROSIL | 171 | +0.14 | +0.11 | −0.06 | +0.015 | — | −25 | |
| | 182 | −0.01 | +0.01 | −0.05 | −0.026 | — | −10 | |
| | 191 | +0.04 | +0.07 | +0.01 | −0.014 | — | − 8 | |
| | | 0.03 max | 4.4 | 0.1 | 0.03 max | 0.1 | −10208 | ←Nominal value |
| | | Deviation from nominal value | | | | | | |
| NISIL | 224 | — | −0.02 | −0.06 | −0.027 | −0.02 | −330 | |
| | 231 | — | −0.15 | −0.04 | −0.023 | 0.00 | − 3 | |
| | 240 | — | −0.22 | −0.01 | −0.028 | +0.11 | − 6 | |

[a] Percentages by weight; balance is nickel.

[b] Values are based on reference junctions at 0 °C.

based on the International Practical Temperature Scale of 1968, IPTS–68 [CIPM, 1969].

Extensive preliminary tests were carried out in Gaithersburg on selections of *AWG 14* wire before any of the *AWG 28* wire cryogenic experiments or final analyses were begun. Those prototype materials and selection tests are described in section 3.

The methods of data analysis are theoretically quite straightforward. However, as with any large experiment with data originating from several different apparatus, there were considerable practical difficulties. There were many trial-and-error preliminary analyses and several false leads. In particular the magnetic transformation in Nisil caused significant problems in fitting (as it did in Type KN reported in Monograph 125). Though these problems required considerable manpower and computer time to resolve, and are at the core of practical data analysis, they will not be described. Only the final, simple path to the reference functions and tables will be outlined below.

As a result of the preliminary high temperature and overlap tests, size *AWG 28* wires from three manufacturers were chosen to be critical for the final cryogenic analysis. They had been laboratory number-coded as 171, 182, and 191 for Nicrosil and 224, 231, and 240 for Nisil. This choice was based on close adherence to the criteria for selection laid down in section 3.3 and on a consensus of manufacturers' opinions in relation to optimum concentrations of minor solutes such as iron and carbon. A summary of the essential chemical and electrical characteristics of these alloys is given in table 7.1.1. Secondary wires were also chosen, in an order of preference based on the above selection criteria, for testing: 150, 170, 180, 181, 190, and 193 for Nicrosil and 201, 210, 220, 232, 241, and 242 for Nisil. Two platinum, Pt–67, wires and one reference material, Ag–Au alloy, were also used in the cryogenic calibration. The values of the thermal emf of the platinum reference wires used were known relative to Pt–67. The resultant graph of network measurements is shown in figure 5.1.2.

Each of the main three Nicrosil versus platinum, three platinum versus Nisil, and the nine Nicrosil versus Nisil sets of data were fit independently. Because they are double valued (negative Seebeck coefficients and reversal in signs of the thermoelectric voltage) below −200 °C, the data for the two separate types of thermoelements could not be fit below −200 °C. The resultant Nicrosil versus Nisil data, however are single valued and they could be fit down to −270 °C (actually −269 °C).

Each set of processed data could have been reported separately (that is, Nicrosil versus Nisil and the two thermoelements versus platinum), but that would have led to slight differences and inconsistencies between the sums of the thermoelements and the resultant thermocouple. Instead, it was decided to process three sets independently, select two of them as fundamental, and obtain the third by subtraction. The cryogenic data were fit first and then the overlap data were fit later, with the constraint that the thermoelectric voltages and Seebeck coefficients for the two regions of *AWG 28* wire had to match at the join, 0 °C.

Several combinations of wires from different manufacturers behaved very smoothly, had low standard deviations, and had average typical values. Therefore, somewhat arbitrarily, *AWG 28* Nicrosil 191 and Nisil 240 were selected as the optimum prototype for generating the final *AWG 28* functions and tables. Data for the thermocouple *AWG 28* Nicrosil 191 versus Nisil 240 were ultimately fit with an eighth degree equation in the cryogenic region (−270 to 0 °C). The standard deviation was 0.15 μV. Data for the thermoelement *AWG 28* Nicrosil versus platinum were also fit with an eighth degree equation; but the standard deviation was somewhat lower, 0.12 μV. Reference functions for the platinum versus *AWG 28* Nisil thermoelement were obtained by subtraction. The

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thermodynamic temperature, Celsius temperature, International Practical Kelvin Temperature, and International Practical Celsius Temperature is given in the text of the IPTS–68 [CIPM, 1976]. Values of Fahrenheit temperature ($t_F$), which appear in the appendixes of this Monograph, are related to International Practical Celsius Temperatures ($t_{68}$) by

$$t_F = (9/5 t_{68} + 32) \quad °F,$$

where degree Fahrenheit, symbol °F, is the unit of Fahrenheit temperature.

equation was eighth degree, of course; the standard deviation would be about 0.19 $\mu$V.

Overlap data were available for *AWG 28* wire between $-75$ and 450 °C. For each prototype alloy, there were data on two or more samples, at least one from each end of the spool of wire. The same batch numbers were used for fitting for the overlap region as were used for the cryogenic one, i.e., Nicrosil 191 and Nisil 240. For each of these batches, there were data on three samples, a pair of adjacent samples from one end of the spool of wire and a third sample from the other end. Because the measured values for the three samples were so little different, they were averaged together to obtain a single typical result before fitting the data. The fits to the averaged values were constrained at the join, 0 °C, so that the generated functions would smoothly match the more accurate cryogenic data near 0 °C. The upper extreme of temperature for the fits was set at 400 °C, due to excessive deviations found in the values at 450 °C. The reference function obtained for *AWG 28* Nicrosil versus platinum, Pt–67, in the range from 0 to 400 °C was fifth degree; the standard deviation, 0.53 $\mu$V. The function obtained for platinum, Pt–67, versus *AWG 28* Nisil was seventh degree; the standard deviation, 0.26 $\mu$V. The experimental techniques in the overlap range were different from those used at cryogenic temperatures: the wires were separately tested against platinum standards; there were no Nicrosil versus Nisil combinations experimentally measured. Therefore, the reference function for the *AWG 28* Nicrosil versus Nisil thermocouple was obtained by addition of the functions for the two thermoelements. The function was seventh degree and the calculated standard deviation was 0.59 $\mu$V.

The wires selected for the high temperature standard reference values came from the same lot as the smaller wires used for the low temperature standards. This is no accident: both sets of wires were selected on the basis of their regular behavior at both high and low temperatures and their closeness of parameters near room temperature. As with the *AWG 28* overlap data, there were results on several adjacent wires as thermoelements, but no results on the thermocouple combinations. Functions on Nicrosil 191 were combined with those on Nisil 240 to obtain the overall thermocouple function.

The fitting function for *AWG 14* Nicrosil versus platinum, Pt–67, for the 0 to 1300 °C range was determined to be sixth degree with a standard deviation of 3.4 $\mu$V. For *AWG 14* Nisil it was ninth degree with a smaller standard deviation, 1.0 $\mu$V. The function for the *AWG 14* Nicrosil versus Nisil thermocouple was determined by the addition of the functions for the two thermoelements. It was ninth degree and had a calculated standard deviation of 3.5 $\mu$V. For all of the functions the main contributions to the overall error came from the high temperature data. This arises from the fact that small shifts in the emf output of both alloys occur on initial heating to elevated temperatures [Burley and Jones, 1975]. For that reason a weighting function of $1+T/400$ was used in the analyses.

The small shifts in emf output indicate that the initial heating produces minor thermoelectric inhomogeneities in the thermoelements. Consequently, when the thermoelements are tested in furnaces that have different temperature gradients, slightly different values of emf are obtained. The differences in emf found for Nicrosil and Nisil samples, due to testing in the two furnaces used in this investigation, can clearly be seen in the next section by comparing the deviation plots for the 0 to 1000 °C range with those for the 800 to 1300 °C range.

The functions and tabular values for *AWG 28* and *AWG 14* Nicrosil versus Nisil thermocouples are presented in section 7.3, those for Nicrosil thermoelements in section 7.4, and those for Nisil thermoelements in section 7.5.

### 7.2 Experimental Deviations

The deviations of the actual experimental values from the table values (or fitted functions) are presented in this section. As mentioned in section 4, *AWG 28* samples for final calibration were taken from near the start and the finish of each of the spools of wire. In the figures presented in this section, the letters X and Y that follow the batch identification numbers denote the sample location, X for start and Y for finish. In a few cases, two adjacent samples from an end of the spool of wire were tested and these samples are further identified by the letters a and b (e.g., Xa and Xb). The *AWG 14* samples for final calibration were also taken from widely separated locations on each coil of wire and the letters D, R, and S designate samples from different locations. Again, the letters a and b denote adjacent samples when more than one sample from a given location was tested.

For only one temperature range, the cryogenic range, were total values separately obtained so that the thermocouple combination could be checked against the total functional values. The experimental values for the deviations of *AWG 28* thermocouples are given in figure 7.2.1. It can be seen that two sets of materials, *from different manufacturers*, give virtually identical results. Though this result may be fortuitous, such close agreement has never been observed by NBS before in any of its thermocouple research on other materials. In fact, the agreement of the two sets of values is better than that for the two reference grade platinum wires that were used as standards. The third set of wires shows a significant deviation, though it is no worse than that regularly observed for other commercial thermocouple materials.

Deviations for *AWG 28* Nicrosil thermoelements are given in figures 7.2.2 and 7.2.3 for the cryogenic range and in figures 7.2.4, 7.2.5, and 7.2.6 for the overlap range. Deviations for *AWG 14* Nicrosil thermoelements are given in figures 7.2.7, 7.2.8, and 7.2.9 for the 0 to 1000 °C range and in figures 7.2.10, 7.2.11, and 7.2.12 for the 800 to 1300 °C range.

Similarly for the Nisil thermoelements, deviations for *AWG 28* thermoelements are given in figures 7.2.13 and 7.2.14 for the cryogenic range and in figures

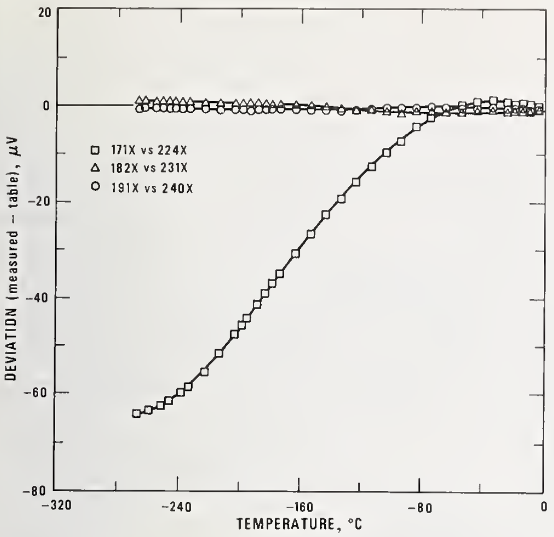

FIGURE 7.2.1 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for various *AWG 28* Nicrosil versus Nisil thermocouples in the cryogenic temperature range.

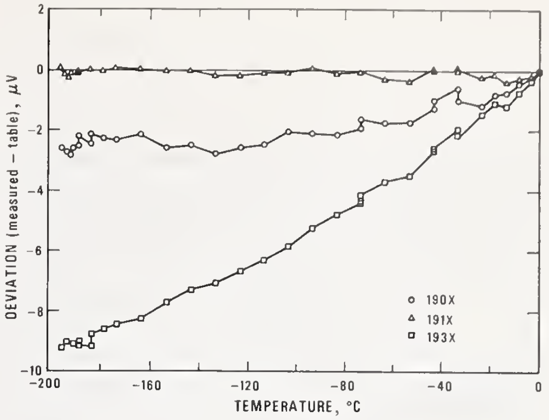

FIGURE 7.2.3 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for various *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, in the cryogenic temperature range.

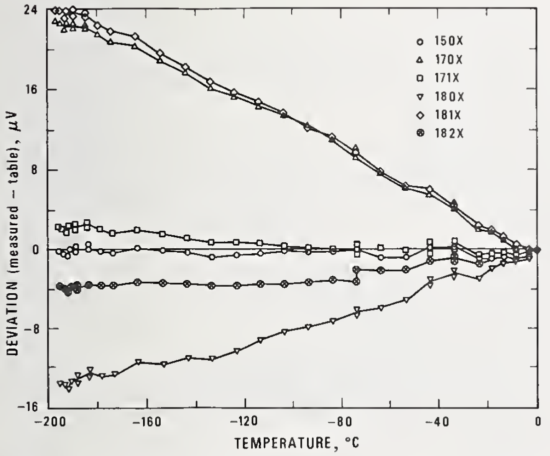

FIGURE 7.2.2 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for various *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, in the cryogenic temperature range.

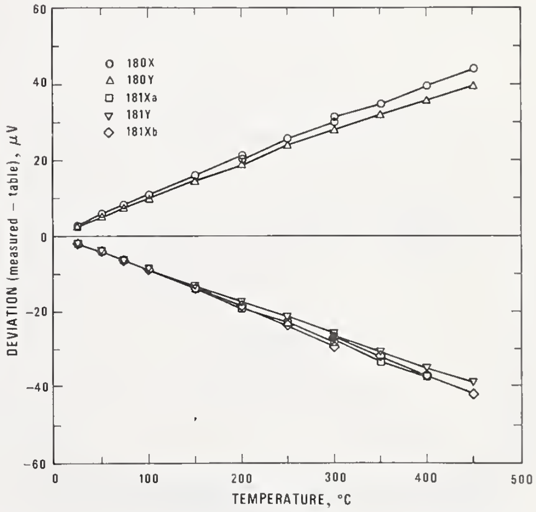

FIGURE 7.2.4 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for various *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, in the overlap temperature range.

7.2.15, 7.2.16, and 7.2.17 for the overlap range. For the larger *AWG 14* thermoelements, deviations are given in figures 7.2.18, 7.2.19, 7.2.20, and 7.2.21 for the 0 to 1000 °C range and in figures 7.2.22, 7.2.23, 7.2.24, and 7.2.25 for the 800 to 1300 °C range.

By comparing these deviations with those reported in NBS Monograph 125 for other base-metal thermocouples, it can be seen that, in general, the deviations for Nicrosil versus Nisil thermocouples are smaller and much smoother than they are for other base-metal thermocouple systems. This smoothness should lead to improved calibration accuracy in practical thermometry.

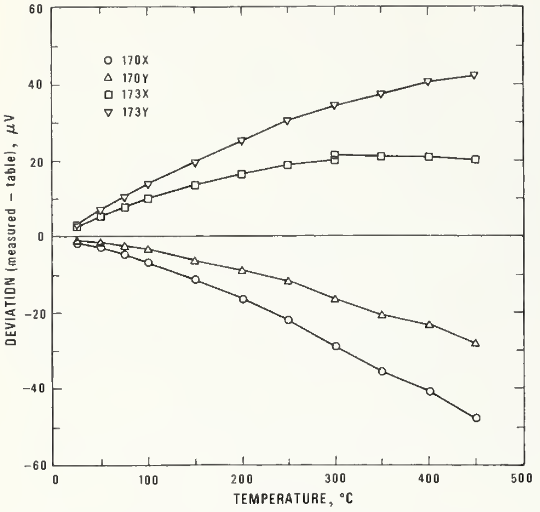

Figure 7.2.5 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, in the overlap temperature range.

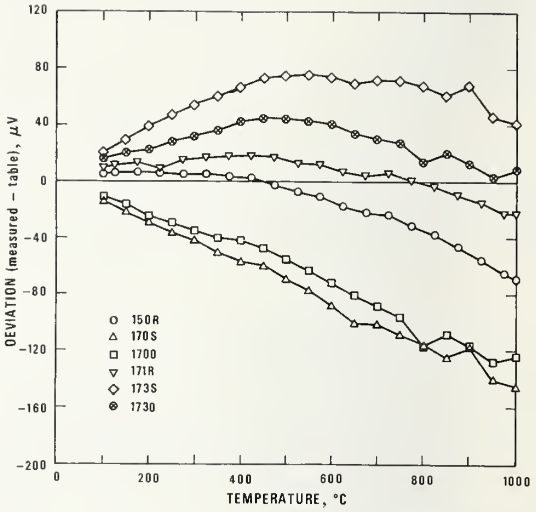

Figure 7.2.7 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, in the 0 to 1000 °C range.

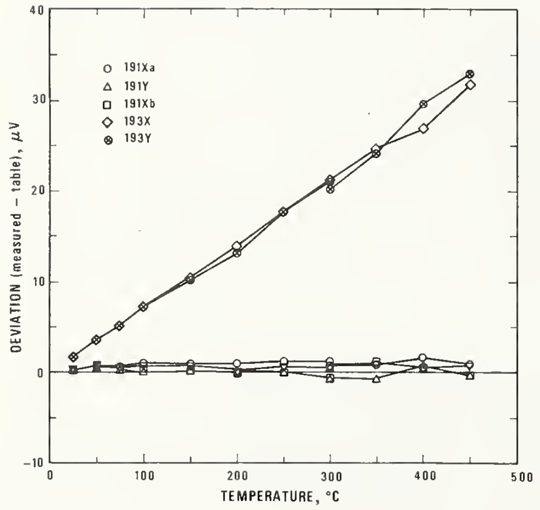

Figure 7.2.6 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, in the overlap temperature range.

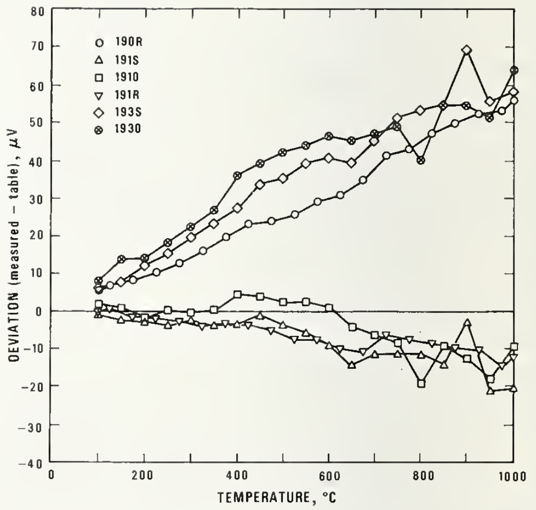

Figure 7.2.8 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, in the 0 to 1000 °C range.

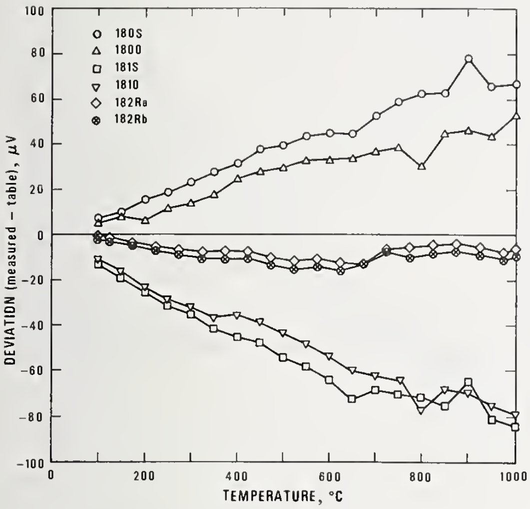

FIGURE 7.2.9 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, in the 0 to 1000 °C range.

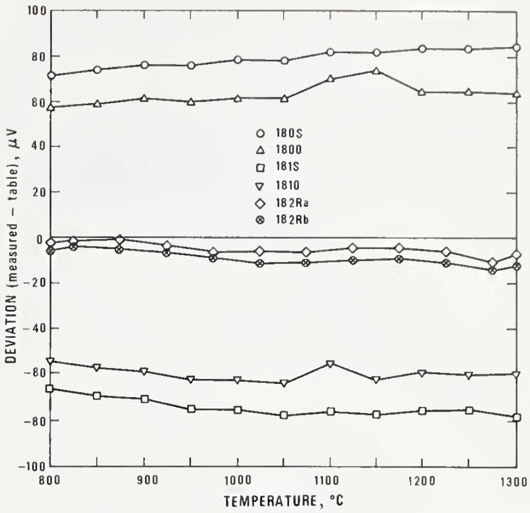

FIGURE 7.2.11 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, in the 800 to 1300 °C range.

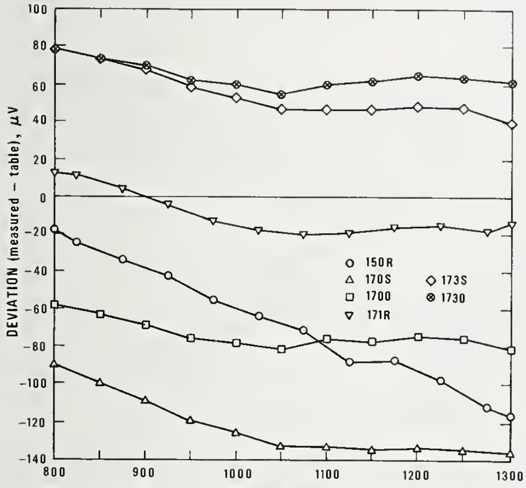

FIGURE 7.2.10 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, in the 800 to 1300 °C range.

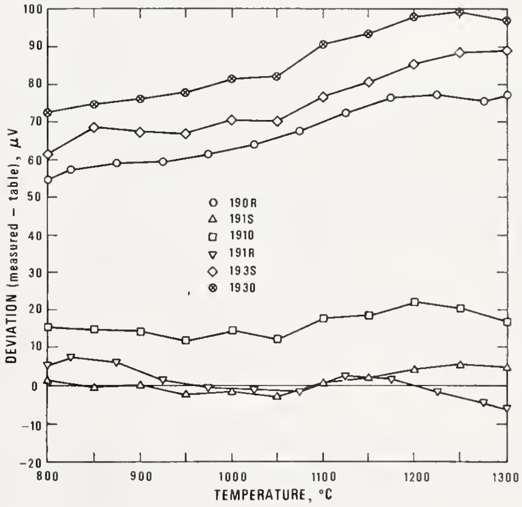

FIGURE 7.2.12 *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for various *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, in the 800 to 1300 °C range.

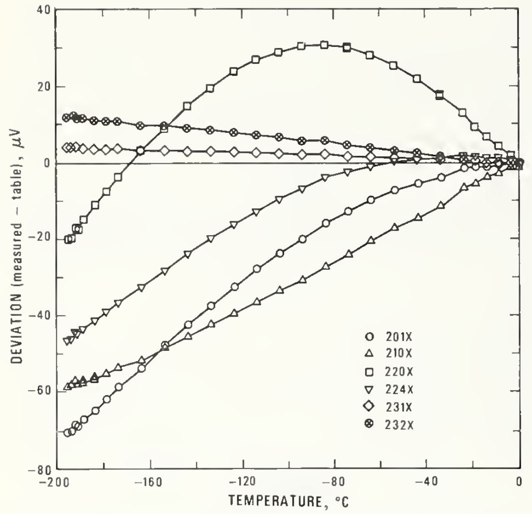

**Figure 7.2.13** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 28* Nisil thermoelements in the cryogenic temperature range.

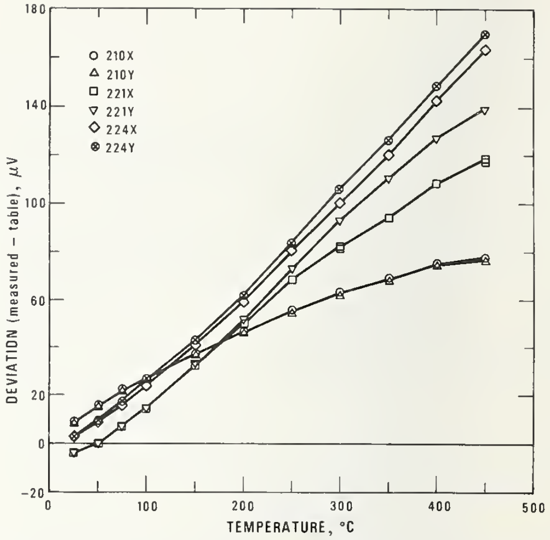

**Figure 7.2.15** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 28* Nisil thermoelements in the overlap temperature range.

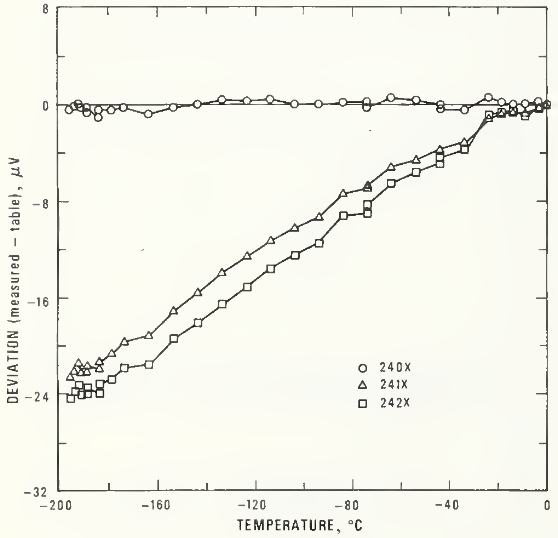

**Figure 7.2.14** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 28* Nisil thermoelements in the cryogenic temperature range.

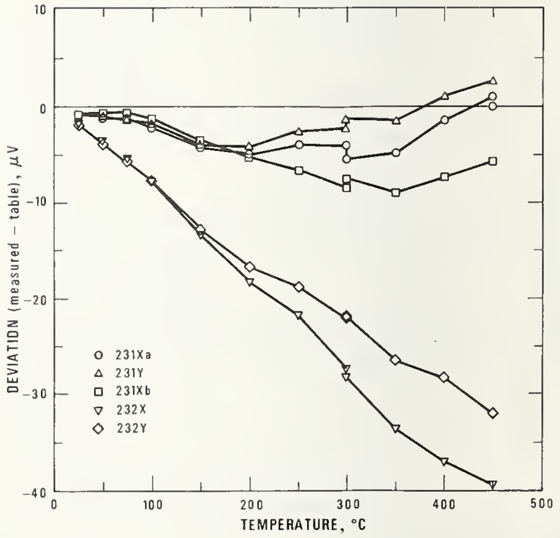

**Figure 7.2.16** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 28* Nisil thermoelements in the overlap temperature range.

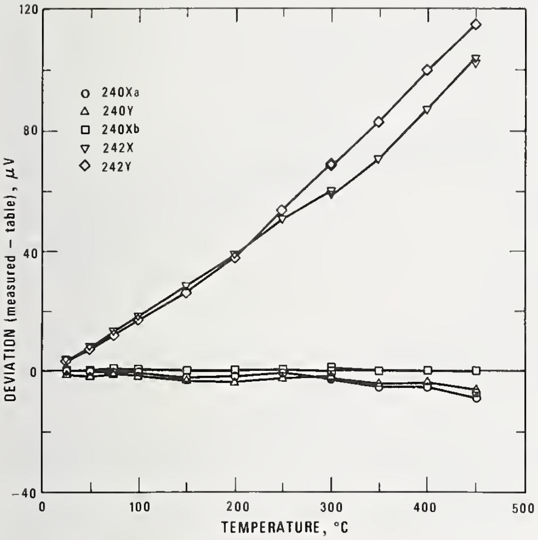

**Figure 7.2.17** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 28* Nisil thermoelements in the overlap temperature range.

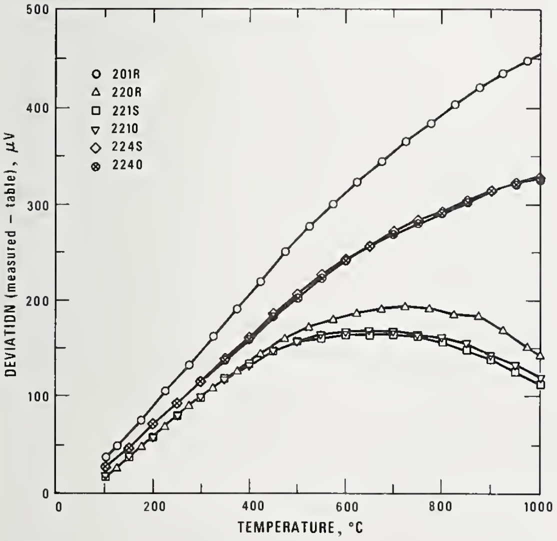

**Figure 7.2.18** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 0 to 1000 °C range.

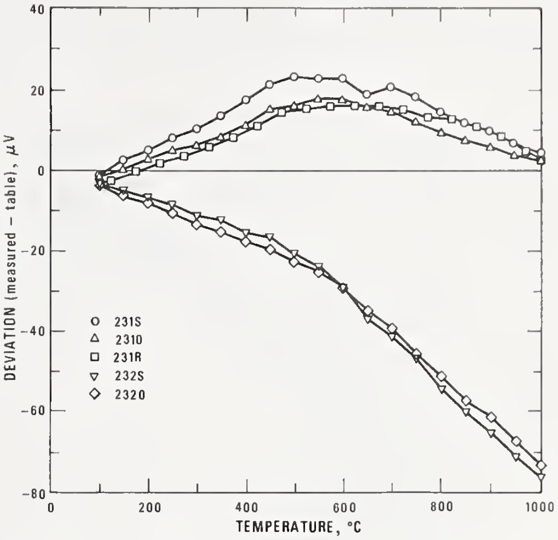

**Figure 7.2.19** *Deviations of measured values of themal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 0 to 1000 °C range.

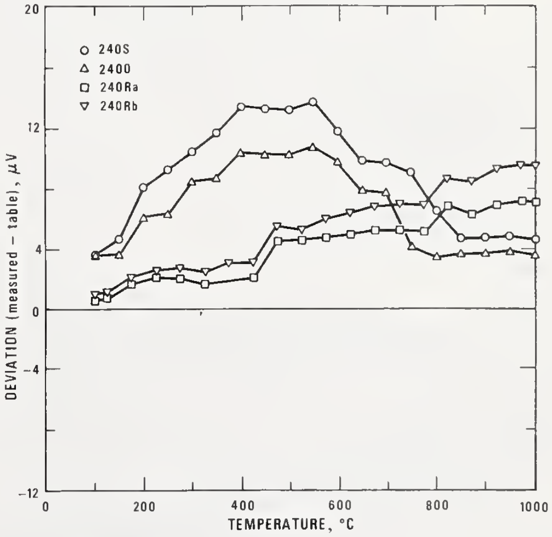

**Figure 7.2.20** *Deviations of measured values of thermal emf's from table values given in this Monograph.*

The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 0 to 1000 °C range.

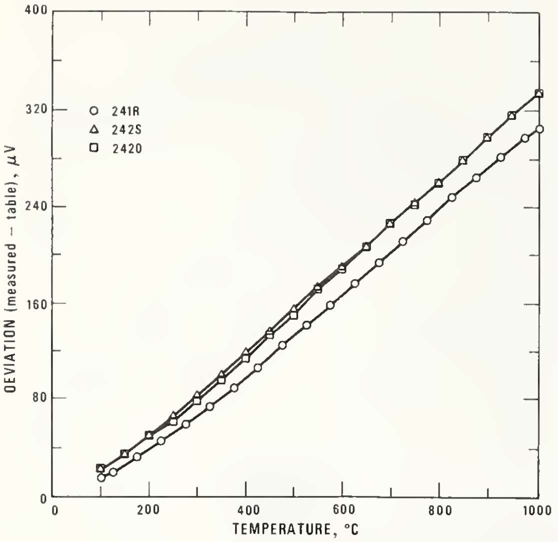

FIGURE 7.2.21 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 0 to 1000 °C range.

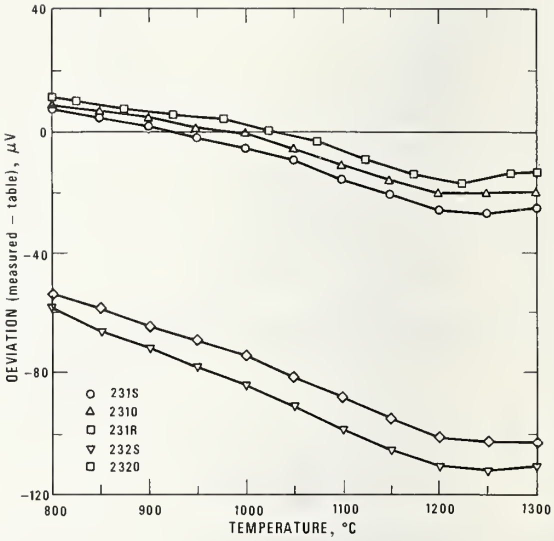

FIGURE 7.2.23 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 800 to 1300 °C range.

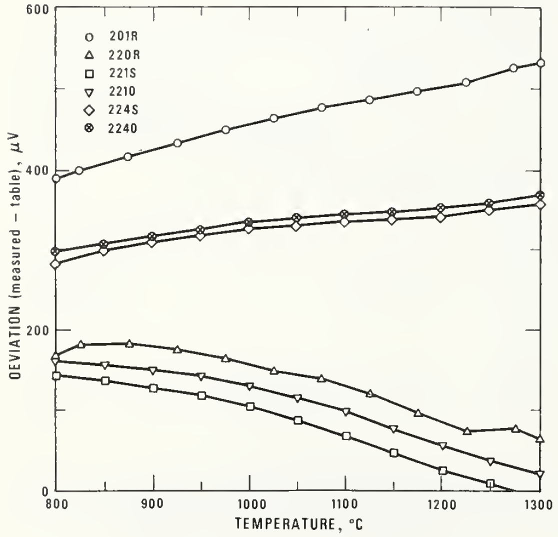

FIGURE 7.2.22 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 800 to 1300 °C range.

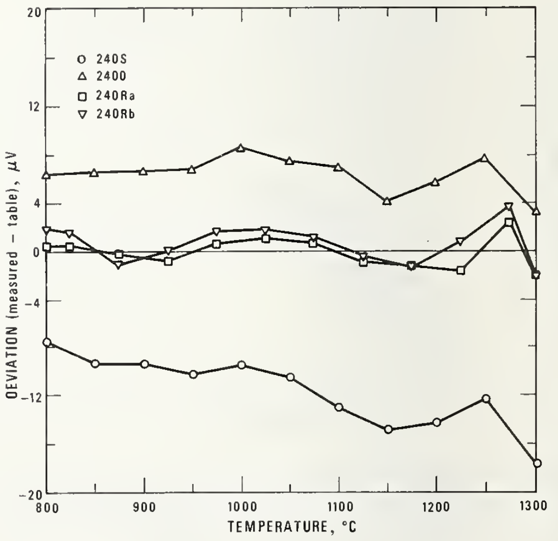

FIGURE 7.2.24 *Deviations of measured values of thermal emf's from table values given in this Monograph.*
The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 800 to 1300 °C range.

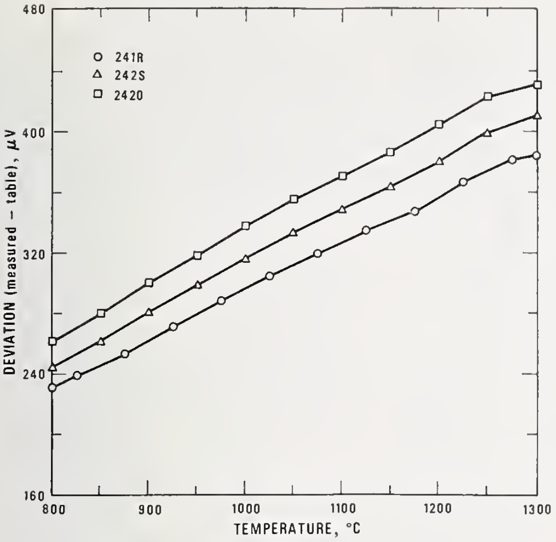

FIGURE 7.2.25 *Deviations of measured values of thermal emf's from table values given in this Monograph.* The data shown are for platinum, Pt–67, versus various *AWG 14* Nisil thermoelements in the 800 to 1300 °C range.

## 7.3 Reference Functions and Tables for the Thermocouple Combination, Nicrosil versus Nisil

The data for the thermocouple combination are divided into two ranges, depending on the wire size. The smaller wire *AWG 28*, has values tabulated from −270 to 0 °C (with an extended range up to 400 °C). The larger wire, *AWG 14*, has values tabulated from 0 to 1300 °C. The functions and tabular values for the two sizes of wire are not quite identical in the temperature range where they overlap (0 to 400 °C). Those differences are shown in the following tables where the wire gage is specified along with the temperatures and thermoelectric values. At the join, 0 °C, of the cryogenic data and the high temperature data, the voltages are identical; the Seebeck coefficients (the first temperature derivatives of the thermal voltage) differ by 1 percent. The difference is a real representation of the effect of wire diameter (and of the ratio of surface area to volume) for the materials, particularly Nisil. This difference, though not well documented for other materials, is a fundamental characteristic of commercially prepared base-metal thermocouple materials. The values of the coefficients for the fine wire (cryogenic) are higher. Actual differences between the voltages of specially prepared test wires of different sizes are discussed in section 6.7.

The coefficients for the eighth degree expansion for the thermoelectric voltage of *AWG 28* Nicrosil versus Nisil thermocouples between −270 and 0 °C are given in table 7.3.1. The coefficients for the seventh degree expansion for *AWG 28* wire between 0 and 400 °C, an extended range, are also given in table 7.3.1. The equivalent coefficients for the ninth degree expansion for the thermoelectric voltage of *AWG 14* Nicrosil versus Nisil thermocouples between 0 and 1300 °C are given in table 7.3.2. The errors caused by using reduced-bit arithmetic for calculating values of those functions are given in tables 7.3.8 and 7.3.9 for the *AWG 28* and *AWG 14* thermocouples, respectively.

TABLE 7.3.1 *Power series expansion for the thermoelectric voltage of* AWG 28 *Nicrosil versus Nisil thermocouples in the cryogenic and extended temperature ranges.*

| Wire gage | Temperature range | Degree | Coefficients | Term |
|---|---|---|---|---|
| AWG 28 | −270 to 0 °C | 8 | $+2.6153540164\times10^{1}$ | $T$ |
| | | | $+1.0933114132\times10^{-2}$ | $T^2$ |
| | | | $-9.3917128470\times10^{-5}$ | $T^3$ |
| | | | $-5.3592739285\times10^{-8}$ | $T^4$ |
| | | | $-2.7406835184\times10^{-9}$ | $T^5$ |
| | | | $-2.3370710645\times10^{-11}$ | $T^6$ |
| | | | $-7.8250681060\times10^{-14}$ | $T^7$ |
| | | | $-9.5885491371\times10^{-17}$ | $T^8$ |
| AWG 28 | 0 to 400 °C | 7 | $+2.6153540164\times10^{1}$ | $T$ |
| | | | $+9.3169626960\times10^{-3}$ | $T^2$ |
| | | | $+1.3507720863\times10^{-4}$ | $T^3$ |
| | | | $-8.5131026625\times10^{-7}$ | $T^4$ |
| | | | $+2.5853558632\times10^{-9}$ | $T^5$ |
| | | | $-3.9887895408\times10^{-12}$ | $T^6$ |
| | | | $+2.4633802582\times10^{-15}$ | $T^7$ |

TABLE 7.3.2 *Power series expansion for the thermoelectric voltage of* AWG 14 *Nicrosil versus Nisil thermocouples in the high temperature range.*

| Wire gage | Temperature range | Degree | Coefficients | Term |
|---|---|---|---|---|
| AWG 14 | 0 to 1300 °C | 9 | $+2.5897798582\times10^{1}$ | $T$ |
| | | | $+1.6656127713\times10^{-2}$ | $T^2$ |
| | | | $+3.1234962101\times10^{-5}$ | $T^3$ |
| | | | $-1.7248130773\times10^{-7}$ | $T^4$ |
| | | | $+3.6526665920\times10^{-10}$ | $T^5$ |
| | | | $-4.4390833504\times10^{-13}$ | $T^6$ |
| | | | $+3.1553382729\times10^{-16}$ | $T^7$ |
| | | | $-1.2150879468\times10^{-19}$ | $T^8$ |
| | | | $+1.9557197559\times10^{-23}$ | $T^9$ |

The primary reference values for *AWG 28* Nicrosil versus Nisil thermocouples in the temperature range from −270 to 0 °C are given in table 7.3.3. Values for the same gage wire in the extended temperature range from 0 to 400 °C are given in table 7.3.4. Values for the larger, *AWG 14*, wire for temperatures from 0 to 1300 °C are given in table 7.3.5. Near the ends of long calibration ranges, mathematical fitting functions become more variable and subject to error. This is especially true for their higher derivatives. Therefore the second derivatives of the thermal voltages are not tabulated above 1260 °C. Values for the smaller *AWG 28* wire at selected thermometric fixed points are given in table 7.3.6, and for the larger *AWG 14* wire, in table 7.3.7.

Graphs of the thermoelectric voltage, its first derivative (Seebeck coefficient), and second derivative are given in figures 7.3.1, 7.3.2, and 7.3.3, respectively, for *AWG 28* wire between −270 and 400 °C; and in figures 7.3.4, 7.3.5, and 7.3.6 for *AWG 14* wire between 0 and 1300 °C.

It should be stressed that because of the small, but nevertheless significant, size effect ***Nicrosil versus Nisil thermocouples that conform closely to the high temperature tabular values may not conform closely at low temperatures (below 0 °C) and vice versa.*** If Nicrosil versus Nisil thermocouples are to be used for accurate measurements both above and below 0 °C, then the material must be calibrated in the full temperature range, both above and below 0 °C. Special selection of material will often be required.

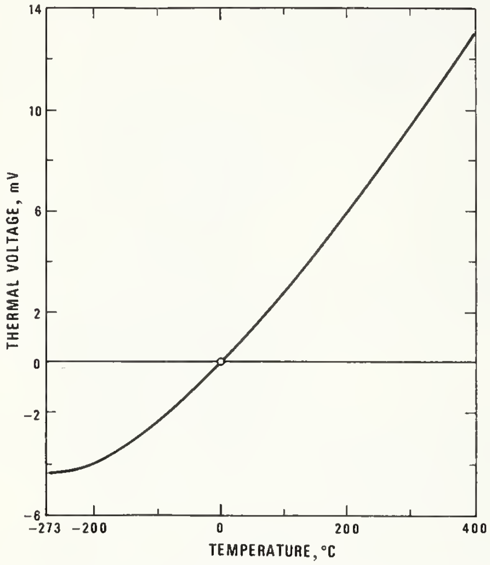

Figure 7.3.1. *Thermoelectric voltage for* AWG 28 *Nicrosil versus Nisil thermocouples.*

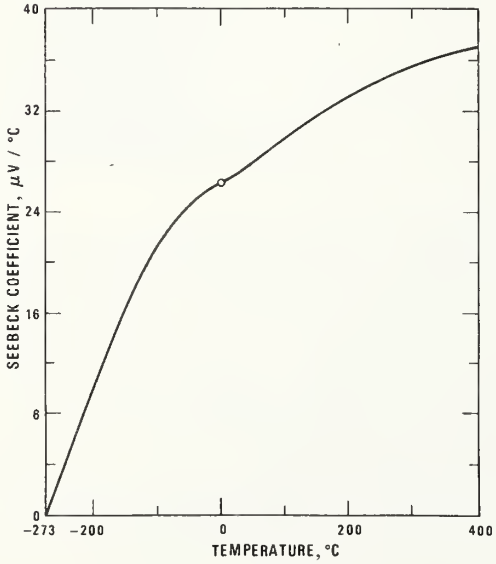

Figure 7.3.2 *Seebeck coefficient for* AWG 28 *Nicrosil versus Nisil thermocouples.*

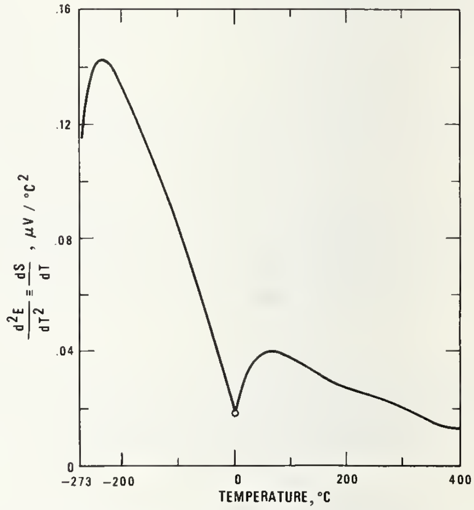

Figure 7.3.3 *Derivative of Seebeck coefficient for* AWG 28 *Nicrosil versus Nisil thermocouples.*

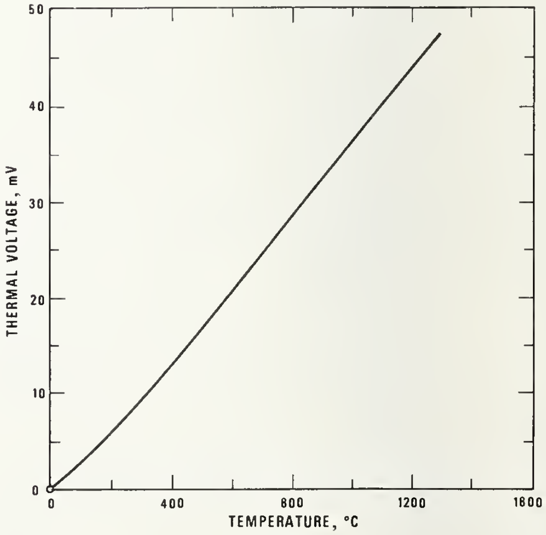

Figure 7.3.4 *Thermoelectric voltage for* AWG 14 *Nicrosil versus Nisil thermocouples.*

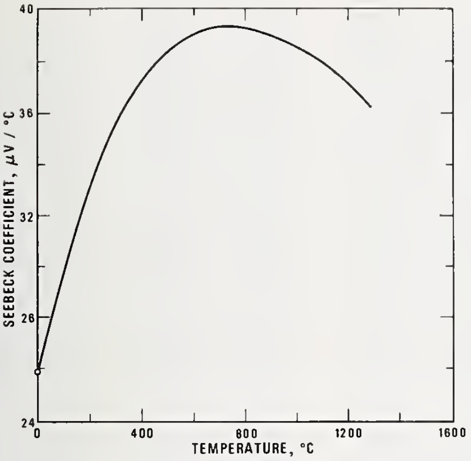

**Figure 7.3.5** *Seebeck coefficient for* AWG 14 *Nicrosil versus Nisil thermocouples.*

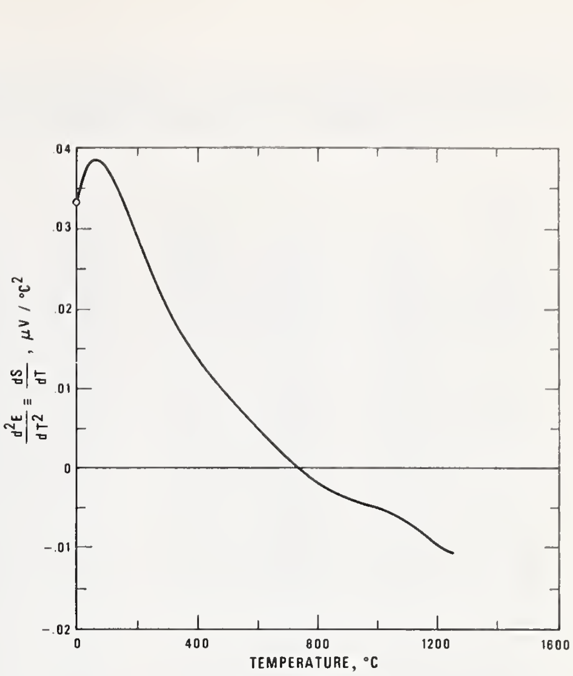

**Figure 7.3.6** *Derivative of Seebeck coefficient for* AWG 14 *Nicrosil versus Nisil thermocouples.*

TABLE 7.3.3 AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Cryogenic temperature range, —270 to 0 °C.*

| T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -270 | -4345.18 | 0.339 | 115.50 | -240 | -4277.03 | 4.335 | 142.45 | -210 | -4082.95 | 8.577 | 137.64 |
| -269 | -4344.78 | 0.455 | 117.35 | -239 | -4272.62 | 4.478 | 142.61 | -209 | -4074.30 | 8.715 | 137.27 |
| -268 | -4344.27 | 0.573 | 119.12 | -238 | -4268.07 | 4.621 | 142.74 | -208 | -4065.52 | 8.852 | 136.88 |
| -267 | -4343.63 | 0.693 | 120.80 | -237 | -4263.38 | 4.763 | 142.84 | -207 | -4056.60 | 8.988 | 136.49 |
| -266 | -4342.88 | 0.815 | 122.40 | -236 | -4258.54 | 4.906 | 142.91 | -206 | -4047.54 | 9.125 | 136.09 |
| -265 | -4342.00 | 0.938 | 123.93 | -235 | -4253.57 | 5.049 | 142.95 | -205 | -4038.35 | 9.261 | 135.69 |
| -264 | -4341.00 | 1.063 | 125.38 | -234 | -4248.45 | 5.192 | 142.96 | -204 | -4029.02 | 9.396 | 135.28 |
| -263 | -4339.88 | 1.189 | 126.75 | -233 | -4243.18 | 5.335 | 142.95 | -203 | -4019.56 | 9.531 | 134.87 |
| -262 | -4338.63 | 1.316 | 128.05 | -232 | -4237.77 | 5.478 | 142.92 | -202 | -4009.96 | 9.666 | 134.45 |
| -261 | -4337.24 | 1.445 | 129.28 | -231 | -4232.23 | 5.621 | 142.86 | -201 | -4000.23 | 9.800 | 134.02 |
| -260 | -4335.73 | 1.575 | 130.45 | -230 | -4226.53 | 5.764 | 142.78 | -200 | -3990.36 | 9.934 | 133.59 |
| -259 | -4334.09 | 1.706 | 131.55 | -229 | -4220.70 | 5.907 | 142.67 | -199 | -3980.36 | 10.067 | 133.16 |
| -258 | -4332.32 | 1.838 | 132.59 | -228 | -4214.72 | 6.049 | 142.55 | -198 | -3970.23 | 10.200 | 132.72 |
| -257 | -4330.42 | 1.971 | 133.56 | -227 | -4208.60 | 6.192 | 142.40 | -197 | -3959.96 | 10.333 | 132.28 |
| -256 | -4328.38 | 2.105 | 134.48 | -226 | -4202.34 | 6.334 | 142.24 | -196 | -3949.56 | 10.465 | 131.84 |
| -255 | -4326.21 | 2.240 | 135.33 | -225 | -4195.93 | 6.476 | 142.06 | -195 | -3939.03 | 10.596 | 131.40 |
| -254 | -4323.90 | 2.376 | 136.14 | -224 | -4189.38 | 6.618 | 141.86 | -194 | -3928.37 | 10.728 | 130.95 |
| -253 | -4321.46 | 2.512 | 136.88 | -223 | -4182.70 | 6.760 | 141.64 | -193 | -3917.57 | 10.858 | 130.50 |
| -252 | -4318.88 | 2.649 | 137.58 | -222 | -4175.87 | 6.901 | 141.41 | -192 | -3906.65 | 10.989 | 130.05 |
| -251 | -4316.16 | 2.787 | 138.23 | -221 | -4168.89 | 7.043 | 141.16 | -191 | -3895.60 | 11.118 | 129.59 |
| -250 | -4313.30 | 2.926 | 138.82 | -220 | -4161.78 | 7.184 | 140.90 | -190 | -3884.41 | 11.248 | 129.13 |
| -249 | -4310.31 | 3.065 | 139.37 | -219 | -4154.53 | 7.324 | 140.63 | -189 | -3873.10 | 11.377 | 128.68 |
| -248 | -4307.17 | 3.204 | 139.88 | -218 | -4147.13 | 7.465 | 140.34 | -188 | -3861.66 | 11.505 | 128.22 |
| -247 | -4303.90 | 3.345 | 140.34 | -217 | -4139.60 | 7.605 | 140.04 | -187 | -3850.09 | 11.633 | 127.76 |
| -246 | -4300.48 | 3.485 | 140.75 | -216 | -4131.92 | 7.745 | 139.73 | -186 | -3838.40 | 11.761 | 127.29 |
| -245 | -4296.93 | 3.626 | 141.13 | -215 | -4124.11 | 7.884 | 139.40 | -185 | -3826.57 | 11.888 | 126.83 |
| -244 | -4293.23 | 3.767 | 141.47 | -214 | -4116.15 | 8.024 | 139.07 | -184 | -3814.62 | 12.014 | 126.37 |
| -243 | -4289.39 | 3.909 | 141.77 | -213 | -4108.06 | 8.163 | 138.73 | -183 | -3802.54 | 12.140 | 125.90 |
| -242 | -4285.41 | 4.051 | 142.03 | -212 | -4099.83 | 8.301 | 138.38 | -182 | -3790.34 | 12.266 | 125.44 |
| -241 | -4281.29 | 4.193 | 142.26 | -211 | -4091.46 | 8.439 | 138.01 | -181 | -3778.01 | 12.391 | 124.97 |
| -240 | -4277.03 | 4.335 | 142.45 | -210 | -4082.95 | 8.577 | 137.64 | -180 | -3765.56 | 12.516 | 124.50 |

**TABLE 7.3.3** AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Cryogenic temperature range, —270 to 0 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -180 | -3765.56 | 12.516 | 124.50 | -120 | -2807.48 | 19.130 | 95.31 | -60 | -1509.02 | 23.782 | 58.42 |
| -179 | -3752.98 | 12.640 | 124.04 | -119 | -2788.31 | 19.225 | 94.77 | -59 | -1485.21 | 23.840 | 57.76 |
| -178 | -3740.28 | 12.764 | 123.57 | -118 | -2769.03 | 19.319 | 94.23 | -58 | -1461.34 | 23.897 | 57.10 |
| -177 | -3727.45 | 12.887 | 123.10 | -117 | -2749.67 | 19.413 | 93.68 | -57 | -1437.41 | 23.954 | 56.44 |
| -176 | -3714.50 | 13.010 | 122.63 | -116 | -2730.21 | 19.507 | 93.14 | -56 | -1413.43 | 24.010 | 55.78 |
| -175 | -3701.43 | 13.133 | 122.17 | -115 | -2710.66 | 19.600 | 92.59 | -55 | -1389.39 | 24.065 | 55.12 |
| -174 | -3688.24 | 13.255 | 121.70 | -114 | -2691.01 | 19.692 | 92.03 | -54 | -1365.30 | 24.120 | 54.47 |
| -173 | -3674.92 | 13.376 | 121.23 | -113 | -2671.27 | 19.784 | 91.48 | -53 | -1341.15 | 24.174 | 53.81 |
| -172 | -3661.49 | 13.497 | 120.76 | -112 | -2651.44 | 19.875 | 90.92 | -52 | -1316.95 | 24.228 | 53.15 |
| -171 | -3647.93 | 13.618 | 120.29 | -111 | -2631.52 | 19.965 | 90.36 | -51 | -1292.70 | 24.281 | 52.50 |
| -170 | -3634.25 | 13.738 | 119.82 | -110 | -2611.51 | 20.056 | 89.79 | -50 | -1268.39 | 24.333 | 51.85 |
| -169 | -3620.45 | 13.857 | 119.35 | -109 | -2591.41 | 20.145 | 89.23 | -49 | -1244.03 | 24.384 | 51.19 |
| -168 | -3606.54 | 13.976 | 118.88 | -108 | -2571.22 | 20.234 | 88.65 | -48 | -1219.62 | 24.435 | 50.54 |
| -167 | -3592.50 | 14.095 | 118.42 | -107 | -2550.94 | 20.322 | 88.08 | -47 | -1195.16 | 24.485 | 49.90 |
| -166 | -3578.35 | 14.213 | 117.95 | -106 | -2530.58 | 20.410 | 87.50 | -46 | -1170.65 | 24.535 | 49.25 |
| -165 | -3564.07 | 14.331 | 117.48 | -105 | -2510.12 | 20.497 | 86.93 | -45 | -1146.09 | 24.584 | 48.60 |
| -164 | -3549.68 | 14.448 | 117.01 | -104 | -2489.58 | 20.584 | 86.34 | -44 | -1121.48 | 24.632 | 47.96 |
| -163 | -3535.18 | 14.565 | 116.54 | -103 | -2468.96 | 20.670 | 85.76 | -43 | -1096.83 | 24.680 | 47.32 |
| -162 | -3520.55 | 14.681 | 116.07 | -102 | -2448.24 | 20.755 | 85.17 | -42 | -1072.12 | 24.727 | 46.68 |
| -161 | -3505.82 | 14.797 | 115.59 | -101 | -2427.45 | 20.840 | 84.58 | -41 | -1047.37 | 24.773 | 46.04 |
| -160 | -3490.96 | 14.912 | 115.12 | -100 | -2406.56 | 20.925 | 83.98 | -40 | -1022.58 | 24.819 | 45.41 |
| -159 | -3475.99 | 15.027 | 114.65 | -99 | -2385.60 | 21.008 | 83.39 | -39 | -997.74 | 24.864 | 44.77 |
| -158 | -3460.91 | 15.142 | 114.18 | -98 | -2364.55 | 21.091 | 82.79 | -38 | -972.85 | 24.909 | 44.14 |
| -157 | -3445.71 | 15.256 | 113.71 | -97 | -2343.41 | 21.174 | 82.18 | -37 | -947.92 | 24.952 | 43.51 |
| -156 | -3430.40 | 15.369 | 113.23 | -96 | -2322.20 | 21.256 | 81.58 | -36 | -922.95 | 24.996 | 42.89 |
| -155 | -3414.97 | 15.482 | 112.76 | -95 | -2300.90 | 21.337 | 80.97 | -35 | -897.93 | 25.038 | 42.26 |
| -154 | -3399.43 | 15.595 | 112.29 | -94 | -2279.52 | 21.418 | 80.36 | -34 | -872.87 | 25.080 | 41.64 |
| -153 | -3383.78 | 15.707 | 111.81 | -93 | -2258.07 | 21.498 | 79.74 | -33 | -847.77 | 25.121 | 41.02 |
| -152 | -3368.02 | 15.818 | 111.34 | -92 | -2236.53 | 21.577 | 79.13 | -32 | -822.63 | 25.162 | 40.41 |
| -151 | -3352.14 | 15.929 | 110.86 | -91 | -2214.91 | 21.656 | 78.51 | -31 | -797.44 | 25.202 | 39.79 |
| -150 | -3336.16 | 16.040 | 110.38 | -90 | -2193.22 | 21.734 | 77.88 | -30 | -772.22 | 25.242 | 39.18 |
| -149 | -3320.06 | 16.150 | 109.90 | -89 | -2171.44 | 21.812 | 77.26 | -29 | -746.96 | 25.281 | 38.57 |
| -148 | -3303.86 | 16.260 | 109.43 | -88 | -2149.59 | 21.889 | 76.63 | -28 | -721.66 | 25.319 | 37.97 |
| -147 | -3287.54 | 16.369 | 108.94 | -87 | -2127.67 | 21.965 | 76.00 | -27 | -696.32 | 25.357 | 37.36 |
| -146 | -3271.12 | 16.478 | 108.46 | -86 | -2105.66 | 22.041 | 75.37 | -26 | -670.95 | 25.394 | 36.76 |
| -145 | -3254.59 | 16.586 | 107.98 | -85 | -2083.59 | 22.116 | 74.74 | -25 | -645.54 | 25.430 | 36.17 |
| -144 | -3237.95 | 16.694 | 107.50 | -84 | -2061.43 | 22.190 | 74.10 | -24 | -620.09 | 25.466 | 35.57 |
| -143 | -3221.20 | 16.801 | 107.01 | -83 | -2039.21 | 22.264 | 73.46 | -23 | -594.61 | 25.501 | 34.98 |
| -142 | -3204.35 | 16.908 | 106.52 | -82 | -2016.91 | 22.337 | 72.82 | -22 | -569.09 | 25.536 | 34.39 |
| -141 | -3187.39 | 17.014 | 106.03 | -81 | -1994.53 | 22.410 | 72.18 | -21 | -543.53 | 25.570 | 33.80 |
| -140 | -3170.32 | 17.120 | 105.54 | -80 | -1972.09 | 22.481 | 71.54 | -20 | -517.95 | 25.603 | 33.22 |
| -139 | -3153.15 | 17.225 | 105.05 | -79 | -1949.57 | 22.553 | 70.89 | -19 | -492.33 | 25.636 | 32.63 |
| -138 | -3135.87 | 17.330 | 104.56 | -78 | -1926.98 | 22.623 | 70.25 | -18 | -466.67 | 25.669 | 32.05 |
| -137 | -3118.49 | 17.434 | 104.06 | -77 | -1904.32 | 22.693 | 69.60 | -17 | -440.99 | 25.700 | 31.48 |
| -136 | -3101.00 | 17.538 | 103.57 | -76 | -1881.60 | 22.762 | 68.95 | -16 | -415.27 | 25.732 | 30.90 |
| -135 | -3083.41 | 17.641 | 103.07 | -75 | -1858.80 | 22.831 | 68.30 | -15 | -389.53 | 25.762 | 30.33 |
| -134 | -3065.72 | 17.744 | 102.57 | -74 | -1835.93 | 22.899 | 67.64 | -14 | -363.75 | 25.792 | 29.75 |
| -133 | -3047.92 | 17.846 | 102.06 | -73 | -1813.00 | 22.966 | 66.99 | -13 | -337.94 | 25.822 | 29.18 |
| -132 | -3030.03 | 17.948 | 101.56 | -72 | -1790.00 | 23.033 | 66.33 | -12 | -312.11 | 25.851 | 28.62 |
| -131 | -3012.03 | 18.050 | 101.05 | -71 | -1766.93 | 23.099 | 65.68 | -11 | -286.24 | 25.879 | 28.05 |
| -130 | -2993.93 | 18.150 | 100.54 | -70 | -1743.80 | 23.164 | 65.02 | -10 | -260.35 | 25.907 | 27.49 |
| -129 | -2975.73 | 18.251 | 100.03 | -69 | -1720.61 | 23.229 | 64.36 | -9 | -234.43 | 25.934 | 26.92 |
| -128 | -2957.43 | 18.350 | 99.51 | -68 | -1697.34 | 23.293 | 63.70 | -8 | -208.48 | 25.961 | 26.36 |
| -127 | -2939.03 | 18.450 | 99.00 | -67 | -1674.02 | 23.356 | 63.04 | -7 | -182.51 | 25.987 | 25.80 |
| -126 | -2920.53 | 18.548 | 98.48 | -66 | -1650.63 | 23.419 | 62.38 | -6 | -156.51 | 26.012 | 25.24 |
| -125 | -2901.93 | 18.647 | 97.95 | -65 | -1627.18 | 23.481 | 61.72 | -5 | -130.48 | 26.037 | 24.67 |
| -124 | -2883.23 | 18.744 | 97.43 | -64 | -1603.67 | 23.543 | 61.06 | -4 | -104.43 | 26.062 | 24.11 |
| -123 | -2864.44 | 18.841 | 96.90 | -63 | -1580.10 | 23.603 | 60.40 | -3 | -78.36 | 26.085 | 23.55 |
| -122 | -2845.55 | 18.938 | 96.37 | -62 | -1556.46 | 23.663 | 59.74 | -2 | -52.26 | 26.109 | 22.99 |
| -121 | -2826.57 | 19.034 | 95.84 | -61 | -1532.77 | 23.723 | 59.08 | -1 | -26.14 | 26.131 | 22.43 |
| -120 | -2807.48 | 19.130 | 95.31 | -60 | -1509.02 | 23.782 | 58.42 | 0 | 0.00 | 26.154 | 21.87 |

TABLE 7.3.4 AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T)*, Seebeck coefficients,* S(T)*, and first derivatives of the Seebeck coefficients,* dS/dT*, reference junctions at 0 °C. Extended temperature range, 0 to 400 °C.*

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 26.154 | 18.63 | 60 | 1622.73 | 28.145 | 40.18 | 120 | 3382.78 | 30.477 | 35.89 |
| 1 | 26.16 | 26.173 | 19.43 | 61 | 1650.89 | 28.185 | 40.23 | 121 | 3413.27 | 30.513 | 35.77 |
| 2 | 52.35 | 26.192 | 20.21 | 62 | 1679.10 | 28.225 | 40.26 | 122 | 3443.80 | 30.549 | 35.64 |
| 3 | 78.55 | 26.213 | 20.97 | 63 | 1707.34 | 28.265 | 40.29 | 123 | 3474.37 | 30.584 | 35.51 |
| 4 | 104.77 | 26.234 | 21.72 | 64 | 1735.63 | 28.306 | 40.32 | 124 | 3504.97 | 30.620 | 35.38 |
| 5 | 131.02 | 26.256 | 22.44 | 65 | 1763.95 | 28.346 | 40.34 | 125 | 3535.61 | 30.655 | 35.25 |
| 6 | 157.28 | 26.279 | 23.14 | 66 | 1792.32 | 28.386 | 40.35 | 126 | 3566.28 | 30.690 | 35.13 |
| 7 | 183.58 | 26.303 | 23.82 | 67 | 1820.73 | 28.427 | 40.36 | 127 | 3596.99 | 30.725 | 35.00 |
| 8 | 209.89 | 26.327 | 24.49 | 68 | 1849.17 | 28.467 | 40.36 | 128 | 3627.73 | 30.760 | 34.87 |
| 9 | 236.23 | 26.352 | 25.14 | 69 | 1877.66 | 28.507 | 40.35 | 129 | 3658.51 | 30.795 | 34.74 |
| 10 | 262.59 | 26.377 | 25.77 | 70 | 1906.19 | 28.548 | 40.35 | 130 | 3689.32 | 30.830 | 34.61 |
| 11 | 288.98 | 26.403 | 26.38 | 71 | 1934.76 | 28.588 | 40.33 | 131 | 3720.17 | 30.864 | 34.49 |
| 12 | 315.40 | 26.430 | 26.98 | 72 | 1963.36 | 28.628 | 40.31 | 132 | 3751.05 | 30.899 | 34.36 |
| 13 | 341.84 | 26.457 | 27.55 | 73 | 1992.01 | 28.669 | 40.29 | 133 | 3781.97 | 30.933 | 34.23 |
| 14 | 368.31 | 26.485 | 28.12 | 74 | 2020.70 | 28.709 | 40.26 | 134 | 3812.92 | 30.967 | 34.10 |
| 15 | 394.81 | 26.513 | 28.66 | 75 | 2049.43 | 28.749 | 40.23 | 135 | 3843.90 | 31.001 | 33.98 |
| 16 | 421.34 | 26.542 | 29.19 | 76 | 2078.20 | 28.789 | 40.19 | 136 | 3874.92 | 31.035 | 33.85 |
| 17 | 447.90 | 26.572 | 29.70 | 77 | 2107.01 | 28.830 | 40.15 | 137 | 3905.97 | 31.069 | 33.72 |
| 18 | 474.49 | 26.602 | 30.20 | 78 | 2135.86 | 28.870 | 40.10 | 138 | 3937.06 | 31.103 | 33.60 |
| 19 | 501.10 | 26.632 | 30.68 | 79 | 2164.75 | 28.910 | 40.06 | 139 | 3968.18 | 31.136 | 33.47 |
| 20 | 527.75 | 26.663 | 31.15 | 80 | 2193.68 | 28.950 | 40.00 | 140 | 3999.33 | 31.169 | 33.35 |
| 21 | 554.43 | 26.694 | 31.60 | 81 | 2222.65 | 28.990 | 39.94 | 141 | 4030.52 | 31.203 | 33.23 |
| 22 | 581.14 | 26.726 | 32.04 | 82 | 2251.66 | 29.030 | 39.88 | 142 | 4061.74 | 31.236 | 33.10 |
| 23 | 607.88 | 26.759 | 32.47 | 83 | 2280.71 | 29.070 | 39.82 | 143 | 4092.99 | 31.269 | 32.98 |
| 24 | 634.66 | 26.791 | 32.88 | 84 | 2309.80 | 29.109 | 39.75 | 144 | 4124.27 | 31.302 | 32.86 |
| 25 | 661.46 | 26.824 | 33.27 | 85 | 2338.93 | 29.149 | 39.68 | 145 | 4155.59 | 31.335 | 32.74 |
| 26 | 688.30 | 26.858 | 33.66 | 86 | 2368.10 | 29.189 | 39.61 | 146 | 4186.94 | 31.367 | 32.61 |
| 27 | 715.18 | 26.892 | 34.02 | 87 | 2397.30 | 29.228 | 39.53 | 147 | 4218.33 | 31.400 | 32.49 |
| 28 | 742.09 | 26.926 | 34.38 | 88 | 2426.55 | 29.268 | 39.45 | 148 | 4249.74 | 31.432 | 32.37 |
| 29 | 769.03 | 26.960 | 34.72 | 89 | 2455.84 | 29.307 | 39.37 | 149 | 4281.19 | 31.465 | 32.26 |
| 30 | 796.01 | 26.995 | 35.06 | 90 | 2485.17 | 29.347 | 39.28 | 150 | 4312.67 | 31.497 | 32.14 |
| 31 | 823.02 | 27.030 | 35.37 | 91 | 2514.53 | 29.386 | 39.19 | 151 | 4344.18 | 31.529 | 32.02 |
| 32 | 850.07 | 27.066 | 35.68 | 92 | 2543.94 | 29.425 | 39.10 | 152 | 4375.73 | 31.561 | 31.90 |
| 33 | 877.15 | 27.102 | 35.97 | 93 | 2573.38 | 29.464 | 39.01 | 153 | 4407.31 | 31.593 | 31.79 |
| 34 | 904.27 | 27.138 | 36.26 | 94 | 2602.87 | 29.503 | 38.92 | 154 | 4438.92 | 31.624 | 31.67 |
| 35 | 931.43 | 27.174 | 36.53 | 95 | 2632.39 | 29.542 | 38.82 | 155 | 4470.56 | 31.656 | 31.56 |
| 36 | 958.62 | 27.211 | 36.79 | 96 | 2661.95 | 29.581 | 38.72 | 156 | 4502.23 | 31.688 | 31.45 |
| 37 | 985.85 | 27.248 | 37.04 | 97 | 2691.55 | 29.619 | 38.62 | 157 | 4533.93 | 31.719 | 31.33 |
| 38 | 1013.12 | 27.285 | 37.28 | 98 | 2721.19 | 29.658 | 38.51 | 158 | 4565.67 | 31.750 | 31.22 |
| 39 | 1040.42 | 27.322 | 37.50 | 99 | 2750.87 | 29.696 | 38.41 | 159 | 4597.43 | 31.781 | 31.11 |
| 40 | 1067.76 | 27.360 | 37.72 | 100 | 2780.58 | 29.735 | 38.30 | 160 | 4629.23 | 31.812 | 31.00 |
| 41 | 1095.14 | 27.398 | 37.93 | 101 | 2810.33 | 29.773 | 38.19 | 161 | 4661.06 | 31.843 | 30.90 |
| 42 | 1122.56 | 27.436 | 38.12 | 102 | 2840.13 | 29.811 | 38.08 | 162 | 4692.92 | 31.874 | 30.79 |
| 43 | 1150.01 | 27.474 | 38.31 | 103 | 2869.96 | 29.849 | 37.97 | 163 | 4724.80 | 31.905 | 30.68 |
| 44 | 1177.51 | 27.513 | 38.49 | 104 | 2899.82 | 29.887 | 37.85 | 164 | 4756.73 | 31.936 | 30.58 |
| 45 | 1205.04 | 27.551 | 38.66 | 105 | 2929.73 | 29.925 | 37.74 | 165 | 4788.68 | 31.966 | 30.47 |
| 46 | 1232.61 | 27.590 | 38.82 | 106 | 2959.67 | 29.962 | 37.62 | 166 | 4820.66 | 31.997 | 30.37 |
| 47 | 1260.22 | 27.629 | 38.97 | 107 | 2989.66 | 30.000 | 37.50 | 167 | 4852.67 | 32.027 | 30.26 |
| 48 | 1287.87 | 27.668 | 39.11 | 108 | 3019.67 | 30.037 | 37.38 | 168 | 4884.71 | 32.057 | 30.16 |
| 49 | 1315.55 | 27.707 | 39.24 | 109 | 3049.73 | 30.075 | 37.26 | 169 | 4916.78 | 32.087 | 30.06 |
| 50 | 1343.28 | 27.746 | 39.37 | 110 | 3079.82 | 30.112 | 37.14 | 170 | 4948.89 | 32.117 | 29.96 |
| 51 | 1371.05 | 27.786 | 39.48 | 111 | 3109.95 | 30.149 | 37.02 | 171 | 4981.02 | 32.147 | 29.86 |
| 52 | 1398.85 | 27.825 | 39.59 | 112 | 3140.12 | 30.186 | 36.90 | 172 | 5013.18 | 32.177 | 29.76 |
| 53 | 1426.70 | 27.865 | 39.69 | 113 | 3170.33 | 30.223 | 36.78 | 173 | 5045.37 | 32.207 | 29.67 |
| 54 | 1454.58 | 27.905 | 39.78 | 114 | 3200.57 | 30.260 | 36.65 | 174 | 5077.59 | 32.236 | 29.57 |
| 55 | 1482.51 | 27.944 | 39.87 | 115 | 3230.84 | 30.296 | 36.53 | 175 | 5109.84 | 32.266 | 29.48 |
| 56 | 1510.47 | 27.984 | 39.94 | 116 | 3261.16 | 30.333 | 36.40 | 176 | 5142.12 | 32.295 | 29.38 |
| 57 | 1538.48 | 28.024 | 40.01 | 117 | 3291.51 | 30.369 | 36.27 | 177 | 5174.43 | 32.325 | 29.29 |
| 58 | 1566.52 | 28.064 | 40.08 | 118 | 3321.90 | 30.405 | 36.15 | 178 | 5206.77 | 32.354 | 29.20 |
| 59 | 1594.60 | 28.104 | 40.13 | 119 | 3352.32 | 30.441 | 36.02 | 179 | 5239.14 | 32.383 | 29.11 |
| 60 | 1622.73 | 28.145 | 40.18 | 120 | 3382.78 | 30.477 | 35.89 | 180 | 5271.54 | 32.412 | 29.02 |

TABLE 7.3.4 AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Extended temperature range, 0 to 400 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 5271.54 | 32.412 | 29.02 | 240 | 7265.71 | 34.019 | 24.89 | 300 | 9349.39 | 35.394 | 20.59 |
| 181 | 5303.97 | 32.441 | 28.93 | 241 | 7299.74 | 34.044 | 24.83 | 301 | 9384.79 | 35.415 | 20.49 |
| 182 | 5336.42 | 32.470 | 28.84 | 242 | 7333.79 | 34.069 | 24.77 | 302 | 9420.22 | 35.435 | 20.40 |
| 183 | 5368.91 | 32.499 | 28.75 | 243 | 7367.88 | 34.094 | 24.71 | 303 | 9455.66 | 35.455 | 20.31 |
| 184 | 5401.42 | 32.527 | 28.66 | 244 | 7401.98 | 34.119 | 24.65 | 304 | 9491.13 | 35.476 | 20.21 |
| 185 | 5433.96 | 32.556 | 28.58 | 245 | 7436.11 | 34.143 | 24.59 | 305 | 9526.61 | 35.496 | 20.12 |
| 186 | 5466.53 | 32.585 | 28.49 | 246 | 7470.27 | 34.168 | 24.53 | 306 | 9562.12 | 35.516 | 20.02 |
| 187 | 5499.13 | 32.613 | 28.41 | 247 | 7504.45 | 34.192 | 24.47 | 307 | 9597.65 | 35.536 | 19.93 |
| 188 | 5531.76 | 32.641 | 28.33 | 248 | 7538.65 | 34.217 | 24.41 | 308 | 9633.19 | 35.556 | 19.83 |
| 189 | 5564.41 | 32.670 | 28.25 | 249 | 7572.88 | 34.241 | 24.35 | 309 | 9668.76 | 35.576 | 19.73 |
| 190 | 5597.10 | 32.698 | 28.16 | 250 | 7607.13 | 34.265 | 24.29 | 310 | 9704.34 | 35.595 | 19.64 |
| 191 | 5629.81 | 32.726 | 28.08 | 251 | 7641.41 | 34.290 | 24.23 | 311 | 9739.95 | 35.615 | 19.54 |
| 192 | 5662.55 | 32.754 | 28.01 | 252 | 7675.71 | 34.314 | 24.17 | 312 | 9775.57 | 35.634 | 19.44 |
| 193 | 5695.32 | 32.782 | 27.93 | 253 | 7710.04 | 34.338 | 24.11 | 313 | 9811.22 | 35.654 | 19.34 |
| 194 | 5728.11 | 32.810 | 27.85 | 254 | 7744.39 | 34.362 | 24.05 | 314 | 9846.88 | 35.673 | 19.24 |
| 195 | 5760.94 | 32.838 | 27.77 | 255 | 7778.76 | 34.386 | 23.98 | 315 | 9882.56 | 35.692 | 19.14 |
| 196 | 5793.79 | 32.865 | 27.70 | 256 | 7813.16 | 34.410 | 23.92 | 316 | 9918.26 | 35.711 | 19.04 |
| 197 | 5826.67 | 32.893 | 27.62 | 257 | 7847.58 | 34.434 | 23.86 | 317 | 9953.98 | 35.730 | 18.94 |
| 198 | 5859.57 | 32.921 | 27.55 | 258 | 7882.03 | 34.458 | 23.80 | 318 | 9989.72 | 35.749 | 18.83 |
| 199 | 5892.51 | 32.948 | 27.47 | 259 | 7916.50 | 34.482 | 23.73 | 319 | 10025.48 | 35.768 | 18.73 |
| 200 | 5925.47 | 32.976 | 27.40 | 260 | 7950.99 | 34.505 | 23.67 | 320 | 10061.26 | 35.787 | 18.63 |
| 201 | 5958.46 | 33.003 | 27.33 | 261 | 7985.51 | 34.529 | 23.60 | 321 | 10097.06 | 35.805 | 18.52 |
| 202 | 5991.48 | 33.030 | 27.26 | 262 | 8020.05 | 34.552 | 23.54 | 322 | 10132.87 | 35.824 | 18.42 |
| 203 | 6024.52 | 33.058 | 27.19 | 263 | 8054.61 | 34.576 | 23.47 | 323 | 10168.70 | 35.842 | 18.32 |
| 204 | 6057.59 | 33.085 | 27.12 | 264 | 8089.20 | 34.599 | 23.41 | 324 | 10204.55 | 35.860 | 18.21 |
| 205 | 6090.69 | 33.112 | 27.05 | 265 | 8123.81 | 34.623 | 23.34 | 325 | 10240.42 | 35.878 | 18.11 |
| 206 | 6123.81 | 33.139 | 26.98 | 266 | 8158.45 | 34.646 | 23.27 | 326 | 10276.31 | 35.896 | 18.00 |
| 207 | 6156.97 | 33.166 | 26.91 | 267 | 8193.11 | 34.669 | 23.21 | 327 | 10312.22 | 35.914 | 17.90 |
| 208 | 6190.15 | 33.193 | 26.84 | 268 | 8227.79 | 34.692 | 23.14 | 328 | 10348.14 | 35.932 | 17.79 |
| 209 | 6223.35 | 33.219 | 26.78 | 269 | 8262.49 | 34.716 | 23.07 | 329 | 10384.08 | 35.950 | 17.68 |
| 210 | 6256.58 | 33.246 | 26.71 | 270 | 8297.22 | 34.739 | 23.00 | 330 | 10420.04 | 35.968 | 17.58 |
| 211 | 6289.84 | 33.273 | 26.64 | 271 | 8331.97 | 34.762 | 22.93 | 331 | 10456.02 | 35.985 | 17.47 |
| 212 | 6323.13 | 33.299 | 26.58 | 272 | 8366.74 | 34.784 | 22.86 | 332 | 10492.01 | 36.003 | 17.37 |
| 213 | 6356.44 | 33.326 | 26.51 | 273 | 8401.54 | 34.807 | 22.79 | 333 | 10528.02 | 36.020 | 17.26 |
| 214 | 6389.78 | 33.352 | 26.45 | 274 | 8436.36 | 34.830 | 22.71 | 334 | 10564.05 | 36.037 | 17.16 |
| 215 | 6423.15 | 33.379 | 26.39 | 275 | 8471.20 | 34.853 | 22.64 | 335 | 10600.10 | 36.054 | 17.05 |
| 216 | 6456.54 | 33.405 | 26.32 | 276 | 8506.06 | 34.875 | 22.57 | 336 | 10636.16 | 36.071 | 16.94 |
| 217 | 6489.96 | 33.431 | 26.26 | 277 | 8540.95 | 34.898 | 22.49 | 337 | 10672.24 | 36.088 | 16.84 |
| 218 | 6523.40 | 33.458 | 26.20 | 278 | 8575.86 | 34.920 | 22.42 | 338 | 10708.33 | 36.105 | 16.73 |
| 219 | 6556.87 | 33.484 | 26.13 | 279 | 8610.79 | 34.943 | 22.34 | 339 | 10744.45 | 36.122 | 16.63 |
| 220 | 6590.37 | 33.510 | 26.07 | 280 | 8645.74 | 34.965 | 22.27 | 340 | 10780.58 | 36.138 | 16.53 |
| 221 | 6623.89 | 33.536 | 26.01 | 281 | 8680.72 | 34.987 | 22.19 | 341 | 10816.72 | 36.155 | 16.42 |
| 222 | 6657.44 | 33.562 | 25.95 | 282 | 8715.72 | 35.009 | 22.11 | 342 | 10852.89 | 36.171 | 16.32 |
| 223 | 6691.02 | 33.588 | 25.89 | 283 | 8750.74 | 35.031 | 22.03 | 343 | 10889.07 | 36.187 | 16.21 |
| 224 | 6724.62 | 33.614 | 25.83 | 284 | 8785.78 | 35.053 | 21.96 | 344 | 10925.26 | 36.203 | 16.11 |
| 225 | 6758.25 | 33.640 | 25.77 | 285 | 8820.84 | 35.075 | 21.88 | 345 | 10961.47 | 36.219 | 16.01 |
| 226 | 6791.90 | 33.665 | 25.71 | 286 | 8855.93 | 35.097 | 21.79 | 346 | 10997.70 | 36.235 | 15.91 |
| 227 | 6825.58 | 33.691 | 25.65 | 287 | 8891.04 | 35.119 | 21.71 | 347 | 11033.94 | 36.251 | 15.81 |
| 228 | 6859.28 | 33.717 | 25.59 | 288 | 8926.17 | 35.141 | 21.63 | 348 | 11070.20 | 36.267 | 15.71 |
| 229 | 6893.01 | 33.742 | 25.53 | 289 | 8961.32 | 35.162 | 21.55 | 349 | 11106.48 | 36.283 | 15.61 |
| 230 | 6926.76 | 33.768 | 25.47 | 290 | 8996.49 | 35.184 | 21.46 | 350 | 11142.77 | 36.298 | 15.51 |
| 231 | 6960.54 | 33.793 | 25.41 | 291 | 9031.69 | 35.205 | 21.38 | 351 | 11179.07 | 36.314 | 15.41 |
| 232 | 6994.35 | 33.819 | 25.36 | 292 | 9066.90 | 35.226 | 21.30 | 352 | 11215.40 | 36.329 | 15.32 |
| 233 | 7028.18 | 33.844 | 25.30 | 293 | 9102.14 | 35.248 | 21.21 | 353 | 11251.73 | 36.344 | 15.22 |
| 234 | 7062.04 | 33.869 | 25.24 | 294 | 9137.40 | 35.269 | 21.12 | 354 | 11288.08 | 36.360 | 15.13 |
| 235 | 7095.92 | 33.894 | 25.18 | 295 | 9172.68 | 35.290 | 21.04 | 355 | 11324.45 | 36.375 | 15.04 |
| 236 | 7129.83 | 33.919 | 25.12 | 296 | 9207.98 | 35.311 | 20.95 | 356 | 11360.83 | 36.390 | 14.95 |
| 237 | 7163.76 | 33.945 | 25.06 | 297 | 9243.30 | 35.332 | 20.86 | 357 | 11397.23 | 36.405 | 14.86 |
| 238 | 7197.72 | 33.970 | 25.00 | 298 | 9278.64 | 35.353 | 20.77 | 358 | 11433.64 | 36.419 | 14.77 |
| 239 | 7231.70 | 33.995 | 24.94 | 299 | 9314.00 | 35.373 | 20.68 | 359 | 11470.07 | 36.434 | 14.68 |
| 240 | 7265.71 | 34.019 | 24.89 | 300 | 9349.39 | 35.394 | 20.59 | 360 | 11506.51 | 36.449 | 14.59 |

TABLE 7.3.4 AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Extended temperature range, 0 to 400 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 360 | 11506.51 | 36.449 | 14.59 | 375 | 12054.84 | 36.659 | 13.57 | 390 | 12606.23 | 36.859 | 13.25 |
| 361 | 11542.97 | 36.463 | 14.51 | 376 | 12091.51 | 36.673 | 13.52 | 391 | 12643.10 | 36.872 | 13.26 |
| 362 | 11579.44 | 36.478 | 14.43 | 377 | 12128.19 | 36.686 | 13.48 | 392 | 12679.98 | 36.886 | 13.28 |
| 363 | 11615.92 | 36.492 | 14.35 | 378 | 12164.88 | 36.700 | 13.44 | 393 | 12716.87 | 36.899 | 13.30 |
| 364 | 11652.42 | 36.506 | 14.27 | 379 | 12201.58 | 36.713 | 13.40 | 394 | 12753.78 | 36.912 | 13.33 |
| 365 | 11688.93 | 36.521 | 14.20 | 380 | 12238.30 | 36.727 | 13.36 | 395 | 12790.70 | 36.926 | 13.36 |
| 366 | 11725.46 | 36.535 | 14.12 | 381 | 12275.04 | 36.740 | 13.33 | 396 | 12827.63 | 36.939 | 13.40 |
| 367 | 11762.00 | 36.549 | 14.05 | 382 | 12311.78 | 36.753 | 13.31 | 397 | 12864.57 | 36.953 | 13.45 |
| 368 | 11798.56 | 36.563 | 13.98 | 383 | 12348.54 | 36.767 | 13.29 | 398 | 12901.53 | 36.966 | 13.50 |
| 369 | 11835.13 | 36.577 | 13.91 | 384 | 12385.32 | 36.780 | 13.27 | 399 | 12938.51 | 36.980 | 13.56 |
| 370 | 11871.71 | 36.591 | 13.85 | 385 | 12422.10 | 36.793 | 13.25 | 400 | 12975.49 | 36.993 | 13.62 |
| 371 | 11908.31 | 36.605 | 13.79 | 386 | 12458.90 | 36.806 | 13.24 | | | | |
| 372 | 11944.92 | 36.618 | 13.73 | 387 | 12495.72 | 36.820 | 13.24 | | | | |
| 373 | 11981.55 | 36.632 | 13.67 | 388 | 12532.54 | 36.833 | 13.23 | | | | |
| 374 | 12018.19 | 36.646 | 13.62 | 389 | 12569.38 | 36.846 | 13.24 | | | | |
| 375 | 12054.84 | 36.659 | 13.57 | 390 | 12606.23 | 36.859 | 13.25 | | | | |

**TABLE 7.3.5** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C.*

| T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 25.898 | 33.31 | 60 | 1618.6 | 28.107 | 38.52 | 120 | 3373.7 | 30.371 | 36.17 |
| 1 | 25.9 | 25.931 | 33.50 | 61 | 1646.7 | 28.145 | 38.53 | 121 | 3404.1 | 30.407 | 36.10 |
| 2 | 51.9 | 25.965 | 33.68 | 62 | 1674.9 | 28.184 | 38.53 | 122 | 3434.5 | 30.443 | 36.02 |
| 3 | 77.8 | 25.999 | 33.86 | 63 | 1703.1 | 28.222 | 38.53 | 123 | 3464.9 | 30.479 | 35.95 |
| 4 | 103.9 | 26.033 | 34.03 | 64 | 1731.3 | 28.261 | 38.53 | 124 | 3495.4 | 30.515 | 35.87 |
| 5 | 129.9 | 26.067 | 34.20 | 65 | 1759.6 | 28.299 | 38.53 | 125 | 3526.0 | 30.551 | 35.79 |
| 6 | 156.0 | 26.101 | 34.36 | 66 | 1787.9 | 28.338 | 38.53 | 126 | 3556.5 | 30.587 | 35.72 |
| 7 | 182.1 | 26.135 | 34.53 | 67 | 1816.3 | 28.376 | 38.52 | 127 | 3587.1 | 30.622 | 35.64 |
| 8 | 208.3 | 26.170 | 34.68 | 68 | 1844.7 | 28.415 | 38.52 | 128 | 3617.8 | 30.658 | 35.56 |
| 9 | 234.5 | 26.205 | 34.84 | 69 | 1873.1 | 28.453 | 38.51 | 129 | 3648.5 | 30.694 | 35.48 |
| 10 | 260.7 | 26.240 | 34.99 | 70 | 1901.6 | 28.492 | 38.50 | 130 | 3679.2 | 30.729 | 35.40 |
| 11 | 286.9 | 26.275 | 35.13 | 71 | 1930.1 | 28.530 | 38.48 | 131 | 3709.9 | 30.764 | 35.32 |
| 12 | 313.2 | 26.310 | 35.28 | 72 | 1958.7 | 28.569 | 38.47 | 132 | 3740.7 | 30.800 | 35.24 |
| 13 | 339.6 | 26.345 | 35.41 | 73 | 1987.2 | 28.607 | 38.45 | 133 | 3771.5 | 30.835 | 35.16 |
| 14 | 365.9 | 26.381 | 35.55 | 74 | 2015.9 | 28.646 | 38.44 | 134 | 3802.4 | 30.870 | 35.08 |
| 15 | 392.3 | 26.416 | 35.68 | 75 | 2044.5 | 28.684 | 38.42 | 135 | 3833.3 | 30.905 | 35.00 |
| 16 | 418.7 | 26.452 | 35.81 | 76 | 2073.2 | 28.722 | 38.40 | 136 | 3864.2 | 30.940 | 34.91 |
| 17 | 445.2 | 26.488 | 35.93 | 77 | 2102.0 | 28.761 | 38.37 | 137 | 3895.1 | 30.975 | 34.83 |
| 18 | 471.7 | 26.524 | 36.06 | 78 | 2130.8 | 28.799 | 38.35 | 138 | 3926.1 | 31.010 | 34.74 |
| 19 | 498.3 | 26.560 | 36.17 | 79 | 2159.6 | 28.838 | 38.32 | 139 | 3957.2 | 31.044 | 34.66 |
| 20 | 524.8 | 26.596 | 36.29 | 80 | 2188.4 | 28.876 | 38.30 | 140 | 3988.2 | 31.079 | 34.57 |
| 21 | 551.5 | 26.633 | 36.40 | 81 | 2217.3 | 28.914 | 38.27 | 141 | 4019.3 | 31.113 | 34.49 |
| 22 | 578.1 | 26.669 | 36.51 | 82 | 2246.3 | 28.952 | 38.24 | 142 | 4050.4 | 31.148 | 34.40 |
| 23 | 604.8 | 26.706 | 36.61 | 83 | 2275.2 | 28.991 | 38.20 | 143 | 4081.6 | 31.182 | 34.32 |
| 24 | 631.5 | 26.742 | 36.71 | 84 | 2304.2 | 29.029 | 38.17 | 144 | 4112.8 | 31.217 | 34.23 |
| 25 | 658.3 | 26.779 | 36.81 | 85 | 2333.3 | 29.067 | 38.14 | 145 | 4144.0 | 31.251 | 34.14 |
| 26 | 685.1 | 26.816 | 36.91 | 86 | 2362.4 | 29.105 | 38.10 | 146 | 4175.3 | 31.285 | 34.05 |
| 27 | 711.9 | 26.853 | 37.00 | 87 | 2391.5 | 29.143 | 38.06 | 147 | 4206.6 | 31.319 | 33.97 |
| 28 | 738.8 | 26.890 | 37.09 | 88 | 2420.7 | 29.181 | 38.02 | 148 | 4237.9 | 31.353 | 33.88 |
| 29 | 765.7 | 26.927 | 37.18 | 89 | 2449.9 | 29.219 | 37.98 | 149 | 4269.3 | 31.387 | 33.79 |
| 30 | 792.6 | 26.964 | 37.26 | 90 | 2479.1 | 29.257 | 37.94 | 150 | 4300.7 | 31.420 | 33.70 |
| 31 | 819.6 | 27.002 | 37.34 | 91 | 2508.4 | 29.295 | 37.90 | 151 | 4332.2 | 31.454 | 33.61 |
| 32 | 846.6 | 27.039 | 37.42 | 92 | 2537.7 | 29.333 | 37.85 | 152 | 4363.6 | 31.488 | 33.52 |
| 33 | 873.7 | 27.076 | 37.49 | 93 | 2567.0 | 29.371 | 37.81 | 153 | 4395.1 | 31.521 | 33.43 |
| 34 | 900.8 | 27.114 | 37.56 | 94 | 2596.4 | 29.409 | 37.76 | 154 | 4426.7 | 31.554 | 33.34 |
| 35 | 927.9 | 27.152 | 37.63 | 95 | 2625.9 | 29.446 | 37.71 | 155 | 4458.2 | 31.588 | 33.25 |
| 36 | 955.1 | 27.189 | 37.70 | 96 | 2655.3 | 29.484 | 37.66 | 156 | 4489.8 | 31.621 | 33.15 |
| 37 | 982.3 | 27.227 | 37.76 | 97 | 2684.8 | 29.522 | 37.61 | 157 | 4521.5 | 31.654 | 33.06 |
| 38 | 1009.5 | 27.265 | 37.82 | 98 | 2714.4 | 29.559 | 37.56 | 158 | 4553.2 | 31.687 | 32.97 |
| 39 | 1036.8 | 27.303 | 37.88 | 99 | 2744.0 | 29.597 | 37.51 | 159 | 4584.9 | 31.720 | 32.88 |
| 40 | 1064.2 | 27.340 | 37.93 | 100 | 2773.6 | 29.634 | 37.45 | 160 | 4616.6 | 31.753 | 32.79 |
| 41 | 1091.5 | 27.378 | 37.98 | 101 | 2803.2 | 29.672 | 37.40 | 161 | 4648.4 | 31.786 | 32.69 |
| 42 | 1118.9 | 27.416 | 38.03 | 102 | 2832.9 | 29.709 | 37.34 | 162 | 4680.2 | 31.818 | 32.60 |
| 43 | 1146.3 | 27.454 | 38.08 | 103 | 2862.6 | 29.746 | 37.29 | 163 | 4712.0 | 31.851 | 32.51 |
| 44 | 1173.8 | 27.493 | 38.13 | 104 | 2892.4 | 29.784 | 37.23 | 164 | 4743.9 | 31.883 | 32.41 |
| 45 | 1201.3 | 27.531 | 38.17 | 105 | 2922.2 | 29.821 | 37.17 | 165 | 4775.8 | 31.916 | 32.32 |
| 46 | 1228.9 | 27.569 | 38.21 | 106 | 2952.0 | 29.858 | 37.11 | 166 | 4807.7 | 31.948 | 32.23 |
| 47 | 1256.5 | 27.607 | 38.24 | 107 | 2981.9 | 29.895 | 37.05 | 167 | 4839.7 | 31.980 | 32.13 |
| 48 | 1284.1 | 27.645 | 38.28 | 108 | 3011.8 | 29.932 | 36.99 | 168 | 4871.7 | 32.012 | 32.04 |
| 49 | 1311.8 | 27.684 | 38.31 | 109 | 3041.8 | 29.969 | 36.92 | 169 | 4903.7 | 32.044 | 31.94 |
| 50 | 1339.5 | 27.722 | 38.34 | 110 | 3071.8 | 30.006 | 36.86 | 170 | 4935.7 | 32.076 | 31.85 |
| 51 | 1367.2 | 27.760 | 38.37 | 111 | 3101.8 | 30.043 | 36.79 | 171 | 4967.8 | 32.108 | 31.75 |
| 52 | 1395.0 | 27.799 | 38.40 | 112 | 3131.9 | 30.079 | 36.73 | 172 | 5000.0 | 32.140 | 31.66 |
| 53 | 1422.8 | 27.837 | 38.42 | 113 | 3162.0 | 30.116 | 36.66 | 173 | 5032.1 | 32.171 | 31.56 |
| 54 | 1450.7 | 27.876 | 38.44 | 114 | 3192.1 | 30.153 | 36.59 | 174 | 5064.3 | 32.203 | 31.47 |
| 55 | 1478.6 | 27.914 | 38.46 | 115 | 3222.3 | 30.189 | 36.52 | 175 | 5096.5 | 32.234 | 31.37 |
| 56 | 1506.5 | 27.953 | 38.48 | 116 | 3252.5 | 30.226 | 36.45 | 176 | 5128.8 | 32.265 | 31.28 |
| 57 | 1534.5 | 27.991 | 38.49 | 117 | 3282.7 | 30.262 | 36.38 | 177 | 5161.1 | 32.297 | 31.18 |
| 58 | 1562.5 | 28.030 | 38.50 | 118 | 3313.0 | 30.299 | 36.31 | 178 | 5193.4 | 32.328 | 31.08 |
| 59 | 1590.5 | 28.068 | 38.51 | 119 | 3343.3 | 30.335 | 36.24 | 179 | 5225.7 | 32.359 | 30.99 |
| 60 | 1618.6 | 28.107 | 38.52 | 120 | 3373.7 | 30.371 | 36.17 | 180 | 5258.1 | 32.390 | 30.89 |

**Table 7.3.5** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 5258.1 | 32.390 | 30.89 | 240 | 7253.6 | 34.071 | 25.19 | 300 | 9340.0 | 35.427 | 20.18 |
| 181 | 5290.5 | 32.421 | 30.80 | 241 | 7287.7 | 34.096 | 25.10 | 301 | 9375.5 | 35.447 | 20.11 |
| 182 | 5322.9 | 32.451 | 30.70 | 242 | 7321.8 | 34.121 | 25.01 | 302 | 9410.9 | 35.467 | 20.03 |
| 183 | 5355.4 | 32.482 | 30.60 | 243 | 7355.9 | 34.146 | 24.92 | 303 | 9446.4 | 35.487 | 19.96 |
| 184 | 5387.9 | 32.512 | 30.51 | 244 | 7390.1 | 34.171 | 24.83 | 304 | 9481.9 | 35.507 | 19.88 |
| 185 | 5420.4 | 32.543 | 30.41 | 245 | 7424.3 | 34.195 | 24.74 | 305 | 9517.4 | 35.527 | 19.81 |
| 186 | 5453.0 | 32.573 | 30.31 | 246 | 7458.5 | 34.220 | 24.65 | 306 | 9553.0 | 35.547 | 19.73 |
| 187 | 5485.6 | 32.604 | 30.22 | 247 | 7492.7 | 34.245 | 24.56 | 307 | 9588.5 | 35.567 | 19.66 |
| 188 | 5518.2 | 32.634 | 30.12 | 248 | 7527.0 | 34.269 | 24.47 | 308 | 9624.1 | 35.586 | 19.58 |
| 189 | 5550.8 | 32.664 | 30.02 | 249 | 7561.3 | 34.294 | 24.38 | 309 | 9659.7 | 35.606 | 19.51 |
| 190 | 5583.5 | 32.694 | 29.93 | 250 | 7595.6 | 34.318 | 24.30 | 310 | 9695.3 | 35.625 | 19.44 |
| 191 | 5616.2 | 32.724 | 29.83 | 251 | 7629.9 | 34.342 | 24.21 | 311 | 9730.9 | 35.645 | 19.37 |
| 192 | 5649.0 | 32.753 | 29.73 | 252 | 7664.2 | 34.366 | 24.12 | 312 | 9766.6 | 35.664 | 19.29 |
| 193 | 5681.7 | 32.783 | 29.64 | 253 | 7698.6 | 34.391 | 24.03 | 313 | 9802.3 | 35.683 | 19.22 |
| 194 | 5714.5 | 32.813 | 29.54 | 254 | 7733.0 | 34.414 | 23.94 | 314 | 9838.0 | 35.702 | 19.15 |
| 195 | 5747.4 | 32.842 | 29.44 | 255 | 7767.4 | 34.438 | 23.86 | 315 | 9873.7 | 35.722 | 19.08 |
| 196 | 5780.2 | 32.872 | 29.35 | 256 | 7801.9 | 34.462 | 23.77 | 316 | 9909.4 | 35.741 | 19.01 |
| 197 | 5813.1 | 32.901 | 29.25 | 257 | 7836.4 | 34.486 | 23.68 | 317 | 9945.2 | 35.760 | 18.94 |
| 198 | 5846.0 | 32.930 | 29.15 | 258 | 7870.9 | 34.510 | 23.59 | 318 | 9980.9 | 35.778 | 18.86 |
| 199 | 5879.0 | 32.959 | 29.06 | 259 | 7905.4 | 34.533 | 23.51 | 319 | 10016.7 | 35.797 | 18.79 |
| 200 | 5911.9 | 32.988 | 28.96 | 260 | 7939.9 | 34.557 | 23.42 | 320 | 10052.5 | 35.816 | 18.72 |
| 201 | 5944.9 | 33.017 | 28.87 | 261 | 7974.5 | 34.580 | 23.33 | 321 | 10088.4 | 35.835 | 18.65 |
| 202 | 5978.0 | 33.046 | 28.77 | 262 | 8009.1 | 34.603 | 23.25 | 322 | 10124.2 | 35.853 | 18.58 |
| 203 | 6011.0 | 33.075 | 28.67 | 263 | 8043.7 | 34.626 | 23.16 | 323 | 10160.1 | 35.872 | 18.51 |
| 204 | 6044.1 | 33.103 | 28.58 | 264 | 8078.4 | 34.650 | 23.08 | 324 | 10195.9 | 35.890 | 18.44 |
| 205 | 6077.2 | 33.132 | 28.48 | 265 | 8113.0 | 34.673 | 22.99 | 325 | 10231.8 | 35.909 | 18.38 |
| 206 | 6110.4 | 33.160 | 28.38 | 266 | 8147.7 | 34.696 | 22.91 | 326 | 10267.8 | 35.927 | 18.31 |
| 207 | 6143.5 | 33.189 | 28.29 | 267 | 8182.4 | 34.718 | 22.82 | 327 | 10303.7 | 35.945 | 18.24 |
| 208 | 6176.8 | 33.217 | 28.19 | 268 | 8217.1 | 34.741 | 22.74 | 328 | 10339.6 | 35.964 | 18.17 |
| 209 | 6210.0 | 33.245 | 28.10 | 269 | 8251.9 | 34.764 | 22.65 | 329 | 10375.6 | 35.982 | 18.10 |
| 210 | 6243.2 | 33.273 | 28.00 | 270 | 8286.7 | 34.787 | 22.57 | 330 | 10411.6 | 36.000 | 18.03 |
| 211 | 6276.5 | 33.301 | 27.90 | 271 | 8321.5 | 34.809 | 22.49 | 331 | 10447.6 | 36.018 | 17.97 |
| 212 | 6309.8 | 33.329 | 27.81 | 272 | 8356.3 | 34.831 | 22.40 | 332 | 10483.6 | 36.036 | 17.90 |
| 213 | 6343.2 | 33.357 | 27.71 | 273 | 8391.1 | 34.854 | 22.32 | 333 | 10519.7 | 36.054 | 17.83 |
| 214 | 6376.6 | 33.384 | 27.62 | 274 | 8426.0 | 34.876 | 22.24 | 334 | 10555.8 | 36.071 | 17.77 |
| 215 | 6410.0 | 33.412 | 27.52 | 275 | 8460.9 | 34.898 | 22.16 | 335 | 10591.8 | 36.089 | 17.70 |
| 216 | 6443.4 | 33.439 | 27.43 | 276 | 8495.8 | 34.920 | 22.07 | 336 | 10627.9 | 36.107 | 17.63 |
| 217 | 6476.8 | 33.467 | 27.33 | 277 | 8530.7 | 34.942 | 21.99 | 337 | 10664.0 | 36.124 | 17.57 |
| 218 | 6510.3 | 33.494 | 27.24 | 278 | 8565.7 | 34.964 | 21.91 | 338 | 10700.2 | 36.142 | 17.50 |
| 219 | 6543.8 | 33.521 | 27.14 | 279 | 8600.6 | 34.986 | 21.83 | 339 | 10736.3 | 36.159 | 17.44 |
| 220 | 6577.4 | 33.548 | 27.05 | 280 | 8635.6 | 35.008 | 21.75 | 340 | 10772.5 | 36.177 | 17.37 |
| 221 | 6610.9 | 33.575 | 26.96 | 281 | 8670.7 | 35.030 | 21.67 | 341 | 10808.7 | 36.194 | 17.31 |
| 222 | 6644.5 | 33.602 | 26.86 | 282 | 8705.7 | 35.051 | 21.59 | 342 | 10844.9 | 36.211 | 17.24 |
| 223 | 6678.1 | 33.629 | 26.77 | 283 | 8740.8 | 35.073 | 21.50 | 343 | 10881.1 | 36.229 | 17.18 |
| 224 | 6711.8 | 33.656 | 26.67 | 284 | 8775.8 | 35.094 | 21.42 | 344 | 10917.3 | 36.246 | 17.11 |
| 225 | 6745.4 | 33.682 | 26.58 | 285 | 8811.0 | 35.116 | 21.35 | 345 | 10953.6 | 36.263 | 17.05 |
| 226 | 6779.1 | 33.709 | 26.49 | 286 | 8846.1 | 35.137 | 21.27 | 346 | 10989.9 | 36.280 | 16.99 |
| 227 | 6812.9 | 33.735 | 26.39 | 287 | 8881.2 | 35.158 | 21.19 | 347 | 11026.2 | 36.297 | 16.92 |
| 228 | 6846.6 | 33.762 | 26.30 | 288 | 8916.4 | 35.179 | 21.11 | 348 | 11062.5 | 36.314 | 16.86 |
| 229 | 6880.4 | 33.788 | 26.21 | 289 | 8951.6 | 35.201 | 21.03 | 349 | 11098.8 | 36.331 | 16.80 |
| 230 | 6914.2 | 33.814 | 26.11 | 290 | 8986.8 | 35.222 | 20.95 | 350 | 11135.1 | 36.347 | 16.73 |
| 231 | 6948.0 | 33.840 | 26.02 | 291 | 9022.0 | 35.242 | 20.87 | 351 | 11171.5 | 36.364 | 16.67 |
| 232 | 6981.9 | 33.866 | 25.93 | 292 | 9057.3 | 35.263 | 20.79 | 352 | 11207.9 | 36.381 | 16.61 |
| 233 | 7015.7 | 33.892 | 25.83 | 293 | 9092.6 | 35.284 | 20.72 | 353 | 11244.2 | 36.397 | 16.55 |
| 234 | 7049.6 | 33.918 | 25.74 | 294 | 9127.8 | 35.305 | 20.64 | 354 | 11280.6 | 36.414 | 16.49 |
| 235 | 7083.6 | 33.943 | 25.65 | 295 | 9163.2 | 35.325 | 20.56 | 355 | 11317.1 | 36.430 | 16.42 |
| 236 | 7117.5 | 33.969 | 25.56 | 296 | 9198.5 | 35.346 | 20.49 | 356 | 11353.5 | 36.447 | 16.36 |
| 237 | 7151.5 | 33.995 | 25.47 | 297 | 9233.9 | 35.366 | 20.41 | 357 | 11390.0 | 36.463 | 16.30 |
| 238 | 7185.5 | 34.020 | 25.38 | 298 | 9269.2 | 35.387 | 20.33 | 358 | 11426.4 | 36.479 | 16.24 |
| 239 | 7219.5 | 34.045 | 25.28 | 299 | 9304.6 | 35.407 | 20.26 | 359 | 11462.9 | 36.495 | 16.18 |
| 240 | 7253.6 | 34.071 | 25.19 | 300 | 9340.0 | 35.427 | 20.18 | 360 | 11499.4 | 36.512 | 16.12 |

**Table 7.3.5** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 360 | 11499.4 | 36.512 | 16.12 | 420 | 13717.1 | 37.378 | 12.85 | 480 | 15981.2 | 38.064 | 10.09 |
| 361 | 11535.9 | 36.528 | 16.06 | 421 | 13754.5 | 37.390 | 12.81 | 481 | 16019.2 | 38.074 | 10.05 |
| 362 | 11572.5 | 36.544 | 16.00 | 422 | 13791.9 | 37.403 | 12.76 | 482 | 16057.3 | 38.084 | 10.00 |
| 363 | 11609.0 | 36.560 | 15.94 | 423 | 13829.3 | 37.416 | 12.71 | 483 | 16095.4 | 38.094 | 9.96 |
| 364 | 11645.6 | 36.576 | 15.88 | 424 | 13866.7 | 37.429 | 12.66 | 484 | 16133.5 | 38.104 | 9.92 |
| 365 | 11682.2 | 36.591 | 15.82 | 425 | 13904.1 | 37.441 | 12.61 | 485 | 16171.6 | 38.114 | 9.87 |
| 366 | 11718.8 | 36.607 | 15.76 | 426 | 13941.6 | 37.454 | 12.56 | 486 | 16209.7 | 38.124 | 9.83 |
| 367 | 11755.4 | 36.623 | 15.70 | 427 | 13979.0 | 37.466 | 12.51 | 487 | 16247.8 | 38.134 | 9.79 |
| 368 | 11792.0 | 36.639 | 15.64 | 428 | 14016.5 | 37.479 | 12.46 | 488 | 16286.0 | 38.143 | 9.74 |
| 369 | 11828.7 | 36.654 | 15.59 | 429 | 14054.0 | 37.491 | 12.42 | 489 | 16324.1 | 38.153 | 9.70 |
| 370 | 11865.3 | 36.670 | 15.53 | 430 | 14091.5 | 37.504 | 12.37 | 490 | 16362.3 | 38.163 | 9.66 |
| 371 | 11902.0 | 36.685 | 15.47 | 431 | 14129.0 | 37.516 | 12.32 | 491 | 16400.5 | 38.172 | 9.61 |
| 372 | 11938.7 | 36.701 | 15.41 | 432 | 14166.5 | 37.528 | 12.27 | 492 | 16438.6 | 38.182 | 9.57 |
| 373 | 11975.4 | 36.716 | 15.35 | 433 | 14204.1 | 37.541 | 12.22 | 493 | 16476.8 | 38.192 | 9.53 |
| 374 | 12012.1 | 36.731 | 15.30 | 434 | 14241.6 | 37.553 | 12.18 | 494 | 16515.0 | 38.201 | 9.49 |
| 375 | 12048.9 | 36.747 | 15.24 | 435 | 14279.2 | 37.565 | 12.13 | 495 | 16553.2 | 38.211 | 9.44 |
| 376 | 12085.6 | 36.762 | 15.18 | 436 | 14316.7 | 37.577 | 12.08 | 496 | 16591.4 | 38.220 | 9.40 |
| 377 | 12122.4 | 36.777 | 15.13 | 437 | 14354.3 | 37.589 | 12.03 | 497 | 16629.7 | 38.229 | 9.36 |
| 378 | 12159.2 | 36.792 | 15.07 | 438 | 14391.9 | 37.601 | 11.99 | 498 | 16667.9 | 38.239 | 9.32 |
| 379 | 12196.0 | 36.807 | 15.01 | 439 | 14429.5 | 37.613 | 11.94 | 499 | 16706.1 | 38.248 | 9.27 |
| 380 | 12232.8 | 36.822 | 14.96 | 440 | 14467.1 | 37.625 | 11.89 | 500 | 16744.4 | 38.257 | 9.23 |
| 381 | 12269.6 | 36.837 | 14.90 | 441 | 14504.8 | 37.637 | 11.85 | 501 | 16782.7 | 38.266 | 9.19 |
| 382 | 12306.5 | 36.852 | 14.85 | 442 | 14542.4 | 37.649 | 11.80 | 502 | 16820.9 | 38.276 | 9.15 |
| 383 | 12343.3 | 36.867 | 14.79 | 443 | 14580.1 | 37.660 | 11.75 | 503 | 16859.2 | 38.285 | 9.10 |
| 384 | 12380.2 | 36.882 | 14.73 | 444 | 14617.7 | 37.672 | 11.71 | 504 | 16897.5 | 38.294 | 9.06 |
| 385 | 12417.1 | 36.896 | 14.68 | 445 | 14655.4 | 37.684 | 11.66 | 505 | 16935.8 | 38.303 | 9.02 |
| 386 | 12454.0 | 36.911 | 14.62 | 446 | 14693.1 | 37.695 | 11.61 | 506 | 16974.1 | 38.312 | 8.98 |
| 387 | 12490.9 | 36.926 | 14.57 | 447 | 14730.8 | 37.707 | 11.57 | 507 | 17012.4 | 38.321 | 8.93 |
| 388 | 12527.9 | 36.940 | 14.51 | 448 | 14768.5 | 37.719 | 11.52 | 508 | 17050.7 | 38.330 | 8.89 |
| 389 | 12564.8 | 36.955 | 14.46 | 449 | 14806.2 | 37.730 | 11.47 | 509 | 17089.1 | 38.339 | 8.85 |
| 390 | 12601.8 | 36.969 | 14.41 | 450 | 14844.0 | 37.742 | 11.43 | 510 | 17127.4 | 38.347 | 8.81 |
| 391 | 12638.7 | 36.983 | 14.35 | 451 | 14881.7 | 37.753 | 11.38 | 511 | 17165.8 | 38.356 | 8.77 |
| 392 | 12675.7 | 36.998 | 14.30 | 452 | 14919.5 | 37.764 | 11.34 | 512 | 17204.1 | 38.365 | 8.72 |
| 393 | 12712.7 | 37.012 | 14.24 | 453 | 14957.2 | 37.776 | 11.29 | 513 | 17242.5 | 38.374 | 8.68 |
| 394 | 12749.8 | 37.026 | 14.19 | 454 | 14995.0 | 37.787 | 11.25 | 514 | 17280.9 | 38.382 | 8.64 |
| 395 | 12786.8 | 37.040 | 14.14 | 455 | 15032.8 | 37.798 | 11.20 | 515 | 17319.3 | 38.391 | 8.60 |
| 396 | 12823.8 | 37.054 | 14.08 | 456 | 15070.6 | 37.809 | 11.15 | 516 | 17357.7 | 38.400 | 8.56 |
| 397 | 12860.9 | 37.069 | 14.03 | 457 | 15108.4 | 37.820 | 11.11 | 517 | 17396.1 | 38.408 | 8.52 |
| 398 | 12898.0 | 37.083 | 13.98 | 458 | 15146.3 | 37.831 | 11.06 | 518 | 17434.5 | 38.417 | 8.47 |
| 399 | 12935.1 | 37.096 | 13.92 | 459 | 15184.1 | 37.843 | 11.02 | 519 | 17472.9 | 38.425 | 8.43 |
| 400 | 12972.2 | 37.110 | 13.87 | 460 | 15221.9 | 37.854 | 10.97 | 520 | 17511.3 | 38.433 | 8.39 |
| 401 | 13009.3 | 37.124 | 13.82 | 461 | 15259.8 | 37.864 | 10.93 | 521 | 17549.8 | 38.442 | 8.35 |
| 402 | 13046.4 | 37.138 | 13.77 | 462 | 15297.7 | 37.875 | 10.88 | 522 | 17588.2 | 38.450 | 8.31 |
| 403 | 13083.6 | 37.152 | 13.72 | 463 | 15335.6 | 37.886 | 10.84 | 523 | 17626.7 | 38.458 | 8.27 |
| 404 | 13120.7 | 37.165 | 13.66 | 464 | 15373.4 | 37.897 | 10.79 | 524 | 17665.1 | 38.467 | 8.22 |
| 405 | 13157.9 | 37.179 | 13.61 | 465 | 15411.4 | 37.908 | 10.75 | 525 | 17703.6 | 38.475 | 8.18 |
| 406 | 13195.1 | 37.193 | 13.56 | 466 | 15449.3 | 37.919 | 10.71 | 526 | 17742.1 | 38.483 | 8.14 |
| 407 | 13232.3 | 37.206 | 13.51 | 467 | 15487.2 | 37.929 | 10.66 | 527 | 17780.6 | 38.491 | 8.10 |
| 408 | 13269.5 | 37.220 | 13.46 | 468 | 15525.1 | 37.940 | 10.62 | 528 | 17819.1 | 38.499 | 8.06 |
| 409 | 13306.7 | 37.233 | 13.41 | 469 | 15563.1 | 37.950 | 10.57 | 529 | 17857.6 | 38.507 | 8.02 |
| 410 | 13344.0 | 37.246 | 13.36 | 470 | 15601.0 | 37.961 | 10.53 | 530 | 17896.1 | 38.515 | 7.97 |
| 411 | 13381.2 | 37.260 | 13.31 | 471 | 15639.0 | 37.972 | 10.48 | 531 | 17934.6 | 38.523 | 7.93 |
| 412 | 13418.5 | 37.273 | 13.25 | 472 | 15677.0 | 37.982 | 10.44 | 532 | 17973.1 | 38.531 | 7.89 |
| 413 | 13455.8 | 37.286 | 13.20 | 473 | 15715.0 | 37.992 | 10.40 | 533 | 18011.7 | 38.539 | 7.85 |
| 414 | 13493.0 | 37.300 | 13.15 | 474 | 15753.0 | 38.003 | 10.35 | 534 | 18050.2 | 38.547 | 7.81 |
| 415 | 13530.4 | 37.313 | 13.10 | 475 | 15791.0 | 38.013 | 10.31 | 535 | 18088.8 | 38.555 | 7.77 |
| 416 | 13567.7 | 37.326 | 13.05 | 476 | 15829.0 | 38.023 | 10.26 | 536 | 18127.3 | 38.562 | 7.73 |
| 417 | 13605.0 | 37.339 | 13.00 | 477 | 15867.0 | 38.034 | 10.22 | 537 | 18165.9 | 38.570 | 7.69 |
| 418 | 13642.3 | 37.352 | 12.95 | 478 | 15905.0 | 38.044 | 10.18 | 538 | 18204.5 | 38.578 | 7.64 |
| 419 | 13679.7 | 37.365 | 12.90 | 479 | 15943.1 | 38.054 | 10.13 | 539 | 18243.0 | 38.585 | 7.60 |
| 420 | 13717.1 | 37.378 | 12.85 | 480 | 15981.2 | 38.064 | 10.09 | 540 | 18281.6 | 38.593 | 7.56 |

TABLE 7.3.5 AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 540 | 18281.6 | 38.593 | 7.56 | 600 | 20609.3 | 38.973 | 5.13 | 660 | 22955.6 | 39.210 | 2.79 |
| 541 | 18320.2 | 38.601 | 7.52 | 601 | 20648.3 | 38.979 | 5.09 | 661 | 22994.8 | 39.213 | 2.75 |
| 542 | 18358.8 | 38.608 | 7.48 | 602 | 20687.3 | 38.984 | 5.05 | 662 | 23034.0 | 39.216 | 2.71 |
| 543 | 18397.4 | 38.615 | 7.44 | 603 | 20726.3 | 38.989 | 5.01 | 663 | 23073.2 | 39.219 | 2.68 |
| 544 | 18436.1 | 38.623 | 7.40 | 604 | 20765.3 | 38.994 | 4.97 | 664 | 23112.4 | 39.221 | 2.64 |
| 545 | 18474.7 | 38.630 | 7.36 | 605 | 20804.3 | 38.999 | 4.93 | 665 | 23151.7 | 39.224 | 2.60 |
| 546 | 18513.3 | 38.638 | 7.32 | 606 | 20843.3 | 39.004 | 4.89 | 666 | 23190.9 | 39.227 | 2.56 |
| 547 | 18552.0 | 38.645 | 7.28 | 607 | 20882.3 | 39.008 | 4.85 | 667 | 23230.1 | 39.229 | 2.53 |
| 548 | 18590.6 | 38.652 | 7.23 | 608 | 20921.3 | 39.013 | 4.81 | 668 | 23269.3 | 39.232 | 2.49 |
| 549 | 18629.3 | 38.659 | 7.19 | 609 | 20960.3 | 39.018 | 4.77 | 669 | 23308.6 | 39.234 | 2.45 |
| 550 | 18667.9 | 38.667 | 7.15 | 610 | 20999.3 | 39.023 | 4.73 | 670 | 23347.8 | 39.236 | 2.41 |
| 551 | 18706.6 | 38.674 | 7.11 | 611 | 21038.4 | 39.027 | 4.69 | 671 | 23387.0 | 39.239 | 2.38 |
| 552 | 18745.3 | 38.681 | 7.07 | 612 | 21077.4 | 39.032 | 4.65 | 672 | 23426.3 | 39.241 | 2.34 |
| 553 | 18784.0 | 38.688 | 7.03 | 613 | 21116.4 | 39.037 | 4.61 | 673 | 23465.5 | 39.244 | 2.30 |
| 554 | 18822.6 | 38.695 | 6.99 | 614 | 21155.5 | 39.041 | 4.57 | 674 | 23504.8 | 39.246 | 2.27 |
| 555 | 18861.3 | 38.702 | 6.95 | 615 | 21194.5 | 39.046 | 4.54 | 675 | 23544.0 | 39.248 | 2.23 |
| 556 | 18900.1 | 38.709 | 6.91 | 616 | 21233.6 | 39.050 | 4.50 | 676 | 23583.3 | 39.250 | 2.19 |
| 557 | 18938.8 | 38.716 | 6.87 | 617 | 21272.6 | 39.055 | 4.46 | 677 | 23622.5 | 39.252 | 2.15 |
| 558 | 18977.5 | 38.722 | 6.83 | 618 | 21311.7 | 39.059 | 4.42 | 678 | 23661.8 | 39.255 | 2.12 |
| 559 | 19016.2 | 38.729 | 6.78 | 619 | 21350.7 | 39.064 | 4.38 | 679 | 23701.0 | 39.257 | 2.08 |
| 560 | 19054.9 | 38.736 | 6.74 | 620 | 21389.8 | 39.068 | 4.34 | 680 | 23740.3 | 39.259 | 2.04 |
| 561 | 19093.7 | 38.743 | 6.70 | 621 | 21428.9 | 39.072 | 4.30 | 681 | 23779.5 | 39.261 | 2.01 |
| 562 | 19132.4 | 38.749 | 6.66 | 622 | 21467.9 | 39.077 | 4.26 | 682 | 23818.8 | 39.263 | 1.97 |
| 563 | 19171.2 | 38.756 | 6.62 | 623 | 21507.0 | 39.081 | 4.22 | 683 | 23858.1 | 39.265 | 1.93 |
| 564 | 19209.9 | 38.763 | 6.58 | 624 | 21546.1 | 39.085 | 4.18 | 684 | 23897.3 | 39.267 | 1.90 |
| 565 | 19248.7 | 38.769 | 6.54 | 625 | 21585.2 | 39.089 | 4.14 | 685 | 23936.6 | 39.269 | 1.86 |
| 566 | 19287.5 | 38.776 | 6.50 | 626 | 21624.3 | 39.093 | 4.10 | 686 | 23975.9 | 39.270 | 1.83 |
| 567 | 19326.3 | 38.782 | 6.46 | 627 | 21663.4 | 39.098 | 4.06 | 687 | 24015.1 | 39.272 | 1.79 |
| 568 | 19365.0 | 38.789 | 6.42 | 628 | 21702.5 | 39.102 | 4.02 | 688 | 24054.4 | 39.274 | 1.75 |
| 569 | 19403.8 | 38.795 | 6.38 | 629 | 21741.6 | 39.106 | 3.98 | 689 | 24093.7 | 39.276 | 1.72 |
| 570 | 19442.6 | 38.801 | 6.34 | 630 | 21780.7 | 39.110 | 3.95 | 690 | 24133.0 | 39.277 | 1.68 |
| 571 | 19481.4 | 38.808 | 6.30 | 631 | 21819.8 | 39.113 | 3.91 | 691 | 24172.2 | 39.279 | 1.64 |
| 572 | 19520.2 | 38.814 | 6.26 | 632 | 21858.9 | 39.117 | 3.87 | 692 | 24211.5 | 39.281 | 1.61 |
| 573 | 19559.1 | 38.820 | 6.22 | 633 | 21898.0 | 39.121 | 3.83 | 693 | 24250.8 | 39.282 | 1.57 |
| 574 | 19597.9 | 38.826 | 6.18 | 634 | 21937.1 | 39.125 | 3.79 | 694 | 24290.1 | 39.284 | 1.54 |
| 575 | 19636.7 | 38.833 | 6.14 | 635 | 21976.3 | 39.129 | 3.75 | 695 | 24329.4 | 39.285 | 1.50 |
| 576 | 19675.6 | 38.839 | 6.10 | 636 | 22015.4 | 39.132 | 3.71 | 696 | 24368.7 | 39.287 | 1.47 |
| 577 | 19714.4 | 38.845 | 6.06 | 637 | 22054.5 | 39.136 | 3.67 | 697 | 24407.9 | 39.288 | 1.43 |
| 578 | 19753.2 | 38.851 | 6.01 | 638 | 22093.7 | 39.140 | 3.63 | 698 | 24447.2 | 39.290 | 1.39 |
| 579 | 19792.1 | 38.857 | 5.97 | 639 | 22132.8 | 39.143 | 3.59 | 699 | 24486.5 | 39.291 | 1.36 |
| 580 | 19831.0 | 38.863 | 5.93 | 640 | 22172.0 | 39.147 | 3.56 | 700 | 24525.8 | 39.292 | 1.32 |
| 581 | 19869.8 | 38.869 | 5.89 | 641 | 22211.1 | 39.151 | 3.52 | 701 | 24565.1 | 39.294 | 1.29 |
| 582 | 19908.7 | 38.875 | 5.85 | 642 | 22250.3 | 39.154 | 3.48 | 702 | 24604.4 | 39.295 | 1.25 |
| 583 | 19947.6 | 38.880 | 5.81 | 643 | 22289.4 | 39.158 | 3.44 | 703 | 24643.7 | 39.296 | 1.22 |
| 584 | 19986.5 | 38.886 | 5.77 | 644 | 22328.6 | 39.161 | 3.40 | 704 | 24683.0 | 39.297 | 1.18 |
| 585 | 20025.3 | 38.892 | 5.73 | 645 | 22367.7 | 39.164 | 3.36 | 705 | 24722.3 | 39.299 | 1.15 |
| 586 | 20064.2 | 38.898 | 5.69 | 646 | 22406.9 | 39.168 | 3.32 | 706 | 24761.6 | 39.300 | 1.11 |
| 587 | 20103.1 | 38.903 | 5.65 | 647 | 22446.1 | 39.171 | 3.29 | 707 | 24800.9 | 39.301 | 1.08 |
| 588 | 20142.0 | 38.909 | 5.61 | 648 | 22485.3 | 39.174 | 3.25 | 708 | 24840.2 | 39.302 | 1.04 |
| 589 | 20181.0 | 38.915 | 5.57 | 649 | 22524.4 | 39.177 | 3.21 | 709 | 24879.5 | 39.303 | 1.01 |
| 590 | 20219.9 | 38.920 | 5.53 | 650 | 22563.6 | 39.181 | 3.17 | 710 | 24918.8 | 39.304 | 0.97 |
| 591 | 20258.8 | 38.926 | 5.49 | 651 | 22602.8 | 39.184 | 3.13 | 711 | 24958.1 | 39.305 | 0.94 |
| 592 | 20297.7 | 38.931 | 5.45 | 652 | 22642.0 | 39.187 | 3.09 | 712 | 24997.4 | 39.306 | 0.91 |
| 593 | 20336.7 | 38.937 | 5.41 | 653 | 22681.2 | 39.190 | 3.06 | 713 | 25036.7 | 39.307 | 0.87 |
| 594 | 20375.6 | 38.942 | 5.37 | 654 | 22720.4 | 39.193 | 3.02 | 714 | 25076.0 | 39.308 | 0.84 |
| 595 | 20414.5 | 38.947 | 5.33 | 655 | 22759.5 | 39.196 | 2.98 | 715 | 25115.3 | 39.308 | 0.80 |
| 596 | 20453.5 | 38.953 | 5.29 | 656 | 22798.7 | 39.199 | 2.94 | 716 | 25154.6 | 39.309 | 0.77 |
| 597 | 20492.4 | 38.958 | 5.25 | 657 | 22837.9 | 39.202 | 2.90 | 717 | 25194.0 | 39.310 | 0.73 |
| 598 | 20531.4 | 38.963 | 5.21 | 658 | 22877.1 | 39.205 | 2.87 | 718 | 25233.3 | 39.311 | 0.70 |
| 599 | 20570.4 | 38.968 | 5.17 | 659 | 22916.4 | 39.208 | 2.83 | 719 | 25272.6 | 39.311 | 0.67 |
| 600 | 20609.3 | 38.973 | 5.13 | 660 | 22955.6 | 39.210 | 2.79 | 720 | 25311.9 | 39.312 | 0.63 |

TABLE 7.3.5 AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 720 | 25311.9 | 39.312 | 0.63 | 780 | 27670.6 | 39.293 | -1.21 | 840 | 30025.1 | 39.175 | -2.64 |
| 721 | 25351.2 | 39.313 | 0.60 | 781 | 27709.9 | 39.292 | -1.23 | 841 | 30064.2 | 39.173 | -2.66 |
| 722 | 25390.5 | 39.313 | 0.57 | 782 | 27749.2 | 39.290 | -1.26 | 842 | 30103.4 | 39.170 | -2.68 |
| 723 | 25429.8 | 39.314 | 0.53 | 783 | 27788.5 | 39.289 | -1.29 | 843 | 30142.6 | 39.167 | -2.70 |
| 724 | 25469.1 | 39.314 | 0.50 | 784 | 27827.7 | 39.288 | -1.32 | 844 | 30181.7 | 39.165 | -2.72 |
| 725 | 25508.5 | 39.315 | 0.47 | 785 | 27867.0 | 39.286 | -1.34 | 845 | 30220.9 | 39.162 | -2.74 |
| 726 | 25547.8 | 39.315 | 0.43 | 786 | 27906.3 | 39.285 | -1.37 | 846 | 30260.1 | 39.159 | -2.76 |
| 727 | 25587.1 | 39.316 | 0.40 | 787 | 27945.6 | 39.284 | -1.40 | 847 | 30299.2 | 39.156 | -2.78 |
| 728 | 25626.4 | 39.316 | 0.37 | 788 | 27984.9 | 39.282 | -1.42 | 848 | 30338.4 | 39.154 | -2.80 |
| 729 | 25665.7 | 39.316 | 0.33 | 789 | 28024.2 | 39.281 | -1.45 | 849 | 30377.5 | 39.151 | -2.81 |
| 730 | 25705.0 | 39.317 | 0.30 | 790 | 28063.4 | 39.279 | -1.47 | 850 | 30416.7 | 39.148 | -2.83 |
| 731 | 25744.3 | 39.317 | 0.27 | 791 | 28102.7 | 39.278 | -1.50 | 851 | 30455.8 | 39.145 | -2.85 |
| 732 | 25783.7 | 39.317 | 0.24 | 792 | 28142.0 | 39.276 | -1.53 | 852 | 30495.0 | 39.142 | -2.87 |
| 733 | 25823.0 | 39.317 | 0.20 | 793 | 28181.3 | 39.275 | -1.55 | 853 | 30534.1 | 39.139 | -2.89 |
| 734 | 25862.3 | 39.318 | 0.17 | 794 | 28220.5 | 39.273 | -1.58 | 854 | 30573.2 | 39.137 | -2.91 |
| 735 | 25901.6 | 39.318 | 0.14 | 795 | 28259.8 | 39.272 | -1.60 | 855 | 30612.4 | 39.134 | -2.93 |
| 736 | 25940.9 | 39.318 | 0.11 | 796 | 28299.1 | 39.270 | -1.63 | 856 | 30651.5 | 39.131 | -2.95 |
| 737 | 25980.3 | 39.318 | 0.07 | 797 | 28338.4 | 39.268 | -1.66 | 857 | 30690.6 | 39.128 | -2.96 |
| 738 | 26019.6 | 39.318 | 0.04 | 798 | 28377.6 | 39.267 | -1.68 | 858 | 30729.8 | 39.125 | -2.98 |
| 739 | 26058.9 | 39.318 | 0.01 | 799 | 28416.9 | 39.265 | -1.71 | 859 | 30768.9 | 39.122 | -3.00 |
| 740 | 26098.2 | 39.318 | -0.02 | 800 | 28456.2 | 39.263 | -1.73 | 860 | 30808.0 | 39.119 | -3.02 |
| 741 | 26137.5 | 39.318 | -0.05 | 801 | 28495.4 | 39.262 | -1.76 | 861 | 30847.1 | 39.116 | -3.04 |
| 742 | 26176.8 | 39.318 | -0.08 | 802 | 28534.7 | 39.260 | -1.78 | 862 | 30886.2 | 39.113 | -3.06 |
| 743 | 26216.2 | 39.318 | -0.12 | 803 | 28573.9 | 39.258 | -1.81 | 863 | 30925.4 | 39.110 | -3.07 |
| 744 | 26255.5 | 39.318 | -0.15 | 804 | 28613.2 | 39.256 | -1.83 | 864 | 30964.5 | 39.107 | -3.09 |
| 745 | 26294.8 | 39.317 | -0.18 | 805 | 28652.5 | 39.254 | -1.85 | 865 | 31003.6 | 39.103 | -3.11 |
| 746 | 26334.1 | 39.317 | -0.21 | 806 | 28691.7 | 39.253 | -1.88 | 866 | 31042.7 | 39.100 | -3.13 |
| 747 | 26373.4 | 39.317 | -0.24 | 807 | 28731.0 | 39.251 | -1.90 | 867 | 31081.8 | 39.097 | -3.14 |
| 748 | 26412.7 | 39.317 | -0.27 | 808 | 28770.2 | 39.249 | -1.93 | 868 | 31120.9 | 39.094 | -3.16 |
| 749 | 26452.1 | 39.317 | -0.30 | 809 | 28809.5 | 39.247 | -1.95 | 869 | 31160.0 | 39.091 | -3.18 |
| 750 | 26491.4 | 39.316 | -0.33 | 810 | 28848.7 | 39.245 | -1.98 | 870 | 31199.0 | 39.088 | -3.19 |
| 751 | 26530.7 | 39.316 | -0.36 | 811 | 28887.9 | 39.243 | -2.00 | 871 | 31238.1 | 39.084 | -3.21 |
| 752 | 26570.0 | 39.315 | -0.40 | 812 | 28927.2 | 39.241 | -2.02 | 872 | 31277.2 | 39.081 | -3.23 |
| 753 | 26609.3 | 39.315 | -0.43 | 813 | 28966.4 | 39.239 | -2.05 | 873 | 31316.3 | 39.078 | -3.25 |
| 754 | 26648.6 | 39.315 | -0.46 | 814 | 29005.7 | 39.237 | -2.07 | 874 | 31355.4 | 39.075 | -3.26 |
| 755 | 26688.0 | 39.314 | -0.49 | 815 | 29044.9 | 39.235 | -2.09 | 875 | 31394.4 | 39.071 | -3.28 |
| 756 | 26727.3 | 39.314 | -0.52 | 816 | 29084.1 | 39.233 | -2.12 | 876 | 31433.5 | 39.068 | -3.29 |
| 757 | 26766.6 | 39.313 | -0.55 | 817 | 29123.4 | 39.230 | -2.14 | 877 | 31472.6 | 39.065 | -3.31 |
| 758 | 26805.9 | 39.313 | -0.58 | 818 | 29162.6 | 39.228 | -2.16 | 878 | 31511.6 | 39.062 | -3.33 |
| 759 | 26845.2 | 39.312 | -0.61 | 819 | 29201.8 | 39.226 | -2.19 | 879 | 31550.7 | 39.058 | -3.34 |
| 760 | 26884.5 | 39.311 | -0.64 | 820 | 29241.0 | 39.224 | -2.21 | 880 | 31589.8 | 39.055 | -3.36 |
| 761 | 26923.8 | 39.311 | -0.67 | 821 | 29280.3 | 39.222 | -2.23 | 881 | 31628.8 | 39.052 | -3.38 |
| 762 | 26963.1 | 39.310 | -0.69 | 822 | 29319.5 | 39.219 | -2.25 | 882 | 31667.9 | 39.048 | -3.39 |
| 763 | 27002.4 | 39.309 | -0.72 | 823 | 29358.7 | 39.217 | -2.28 | 883 | 31706.9 | 39.045 | -3.41 |
| 764 | 27041.8 | 39.309 | -0.75 | 824 | 29397.9 | 39.215 | -2.30 | 884 | 31745.9 | 39.041 | -3.42 |
| 765 | 27081.1 | 39.308 | -0.78 | 825 | 29437.1 | 39.213 | -2.32 | 885 | 31785.0 | 39.038 | -3.44 |
| 766 | 27120.4 | 39.307 | -0.81 | 826 | 29476.4 | 39.210 | -2.34 | 886 | 31824.0 | 39.034 | -3.45 |
| 767 | 27159.7 | 39.306 | -0.84 | 827 | 29515.6 | 39.208 | -2.36 | 887 | 31863.1 | 39.031 | -3.47 |
| 768 | 27199.0 | 39.305 | -0.87 | 828 | 29554.8 | 39.206 | -2.38 | 888 | 31902.1 | 39.028 | -3.49 |
| 769 | 27238.3 | 39.304 | -0.90 | 829 | 29594.0 | 39.203 | -2.41 | 889 | 31941.1 | 39.024 | -3.50 |
| 770 | 27277.6 | 39.304 | -0.93 | 830 | 29633.2 | 39.201 | -2.43 | 890 | 31980.1 | 39.021 | -3.52 |
| 771 | 27316.9 | 39.303 | -0.96 | 831 | 29672.4 | 39.198 | -2.45 | 891 | 32019.2 | 39.017 | -3.53 |
| 772 | 27356.2 | 39.302 | -0.98 | 832 | 29711.6 | 39.196 | -2.47 | 892 | 32058.2 | 39.013 | -3.55 |
| 773 | 27395.5 | 39.301 | -1.01 | 833 | 29750.8 | 39.193 | -2.49 | 893 | 32097.2 | 39.010 | -3.56 |
| 774 | 27434.8 | 39.300 | -1.04 | 834 | 29790.0 | 39.191 | -2.51 | 894 | 32136.2 | 39.006 | -3.58 |
| 775 | 27474.1 | 39.299 | -1.07 | 835 | 29829.1 | 39.188 | -2.53 | 895 | 32175.2 | 39.003 | -3.59 |
| 776 | 27513.4 | 39.297 | -1.10 | 836 | 29868.3 | 39.186 | -2.55 | 896 | 32214.2 | 38.999 | -3.60 |
| 777 | 27552.7 | 39.296 | -1.12 | 837 | 29907.5 | 39.183 | -2.58 | 897 | 32253.2 | 38.996 | -3.62 |
| 778 | 27592.0 | 39.295 | -1.15 | 838 | 29946.7 | 39.181 | -2.60 | 898 | 32292.2 | 38.992 | -3.63 |
| 779 | 27631.3 | 39.294 | -1.18 | 839 | 29985.9 | 39.178 | -2.62 | 899 | 32331.2 | 38.988 | -3.65 |
| 780 | 27670.6 | 39.293 | -1.21 | 840 | 30025.1 | 39.175 | -2.64 | 900 | 32370.2 | 38.985 | -3.66 |

TABLE 7.3.5 AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | 32370.2 | 38.985 | -3.66 | 960 | 34702.2 | 38.741 | -4.43 | 1020 | 37018.2 | 38.453 | -5.20 |
| 901 | 32409.1 | 38.981 | -3.68 | 961 | 34740.9 | 38.737 | -4.44 | 1021 | 37056.7 | 38.448 | -5.22 |
| 902 | 32448.1 | 38.977 | -3.69 | 962 | 34779.6 | 38.732 | -4.45 | 1022 | 37095.1 | 38.443 | -5.23 |
| 903 | 32487.1 | 38.974 | -3.71 | 963 | 34818.4 | 38.728 | -4.47 | 1023 | 37133.6 | 38.437 | -5.25 |
| 904 | 32526.1 | 38.970 | -3.72 | 964 | 34857.1 | 38.723 | -4.48 | 1024 | 37172.0 | 38.432 | -5.26 |
| 905 | 32565.0 | 38.966 | -3.73 | 965 | 34895.8 | 38.719 | -4.49 | 1025 | 37210.4 | 38.427 | -5.28 |
| 906 | 32604.0 | 38.962 | -3.75 | 966 | 34934.5 | 38.714 | -4.50 | 1026 | 37248.8 | 38.422 | -5.29 |
| 907 | 32643.0 | 38.959 | -3.76 | 967 | 34973.2 | 38.710 | -4.51 | 1027 | 37287.3 | 38.416 | -5.31 |
| 908 | 32681.9 | 38.955 | -3.78 | 968 | 35011.9 | 38.705 | -4.53 | 1028 | 37325.7 | 38.411 | -5.32 |
| 909 | 32720.9 | 38.951 | -3.79 | 969 | 35050.7 | 38.701 | -4.54 | 1029 | 37364.1 | 38.406 | -5.34 |
| 910 | 32759.8 | 38.947 | -3.80 | 970 | 35089.4 | 38.696 | -4.55 | 1030 | 37402.5 | 38.400 | -5.35 |
| 911 | 32798.8 | 38.943 | -3.82 | 971 | 35128.0 | 38.692 | -4.56 | 1031 | 37440.9 | 38.395 | -5.37 |
| 912 | 32837.7 | 38.940 | -3.83 | 972 | 35166.7 | 38.687 | -4.57 | 1032 | 37479.3 | 38.390 | -5.38 |
| 913 | 32876.6 | 38.936 | -3.84 | 973 | 35205.4 | 38.683 | -4.59 | 1033 | 37517.7 | 38.384 | -5.40 |
| 914 | 32915.6 | 38.932 | -3.86 | 974 | 35244.1 | 38.678 | -4.60 | 1034 | 37556.0 | 38.379 | -5.42 |
| 915 | 32954.5 | 38.928 | -3.87 | 975 | 35282.8 | 38.673 | -4.61 | 1035 | 37594.4 | 38.373 | -5.43 |
| 916 | 32993.4 | 38.924 | -3.88 | 976 | 35321.4 | 38.669 | -4.62 | 1036 | 37632.8 | 38.368 | -5.45 |
| 917 | 33032.4 | 38.920 | -3.90 | 977 | 35360.1 | 38.664 | -4.63 | 1037 | 37671.2 | 38.362 | -5.46 |
| 918 | 33071.3 | 38.916 | -3.91 | 978 | 35398.8 | 38.659 | -4.65 | 1038 | 37709.5 | 38.357 | -5.48 |
| 919 | 33110.2 | 38.913 | -3.92 | 979 | 35437.4 | 38.655 | -4.66 | 1039 | 37747.9 | 38.351 | -5.50 |
| 920 | 33149.1 | 38.909 | -3.94 | 980 | 35476.1 | 38.650 | -4.67 | 1040 | 37786.2 | 38.346 | -5.51 |
| 921 | 33188.0 | 38.905 | -3.95 | 981 | 35514.7 | 38.645 | -4.68 | 1041 | 37824.6 | 38.340 | -5.53 |
| 922 | 33226.9 | 38.901 | -3.96 | 982 | 35553.4 | 38.641 | -4.70 | 1042 | 37862.9 | 38.335 | -5.55 |
| 923 | 33265.8 | 38.897 | -3.98 | 983 | 35592.0 | 38.636 | -4.71 | 1043 | 37901.2 | 38.329 | -5.56 |
| 924 | 33304.7 | 38.893 | -3.99 | 984 | 35630.6 | 38.631 | -4.72 | 1044 | 37939.6 | 38.324 | -5.58 |
| 925 | 33343.6 | 38.889 | -4.00 | 985 | 35669.3 | 38.627 | -4.73 | 1045 | 37977.9 | 38.318 | -5.60 |
| 926 | 33382.5 | 38.885 | -4.01 | 986 | 35707.9 | 38.622 | -4.74 | 1046 | 38016.2 | 38.313 | -5.62 |
| 927 | 33421.4 | 38.881 | -4.03 | 987 | 35746.5 | 38.617 | -4.76 | 1047 | 38054.5 | 38.307 | -5.63 |
| 928 | 33460.2 | 38.877 | -4.04 | 988 | 35785.1 | 38.612 | -4.77 | 1048 | 38092.8 | 38.301 | -5.65 |
| 929 | 33499.1 | 38.873 | -4.05 | 989 | 35823.7 | 38.608 | -4.78 | 1049 | 38131.1 | 38.296 | -5.67 |
| 930 | 33538.0 | 38.869 | -4.06 | 990 | 35862.3 | 38.603 | -4.80 | 1050 | 38169.4 | 38.290 | -5.69 |
| 931 | 33576.9 | 38.865 | -4.08 | 991 | 35900.9 | 38.598 | -4.81 | 1051 | 38207.7 | 38.284 | -5.70 |
| 932 | 33615.7 | 38.860 | -4.09 | 992 | 35939.5 | 38.593 | -4.82 | 1052 | 38246.0 | 38.279 | -5.72 |
| 933 | 33654.6 | 38.856 | -4.10 | 993 | 35978.1 | 38.588 | -4.83 | 1053 | 38284.2 | 38.273 | -5.74 |
| 934 | 33693.4 | 38.852 | -4.11 | 994 | 36016.7 | 38.584 | -4.85 | 1054 | 38322.5 | 38.267 | -5.76 |
| 935 | 33732.3 | 38.848 | -4.13 | 995 | 36055.3 | 38.579 | -4.86 | 1055 | 38360.8 | 38.261 | -5.78 |
| 936 | 33771.1 | 38.844 | -4.14 | 996 | 36093.9 | 38.574 | -4.87 | 1056 | 38399.0 | 38.255 | -5.80 |
| 937 | 33810.0 | 38.840 | -4.15 | 997 | 36132.5 | 38.569 | -4.88 | 1057 | 38437.3 | 38.250 | -5.81 |
| 938 | 33848.8 | 38.836 | -4.16 | 998 | 36171.0 | 38.564 | -4.90 | 1058 | 38475.5 | 38.244 | -5.83 |
| 939 | 33887.6 | 38.831 | -4.18 | 999 | 36209.6 | 38.559 | -4.91 | 1059 | 38513.8 | 38.238 | -5.85 |
| 940 | 33926.5 | 38.827 | -4.19 | 1000 | 36248.1 | 38.554 | -4.92 | 1060 | 38552.0 | 38.232 | -5.87 |
| 941 | 33965.3 | 38.823 | -4.20 | 1001 | 36286.7 | 38.549 | -4.94 | 1061 | 38590.2 | 38.226 | -5.89 |
| 942 | 34004.1 | 38.819 | -4.21 | 1002 | 36325.2 | 38.544 | -4.95 | 1062 | 38628.5 | 38.220 | -5.91 |
| 943 | 34042.9 | 38.815 | -4.22 | 1003 | 36363.8 | 38.539 | -4.96 | 1063 | 38666.7 | 38.214 | -5.93 |
| 944 | 34081.7 | 38.810 | -4.24 | 1004 | 36402.3 | 38.534 | -4.98 | 1064 | 38704.9 | 38.209 | -5.95 |
| 945 | 34120.6 | 38.806 | -4.25 | 1005 | 36440.8 | 38.529 | -4.99 | 1065 | 38743.1 | 38.203 | -5.97 |
| 946 | 34159.4 | 38.802 | -4.26 | 1006 | 36479.4 | 38.524 | -5.00 | 1066 | 38781.3 | 38.197 | -5.99 |
| 947 | 34198.2 | 38.798 | -4.27 | 1007 | 36517.9 | 38.519 | -5.02 | 1067 | 38819.5 | 38.191 | -6.01 |
| 948 | 34237.0 | 38.793 | -4.29 | 1008 | 36556.4 | 38.514 | -5.03 | 1068 | 38857.7 | 38.185 | -6.03 |
| 949 | 34275.7 | 38.789 | -4.30 | 1009 | 36594.9 | 38.509 | -5.05 | 1069 | 38895.9 | 38.179 | -6.05 |
| 950 | 34314.5 | 38.785 | -4.31 | 1010 | 36633.4 | 38.504 | -5.06 | 1070 | 38934.0 | 38.172 | -6.07 |
| 951 | 34353.3 | 38.780 | -4.32 | 1011 | 36671.9 | 38.499 | -5.07 | 1071 | 38972.2 | 38.166 | -6.09 |
| 952 | 34392.1 | 38.776 | -4.33 | 1012 | 36710.4 | 38.494 | -5.09 | 1072 | 39010.4 | 38.160 | -6.11 |
| 953 | 34430.9 | 38.772 | -4.35 | 1013 | 36748.9 | 38.489 | -5.10 | 1073 | 39048.5 | 38.154 | -6.13 |
| 954 | 34469.6 | 38.767 | -4.36 | 1014 | 36787.4 | 38.484 | -5.11 | 1074 | 39086.7 | 38.148 | -6.15 |
| 955 | 34508.4 | 38.763 | -4.37 | 1015 | 36825.9 | 38.479 | -5.13 | 1075 | 39124.8 | 38.142 | -6.17 |
| 956 | 34547.2 | 38.759 | -4.38 | 1016 | 36864.4 | 38.474 | -5.14 | 1076 | 39163.0 | 38.136 | -6.19 |
| 957 | 34585.9 | 38.754 | -4.39 | 1017 | 36902.8 | 38.469 | -5.16 | 1077 | 39201.1 | 38.129 | -6.22 |
| 958 | 34624.7 | 38.750 | -4.41 | 1018 | 36941.3 | 38.463 | -5.17 | 1078 | 39239.2 | 38.123 | -6.24 |
| 959 | 34663.4 | 38.746 | -4.42 | 1019 | 36979.8 | 38.458 | -5.19 | 1079 | 39277.3 | 38.117 | -6.26 |
| 960 | 34702.2 | 38.741 | -4.43 | 1020 | 37018.2 | 38.453 | -5.20 | 1080 | 39315.5 | 38.111 | -6.28 |

TABLE 7.3.5 AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1080 | 39315.5 | 38.111 | -6.28 | 1140 | 41589.9 | 37.690 | -7.83 | 1200 | 43836.1 | 37.166 | -9.61 |
| 1081 | 39353.6 | 38.104 | -6.30 | 1141 | 41627.6 | 37.682 | -7.86 | 1201 | 43873.3 | 37.156 | -9.63 |
| 1082 | 39391.7 | 38.098 | -6.32 | 1142 | 41665.3 | 37.674 | -7.89 | 1202 | 43910.4 | 37.146 | -9.66 |
| 1083 | 39429.8 | 38.092 | -6.35 | 1143 | 41703.0 | 37.666 | -7.92 | 1203 | 43947.6 | 37.137 | -9.69 |
| 1084 | 39467.8 | 38.085 | -6.37 | 1144 | 41740.6 | 37.658 | -7.95 | 1204 | 43984.7 | 37.127 | -9.71 |
| 1085 | 39505.9 | 38.079 | -6.39 | 1145 | 41778.3 | 37.650 | -7.98 | 1205 | 44021.8 | 37.117 | -9.74 |
| 1086 | 39544.0 | 38.073 | -6.41 | 1146 | 41815.9 | 37.642 | -8.01 | 1206 | 44058.9 | 37.108 | -9.76 |
| 1087 | 39582.1 | 38.066 | -6.44 | 1147 | 41853.6 | 37.634 | -8.04 | 1207 | 44096.0 | 37.098 | -9.79 |
| 1088 | 39620.1 | 38.060 | -6.46 | 1148 | 41891.2 | 37.626 | -8.07 | 1208 | 44133.1 | 37.088 | -9.82 |
| 1089 | 39658.2 | 38.053 | -6.48 | 1149 | 41928.8 | 37.618 | -8.10 | 1209 | 44170.2 | 37.078 | -9.84 |
| 1090 | 39696.2 | 38.047 | -6.51 | 1150 | 41966.4 | 37.610 | -8.13 | 1210 | 44207.3 | 37.068 | -9.86 |
| 1091 | 39734.3 | 38.040 | -6.53 | 1151 | 42004.0 | 37.602 | -8.16 | 1211 | 44244.4 | 37.058 | -9.89 |
| 1092 | 39772.3 | 38.034 | -6.55 | 1152 | 42041.6 | 37.593 | -8.19 | 1212 | 44281.4 | 37.049 | -9.91 |
| 1093 | 39810.4 | 38.027 | -6.58 | 1153 | 42079.2 | 37.585 | -8.22 | 1213 | 44318.5 | 37.039 | -9.94 |
| 1094 | 39848.4 | 38.021 | -6.60 | 1154 | 42116.8 | 37.577 | -8.25 | 1214 | 44355.5 | 37.029 | -9.96 |
| 1095 | 39886.4 | 38.014 | -6.62 | 1155 | 42154.4 | 37.569 | -8.28 | 1215 | 44392.5 | 37.019 | -9.98 |
| 1096 | 39924.4 | 38.007 | -6.65 | 1156 | 42191.9 | 37.560 | -8.31 | 1216 | 44429.5 | 37.009 | -10.01 |
| 1097 | 39962.4 | 38.001 | -6.67 | 1157 | 42229.5 | 37.552 | -8.34 | 1217 | 44466.5 | 36.999 | -10.03 |
| 1098 | 40000.4 | 37.994 | -6.70 | 1158 | 42267.0 | 37.544 | -8.37 | 1218 | 44503.5 | 36.989 | -10.05 |
| 1099 | 40038.4 | 37.987 | -6.72 | 1159 | 42304.6 | 37.535 | -8.40 | 1219 | 44540.5 | 36.979 | -10.07 |
| 1100 | 40076.4 | 37.981 | -6.75 | 1160 | 42342.1 | 37.527 | -8.43 | 1220 | 44577.5 | 36.969 | -10.09 |
| 1101 | 40114.4 | 37.974 | -6.77 | 1161 | 42379.6 | 37.519 | -8.46 | 1221 | 44614.4 | 36.958 | -10.11 |
| 1102 | 40152.3 | 37.967 | -6.80 | 1162 | 42417.1 | 37.510 | -8.49 | 1222 | 44651.4 | 36.948 | -10.13 |
| 1103 | 40190.3 | 37.960 | -6.82 | 1163 | 42454.7 | 37.502 | -8.52 | 1223 | 44688.3 | 36.938 | -10.16 |
| 1104 | 40228.2 | 37.953 | -6.85 | 1164 | 42492.2 | 37.493 | -8.55 | 1224 | 44725.3 | 36.928 | -10.17 |
| 1105 | 40266.2 | 37.947 | -6.87 | 1165 | 42529.6 | 37.484 | -8.58 | 1225 | 44762.2 | 36.918 | -10.19 |
| 1106 | 40304.1 | 37.940 | -6.90 | 1166 | 42567.1 | 37.476 | -8.61 | 1226 | 44799.1 | 36.908 | -10.21 |
| 1107 | 40342.1 | 37.933 | -6.92 | 1167 | 42604.6 | 37.467 | -8.64 | 1227 | 44836.0 | 36.897 | -10.23 |
| 1108 | 40380.0 | 37.926 | -6.95 | 1168 | 42642.1 | 37.459 | -8.67 | 1228 | 44872.9 | 36.887 | -10.25 |
| 1109 | 40417.9 | 37.919 | -6.97 | 1169 | 42679.5 | 37.450 | -8.70 | 1229 | 44909.8 | 36.877 | -10.27 |
| 1110 | 40455.8 | 37.912 | -7.00 | 1170 | 42717.0 | 37.441 | -8.74 | 1230 | 44946.7 | 36.867 | -10.28 |
| 1111 | 40493.8 | 37.905 | -7.03 | 1171 | 42754.4 | 37.432 | -8.77 | 1231 | 44983.5 | 36.856 | -10.30 |
| 1112 | 40531.7 | 37.898 | -7.05 | 1172 | 42791.8 | 37.424 | -8.80 | 1232 | 45020.4 | 36.846 | -10.32 |
| 1113 | 40569.5 | 37.891 | -7.08 | 1173 | 42829.2 | 37.415 | -8.83 | 1233 | 45057.2 | 36.836 | -10.33 |
| 1114 | 40607.4 | 37.884 | -7.10 | 1174 | 42866.6 | 37.406 | -8.86 | 1234 | 45094.0 | 36.825 | -10.35 |
| 1115 | 40645.3 | 37.877 | -7.13 | 1175 | 42904.1 | 37.397 | -8.89 | 1235 | 45130.9 | 36.815 | -10.36 |
| 1116 | 40683.2 | 37.869 | -7.16 | 1176 | 42941.4 | 37.388 | -8.92 | 1236 | 45167.7 | 36.805 | -10.38 |
| 1117 | 40721.1 | 37.862 | -7.19 | 1177 | 42978.8 | 37.379 | -8.95 | 1237 | 45204.5 | 36.794 | -10.39 |
| 1118 | 40758.9 | 37.855 | -7.21 | 1178 | 43016.2 | 37.370 | -8.98 | 1238 | 45241.3 | 36.784 | -10.40 |
| 1119 | 40796.8 | 37.848 | -7.24 | 1179 | 43053.6 | 37.361 | -9.01 | 1239 | 45278.0 | 36.773 | -10.41 |
| 1120 | 40834.6 | 37.841 | -7.27 | 1180 | 43090.9 | 37.352 | -9.04 | 1240 | 45314.8 | 36.763 | -10.43 |
| 1121 | 40872.4 | 37.833 | -7.29 | 1181 | 43128.3 | 37.343 | -9.07 | 1241 | 45351.6 | 36.753 | -10.44 |
| 1122 | 40910.3 | 37.826 | -7.32 | 1182 | 43165.6 | 37.334 | -9.10 | 1242 | 45388.3 | 36.742 | -10.45 |
| 1123 | 40948.1 | 37.819 | -7.35 | 1183 | 43202.9 | 37.325 | -9.12 | 1243 | 45425.1 | 36.732 | -10.46 |
| 1124 | 40985.9 | 37.811 | -7.38 | 1184 | 43240.3 | 37.316 | -9.15 | 1244 | 45461.8 | 36.721 | -10.47 |
| 1125 | 41023.7 | 37.804 | -7.40 | 1185 | 43277.6 | 37.307 | -9.18 | 1245 | 45498.5 | 36.711 | -10.48 |
| 1126 | 41061.5 | 37.796 | -7.43 | 1186 | 43314.9 | 37.298 | -9.21 | 1246 | 45535.2 | 36.700 | -10.48 |
| 1127 | 41099.3 | 37.789 | -7.46 | 1187 | 43352.2 | 37.288 | -9.24 | 1247 | 45571.9 | 36.690 | -10.49 |
| 1128 | 41137.1 | 37.781 | -7.49 | 1188 | 43389.5 | 37.279 | -9.27 | 1248 | 45608.6 | 36.679 | -10.50 |
| 1129 | 41174.9 | 37.774 | -7.52 | 1189 | 43426.7 | 37.270 | -9.30 | 1249 | 45645.3 | 36.669 | -10.50 |
| 1130 | 41212.6 | 37.766 | -7.54 | 1190 | 43464.0 | 37.260 | -9.33 | 1250 | 45681.9 | 36.658 | -10.51 |
| 1131 | 41250.4 | 37.759 | -7.57 | 1191 | 43501.2 | 37.251 | -9.36 | 1251 | 45718.6 | 36.648 | -10.51 |
| 1132 | 41288.2 | 37.751 | -7.60 | 1192 | 43538.5 | 37.242 | -9.39 | 1252 | 45755.2 | 36.637 | -10.52 |
| 1133 | 41325.9 | 37.744 | -7.63 | 1193 | 43575.7 | 37.232 | -9.41 | 1253 | 45791.8 | 36.627 | -10.52 |
| 1134 | 41363.6 | 37.736 | -7.66 | 1194 | 43613.0 | 37.223 | -9.44 | 1254 | 45828.5 | 36.616 | -10.52 |
| 1135 | 41401.4 | 37.728 | -7.69 | 1195 | 43650.2 | 37.213 | -9.47 | 1255 | 45865.1 | 36.606 | -10.52 |
| 1136 | 41439.1 | 37.721 | -7.72 | 1196 | 43687.4 | 37.204 | -9.50 | 1256 | 45901.7 | 36.595 | -10.52 |
| 1137 | 41476.8 | 37.713 | -7.75 | 1197 | 43724.6 | 37.194 | -9.53 | 1257 | 45938.3 | 36.585 | -10.52 |
| 1138 | 41514.5 | 37.705 | -7.78 | 1198 | 43761.8 | 37.185 | -9.55 | 1258 | 45974.8 | 36.574 | -10.52 |
| 1139 | 41552.2 | 37.697 | -7.80 | 1199 | 43799.0 | 37.175 | -9.58 | 1259 | 46011.4 | 36.564 | -10.52 |
| 1140 | 41589.9 | 37.690 | -7.83 | 1200 | 43836.1 | 37.166 | -9.61 | 1260 | 46048.0 | 36.553 | -10.52 |

TABLE 7.3.5 AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C* —Continued

| T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1260 | 46048.0 | 36.553 | | 1275 | 46595.1 | 36.396 | | 1290 | 47139.9 | 36.244 | |
| 1261 | 46084.5 | 36.543 | | 1276 | 46631.5 | 36.386 | | 1291 | 47176.1 | 36.234 | |
| 1262 | 46121.1 | 36.532 | | 1277 | 46667.9 | 36.376 | | 1292 | 47212.3 | 36.224 | |
| 1263 | 46157.6 | 36.522 | | 1278 | 46704.2 | 36.365 | | 1293 | 47248.6 | 36.214 | |
| 1264 | 46194.1 | 36.511 | | 1279 | 46740.6 | 36.355 | | 1294 | 47284.8 | 36.204 | |
| 1265 | 46230.6 | 36.501 | | 1280 | 46776.9 | 36.345 | | 1295 | 47321.0 | 36.194 | |
| 1266 | 46267.1 | 36.490 | | 1281 | 46813.3 | 36.334 | | 1296 | 47357.2 | 36.185 | |
| 1267 | 46303.6 | 36.480 | | 1282 | 46849.6 | 36.324 | | 1297 | 47393.3 | 36.175 | |
| 1268 | 46340.1 | 36.469 | | 1283 | 46885.9 | 36.314 | | 1298 | 47429.5 | 36.165 | |
| 1269 | 46376.5 | 36.459 | | 1284 | 46922.2 | 36.304 | | 1299 | 47465.7 | 36.156 | |
| 1270 | 46413.0 | 36.448 | | 1285 | 46958.5 | 36.294 | | 1300 | 47501.8 | 36.146 | |
| 1271 | 46449.4 | 36.438 | | 1286 | 46994.8 | 36.284 | | | | | |
| 1272 | 46485.9 | 36.427 | | 1287 | 47031.1 | 36.274 | | | | | |
| 1273 | 46522.3 | 36.417 | | 1288 | 47067.4 | 36.264 | | | | | |
| 1274 | 46558.7 | 36.407 | | 1289 | 47103.6 | 36.254 | | | | | |
| 1275 | 46595.1 | 36.396 | | 1290 | 47139.9 | 36.244 | | | | | |

TABLE 7.3.6 *Thermoelectric values at the fixed points for* AWG 28 *Nicrosil versus Nisil thermocouples in the cryogenic and extended temperature ranges.*

| Temperature range | Fixed point | Temp.[a]<br>°C. | *E*<br>μV | *S*<br>μV/°C | *dS/dT*<br>nV/°C$^2$ |
|---|---|---|---|---|---|
| | Helium NBP | —268.935 | —4344.75 | 0.463 | 117.47 |
| —270 to 0 °C | Hydrogen TP | —259.340 | —4334.67 | 1.661 | 131.18 |
| | Hydrogen NBP | —252.870 | —4321.13 | 2.530 | 136.98 |
| | Neon TP | —248.589 | —4309.04 | 3.122 | 139.58 |
| | Neon NBP | —246.048 | —4300.65 | 3.478 | 140.73 |
| | Oxygen TP | —218.789 | —4152.98 | 7.354 | 140.57 |
| | Nitrogen TP | —210.004 | —4082.98 | 8.577 | 137.65 |
| | Nitrogen NBP | —195.806 | —3947.53 | 10.490 | 131.76 |
| | Oxygen NBP | —182.962 | —3802.08 | 12.145 | 125.88 |
| | Carbon Dioxide SP | —78.476 | —1937.74 | 22.590 | 70.55 |
| | Mercury FP | —38.836 | —993.66 | 24.871 | 44.67 |
| | Ice point[b] | 0.000 | 0.00 | 26.154 | 21.87 |
| | Ether TP | 26.87 | 711.68 | 26.887 | 33.98 |
| 0 to 400 °C | Water BP | 100.000 | 2780.58 | 29.735 | 38.30 |
| | Benzoic Acid TP | 122.37 | 3455.11 | 30.562 | 35.59 |
| | Indium FP | 156.634 | 4522.32 | 31.708 | 31.38 |
| | Tin FP | 231.968 | 6993.27 | 33.818 | 25.36 |
| | Bismuth FP | 271.442 | 8347.33 | 34.772 | 22.90 |
| | Cadmium FP | 321.108 | 10100.92 | 35.807 | 18.51 |
| | Lead FP | 327.502 | 10330.25 | 35.923 | 17.84 |
| | Mercury BP | 356.66 | 11384.85 | 36.399 | 14.89 |

[a] Values of temperature are from the published text of the IPTS-68 amended edition of 1975 [CIPM, 1976], except for Helium NBP.

[b] Junction point of different functions.

Table 7.3.7 *Thermoelectric values at the fixed points for* AWG 14 *Nicrosil versus Nisil thermocouples in the high temperature range.*

| Temperature range | Fixed point | Temp.[a] °C | $E$ μV | $S$ μV/°C | $dS/dT$ nV/°C$^2$ |
|---|---|---|---|---|---|
| 0 to 1300 °C | Ice point | 0.000 | 0.00 | 25.898 | 33.31 |
| | Ether TP | 26.87 | 708.42 | 26.848 | 36.99 |
| | Water BP | 100.000 | 2773.57 | 29.634 | 37.45 |
| | Benzoic Acid TP | 122.37 | 3445.74 | 30.457 | 35.99 |
| | Indium FP | 156.634 | 4509.90 | 31.642 | 33.10 |
| | Tin FP | 231.968 | 6980.78 | 33.865 | 25.93 |
| | Bismuth FP | 271.442 | 8336.85 | 34.819 | 22.45 |
| | Cadmium FP | 321.108 | 10092.22 | 35.837 | 18.65 |
| | Lead FP | 327.502 | 10321.74 | 35.955 | 18.20 |
| | Mercury BP | 356.66 | 11377.57 | 36.457 | 16.32 |
| | Zinc FP | 419.580 | 13701.38 | 37.372 | 12.88 |
| | Sulphur BP | 444.674 | 14643.12 | 37.680 | 11.67 |
| | Cu–Al FP | 548.26 | 18600.66 | 38.654 | 7.22 |
| | Antimony FP | 630.755 | 21810.21 | 39.112 | 3.92 |
| | Aluminum FP | 660.46 | 22973.60 | 39.212 | 2.77 |
| | Silver FP | 961.93 | 34776.92 | 38.733 | −4.45 |
| | Gold FP | 1064.43 | 38721.32 | 38.206 | −5.96 |
| | Copper FP | 1084.88 | 39501.36 | 38.080 | −6.39 |

[a] Values of temperature are from the published text of the IPTS–68 amended edition of 1975 [CIPM, 1976].

Table 7.3.8 *Estimated maximum errors that occur when using reduced-bit arithmetic for the power series expansion for the thermoelectric voltage of* AWG 28 *Nicrosil versus Nisil thermocouples.*

| Temperature range | Degree | Estimated maximum error in microvolts | | | | |
|---|---|---|---|---|---|---|
| | | 12 Bit | 16 Bit | 24 Bit | 27 Bit | 36 Bit |
| −270 to 0 °C | 8 | 1.3 | 0.1 | <0.01 | <0.01 | <0.01 |
| 0 to 200 °C | 7 | 0.9 | 0.1 | <0.01 | <0.01 | <0.01 |
| 200 to 400 °C | 7 | [a] | 1.3 | <0.01 | <0.01 | <0.01 |

[a] A high order polynomial with a low-bit machine causes extreme error.

Table 7.3.9 *Estimated maximum errors that occur when using reduced-bit arithmetic for the power series expansion for the thermoelectric voltage of* AWG 14 *Nicrosil versus Nisil thermocouples.*

| Temperature range | Degree | Estimated maximum error in microvolts | | | | |
|---|---|---|---|---|---|---|
| | | 12 Bit | 16 Bit | 24 Bit | 27 Bit | 36 Bit |
| 0 to 200 °C | 9 | 1.5 | 0.1 | <0.01 | <0.01 | <0.01 |
| 200 to 400 °C | 9 | 5.2 | 0.5 | <0.01 | <0.01 | <0.01 |
| 400 to 600 °C | 9 | [a] | 2.3 | <0.01 | <0.01 | <0.01 |
| 600 to 800 °C | 9 | [a] | 8.7 | 0.01 | <0.01 | <0.01 |
| 800 to 1000 °C | 9 | [a] | [a] | 0.05 | <0.01 | <0.01 |
| 1000 to 1200 °C | 9 | [a] | [a] | 0.2 | 0.01 | <0.01 |
| 1200 to 1300 °C | 9 | [a] | [a] | 0.3 | 0.02 | <0.01 |

[a] A high order polynomial with a low-bit machine causes extreme error.

## 7.4 Reference Functions and Tables for the Positive Thermoelement Nicrosil versus Platinum, Pt-67

As explained earlier, fine and heavy gage Nicrosil wires have slightly different effective overall compositions and therefore have slightly different thermoelectric properties. For that reason the expansion coefficients and the tabular values for the two sizes of wire are not quite identical in the temperature ranges where they overlap. Those differences are reflected in the accompanying tables where the wire gage is specified along with the temperatures and thermoelectric values. At the join, 0 °C, of the cryogenic data (fine wire–*AWG 28*) and the high temperature data (heavy wire–*AWG 14*) the voltages are identical, by definition; and the Seebeck coefficients differ by only 0.12 percent. The values of the coefficients for fine wire (cryogenic) are slightly higher. Actual differences between the voltages for different sizes are discussed in the previous chapter, section 6.7.

The coefficients for the eighth degree expansion for the thermoelectric voltage of *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, between −200 and 0 °C are given in table 7.4.1. The coefficients for the fifth degree expansion for *AWG 28* wire between 0 and 400 °C, an extended range, are also given in table 7.4.1. The equivalent coefficients for the sixth degree expansion for the thermoelectric voltage of *AWG 14* Nicrosil thermoelements versus platinum, Pt–67, between 0 and 1300 °C are given in table 7.4.2. The errors caused by using reduced-bit arithmetic for calculating values of those functions are given in tables 7.4.8 and 7.4.9 for *AWG 28* and *AWG 14* thermoelements, respectively.

The primary reference values for *AWG 28* Nicrosil thermoelements versus platinum, Pt–67, in the temperature range from −200 to 0 °C are given in table 7.4.3. Values for the same gage wire in the extended temperature range from 0 to 400 °C are given in table 7.4.4. Values for the larger, *AWG 14*, wire for temperatures from 0 to 1300 °C are given in table 7.4.5. Near the ends of long calibration ranges, mathematical fitting functions become more variable and subject to error. This is especially true for their higher derivatives. Therefore the second derivatives of the thermal voltages are not tabulated above 1260 °C. Values for the smaller *AWG 28* wire at selected thermometric fixed points are given in table 7.4.6; and for the larger *AWG 14* wire, in table 7.4.7.

Graphs of the thermoelectric voltage, its first derivative (Seebeck coefficient), and second derivative are given in figures 7.4.1, 7.4.2 and 7.4.3 respectively for *AWG 28* wire between −200 and 400 °C; and in figures 7.4.4, 7.4.5, and 7.4.6 for *AWG 14* wire between 0 and 1300 °C.

It should be stressed that because of the small, but significant, size effect ***Nicrosil thermoelement material that conforms closely to the high temperature tabular values may not conform closely at low temperatures (below 0 °C) and vice versa.*** If Nicrosil thermoelements are to be used for accurate measurements both above and below 0 °C, then the material must be calibrated in the full temperature range, both above and below 0 °C. Special selection of material will often be required.

Table 7.4.1 *Power series expansion for the thermoelectric voltage of* AWG 28 *for Nicrosil thermoelements versus platinum,* Pt–67, *in the cryogenic and extended temperature ranges.*

| Wire gage | Temperature range | Degree | Coefficients | Term |
|---|---|---|---|---|
| AWG 28 | −200 to 0 °C | 8 | $+1.5439801101\times10^{1}$<br>$+2.7740484890\times10^{-2}$<br>$-3.4049445417\times10^{-5}$<br>$+1.1939020268\times10^{-7}$<br>$-4.0789319444\times10^{-10}$<br>$-1.0328196551\times10^{-11}$<br>$-6.3786260843\times10^{-14}$<br>$-1.3906860189\times10^{-16}$ | $T$<br>$T^2$<br>$T^3$<br>$T^4$<br>$T^5$<br>$T^6$<br>$T^7$<br>$T^8$ |
| AWG 28 | 0 to 400 °C | 5 | $+1.5439801101\times10^{1}$<br>$+2.7740484890\times10^{-2}$<br>$-3.7799095566\times10^{-5}$<br>$+3.4845935715\times10^{-8}$<br>$-1.6404244459\times10^{-11}$ | $T$<br>$T^2$<br>$T^3$<br>$T^4$<br>$T^5$ |

Table 7.4.2 *Power series expansion for the thermoelectric voltage of* AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67, *in the high temperature range.*

| Wire gage | Temperature range | Degree | Coefficients | Term |
|---|---|---|---|---|
| AWG 14 | 0 to 1300 °C | 6 | $+1.5420916112\times10^{1}$<br>$+2.7473103889\times10^{-2}$<br>$-3.5459786407\times10^{-5}$<br>$+2.9024574608\times10^{-8}$<br>$-1.2598547166\times10^{-11}$<br>$+2.1794779288\times10^{-15}$ | $T$<br>$T^2$<br>$T^3$<br>$T^4$<br>$T^5$<br>$T^6$ |

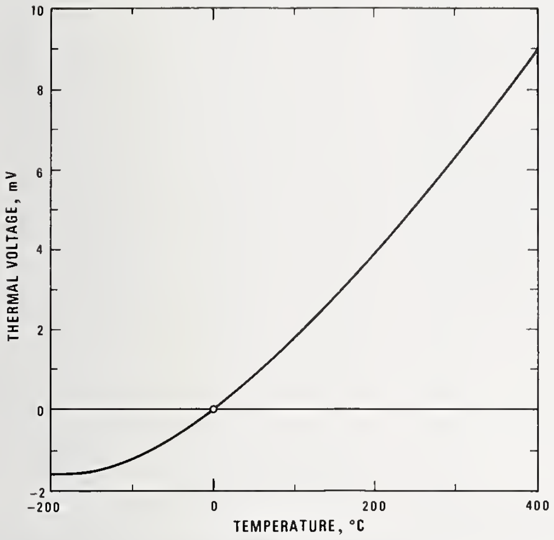

FIGURE 7.4.1 *Thermoelectric voltage for* AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67.

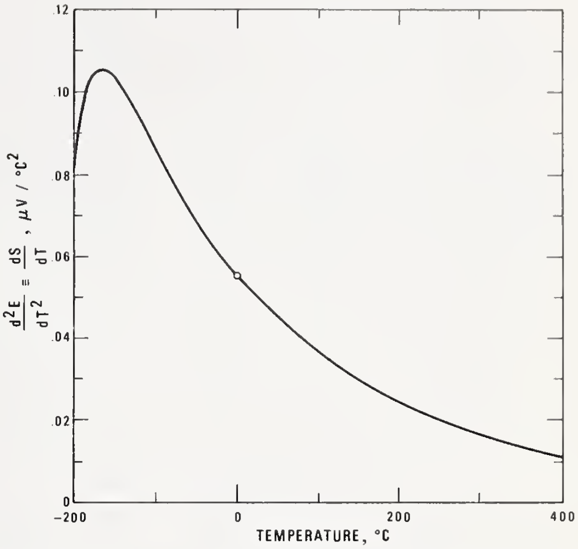

FIGURE 7.4.3 *Derivative of Seebeck coefficient for* AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67.

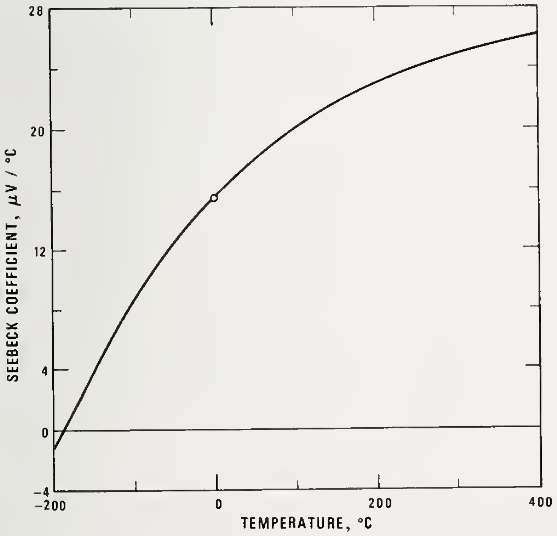

FIGURE 7.4.2 *Seebeck coefficient for* AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67.

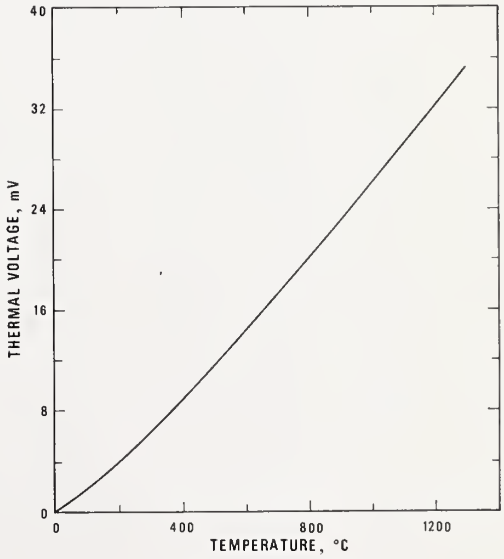

FIGURE 7.4.4 *Thermoelectric voltage for* AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67.

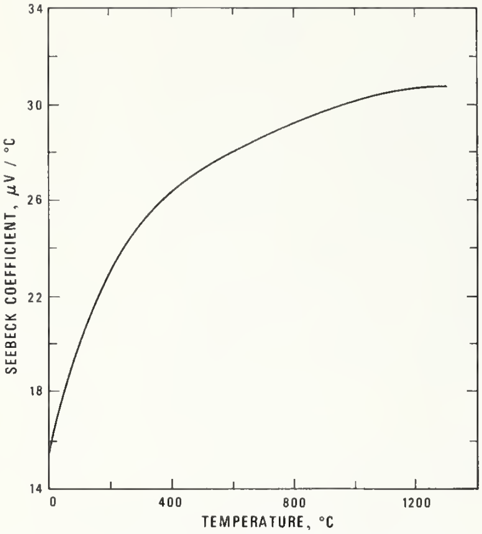

Figure 7.4.5 *Seebeck coefficient for* AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67.

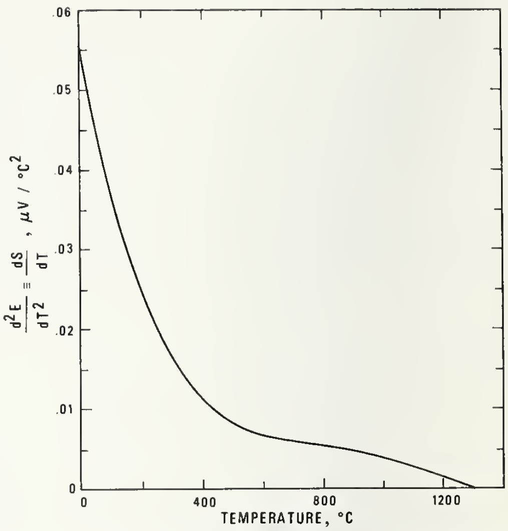

Figure 7.4.6 *Derivative of Seebeck coefficient for* AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67.

TABLE 7.4.3 AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67,—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Cryogenic temperature range, —200 to 0 °C.*

| T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C² | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C² | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -200 | -1584.95 | -1.331 | 82.02 | -190 | -1593.92 | -0.440 | 95.14 |
| | | | | -199 | -1586.24 | -1.249 | 83.66 | -189 | -1594.31 | -0.344 | 96.10 |
| | | | | -198 | -1587.45 | -1.164 | 85.22 | -188 | -1594.60 | -0.248 | 96.99 |
| | | | | -197 | -1588.57 | -1.078 | 86.71 | -187 | -1594.80 | -0.150 | 97.83 |
| | | | | -196 | -1589.60 | -0.991 | 88.12 | -186 | -1594.90 | -0.052 | 98.62 |
| | | | | -195 | -1590.55 | -0.902 | 89.45 | -185 | -1594.91 | 0.047 | 99.36 |
| | | | | -194 | -1591.41 | -0.812 | 90.72 | -184 | -1594.81 | 0.147 | 100.04 |
| | | | | -193 | -1592.17 | -0.721 | 91.92 | -183 | -1594.61 | 0.247 | 100.68 |
| | | | | -192 | -1592.85 | -0.628 | 93.06 | -182 | -1594.32 | 0.348 | 101.27 |
| | | | | -191 | -1593.43 | -0.534 | 94.13 | -181 | -1593.92 | 0.450 | 101.82 |
| -200 | -1584.95 | -1.331 | 82.02 | -190 | -1593.92 | -0.440 | 95.14 | -180 | -1593.42 | 0.552 | 102.32 |

TABLE 7.4.3 AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67,—*thermoelectric voltages,* E(T), *Seebeck coefficients.* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Cryogenic temperature range, —200 to 0 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -180 | -1593.42 | 0.552 | 102.32 | -120 | -1373.53 | 6.670 | 93.88 | -60 | -817.63 | 11.644 | 72.36 |
| -179 | -1592.81 | 0.654 | 102.79 | -119 | -1366.82 | 6.764 | 93.51 | -59 | -805.95 | 11.716 | 72.03 |
| -178 | -1592.11 | 0.757 | 103.21 | -118 | -1360.00 | 6.857 | 93.13 | -58 | -794.20 | 11.788 | 71.70 |
| -177 | -1591.30 | 0.861 | 103.59 | -117 | -1353.10 | 6.950 | 92.76 | -57 | -782.37 | 11.860 | 71.37 |
| -176 | -1590.39 | 0.964 | 103.94 | -116 | -1346.10 | 7.043 | 92.38 | -56 | -770.48 | 11.931 | 71.04 |
| -175 | -1589.37 | 1.069 | 104.25 | -115 | -1339.02 | 7.135 | 92.01 | -55 | -758.51 | 12.002 | 70.71 |
| -174 | -1588.25 | 1.173 | 104.53 | -114 | -1331.83 | 7.227 | 91.63 | -54 | -746.47 | 12.072 | 70.38 |
| -173 | -1587.02 | 1.278 | 104.77 | -113 | -1324.56 | 7.318 | 91.26 | -53 | -734.37 | 12.143 | 70.05 |
| -172 | -1585.69 | 1.382 | 104.98 | -112 | -1317.20 | 7.409 | 90.88 | -52 | -722.19 | 12.212 | 69.72 |
| -171 | -1584.26 | 1.488 | 105.16 | -111 | -1309.74 | 7.500 | 90.51 | -51 | -709.94 | 12.282 | 69.40 |
| -170 | -1582.72 | 1.593 | 105.31 | -110 | -1302.20 | 7.590 | 90.13 | -50 | -697.63 | 12.351 | 69.08 |
| -169 | -1581.07 | 1.698 | 105.44 | -109 | -1294.56 | 7.680 | 89.76 | -49 | -685.24 | 12.420 | 68.75 |
| -168 | -1579.32 | 1.804 | 105.53 | -108 | -1286.84 | 7.770 | 89.38 | -48 | -672.79 | 12.489 | 68.43 |
| -167 | -1577.47 | 1.909 | 105.60 | -107 | -1279.02 | 7.859 | 89.01 | -47 | -660.26 | 12.557 | 68.11 |
| -166 | -1575.50 | 2.015 | 105.65 | -106 | -1271.12 | 7.948 | 88.64 | -46 | -647.67 | 12.625 | 67.79 |
| -165 | -1573.44 | 2.120 | 105.67 | -105 | -1263.13 | 8.036 | 88.26 | -45 | -635.01 | 12.693 | 67.48 |
| -164 | -1571.26 | 2.226 | 105.67 | -104 | -1255.05 | 8.125 | 87.89 | -44 | -622.29 | 12.760 | 67.16 |
| -163 | -1568.98 | 2.332 | 105.65 | -103 | -1246.88 | 8.212 | 87.52 | -43 | -609.49 | 12.827 | 66.85 |
| -162 | -1566.60 | 2.437 | 105.60 | -102 | -1238.62 | 8.300 | 87.15 | -42 | -596.63 | 12.894 | 66.54 |
| -161 | -1564.11 | 2.543 | 105.54 | -101 | -1230.28 | 8.387 | 86.78 | -41 | -583.71 | 12.960 | 66.23 |
| -160 | -1561.51 | 2.648 | 105.46 | -100 | -1221.85 | 8.473 | 86.41 | -40 | -570.71 | 13.026 | 65.92 |
| -159 | -1558.81 | 2.754 | 105.36 | -99 | -1213.33 | 8.559 | 86.05 | -39 | -557.65 | 13.092 | 65.61 |
| -158 | -1556.01 | 2.859 | 105.24 | -98 | -1204.73 | 8.645 | 85.68 | -38 | -544.53 | 13.157 | 65.30 |
| -157 | -1553.09 | 2.964 | 105.10 | -97 | -1196.04 | 8.731 | 85.31 | -37 | -531.34 | 13.222 | 65.00 |
| -156 | -1550.08 | 3.069 | 104.95 | -96 | -1187.27 | 8.816 | 84.95 | -36 | -518.09 | 13.287 | 64.70 |
| -155 | -1546.96 | 3.174 | 104.79 | -95 | -1178.41 | 8.901 | 84.58 | -35 | -504.77 | 13.352 | 64.40 |
| -154 | -1543.73 | 3.279 | 104.61 | -94 | -1169.47 | 8.985 | 84.22 | -34 | -491.38 | 13.416 | 64.10 |
| -153 | -1540.40 | 3.383 | 104.42 | -93 | -1160.44 | 9.069 | 83.85 | -33 | -477.93 | 13.480 | 63.80 |
| -152 | -1536.96 | 3.488 | 104.21 | -92 | -1151.33 | 9.153 | 83.49 | -32 | -464.42 | 13.544 | 63.51 |
| -151 | -1533.42 | 3.592 | 103.99 | -91 | -1142.13 | 9.236 | 83.13 | -31 | -450.85 | 13.607 | 63.22 |
| -150 | -1529.78 | 3.696 | 103.76 | -90 | -1132.86 | 9.319 | 82.77 | -30 | -437.21 | 13.670 | 62.93 |
| -149 | -1526.03 | 3.799 | 103.52 | -89 | -1123.50 | 9.402 | 82.41 | -29 | -423.51 | 13.733 | 62.64 |
| -148 | -1522.18 | 3.903 | 103.27 | -88 | -1114.05 | 9.484 | 82.05 | -28 | -409.74 | 13.795 | 62.36 |
| -147 | -1518.23 | 4.006 | 103.01 | -87 | -1104.53 | 9.566 | 81.70 | -27 | -395.92 | 13.858 | 62.07 |
| -146 | -1514.17 | 4.109 | 102.74 | -86 | -1094.92 | 9.647 | 81.34 | -26 | -382.03 | 13.920 | 61.79 |
| -145 | -1510.01 | 4.211 | 102.47 | -85 | -1085.23 | 9.728 | 80.98 | -25 | -368.08 | 13.981 | 61.51 |
| -144 | -1505.74 | 4.314 | 102.18 | -84 | -1075.47 | 9.809 | 80.63 | -24 | -354.06 | 14.043 | 61.24 |
| -143 | -1501.38 | 4.416 | 101.89 | -83 | -1065.62 | 9.890 | 80.27 | -23 | -339.99 | 14.104 | 60.97 |
| -142 | -1496.91 | 4.518 | 101.59 | -82 | -1055.69 | 9.970 | 79.92 | -22 | -325.86 | 14.164 | 60.70 |
| -141 | -1492.34 | 4.619 | 101.28 | -81 | -1045.68 | 10.049 | 79.57 | -21 | -311.66 | 14.225 | 60.43 |
| -140 | -1487.68 | 4.720 | 100.96 | -80 | -1035.59 | 10.129 | 79.22 | -20 | -297.41 | 14.285 | 60.16 |
| -139 | -1482.90 | 4.821 | 100.64 | -79 | -1025.42 | 10.208 | 78.87 | -19 | -283.09 | 14.345 | 59.90 |
| -138 | -1478.03 | 4.921 | 100.32 | -78 | -1015.17 | 10.287 | 78.52 | -18 | -268.72 | 14.405 | 59.64 |
| -137 | -1473.06 | 5.022 | 99.99 | -77 | -1004.85 | 10.365 | 78.17 | -17 | -254.28 | 14.465 | 59.39 |
| -136 | -1467.99 | 5.121 | 99.65 | -76 | -994.44 | 10.443 | 77.82 | -16 | -239.79 | 14.524 | 59.13 |
| -135 | -1462.82 | 5.221 | 99.31 | -75 | -983.96 | 10.521 | 77.47 | -15 | -225.23 | 14.583 | 58.88 |
| -134 | -1457.55 | 5.320 | 98.97 | -74 | -973.40 | 10.598 | 77.12 | -14 | -210.62 | 14.642 | 58.63 |
| -133 | -1452.18 | 5.419 | 98.62 | -73 | -962.77 | 10.675 | 76.78 | -13 | -195.95 | 14.700 | 58.39 |
| -132 | -1446.71 | 5.517 | 98.27 | -72 | -952.05 | 10.751 | 76.43 | -12 | -181.22 | 14.758 | 58.15 |
| -131 | -1441.15 | 5.615 | 97.92 | -71 | -941.26 | 10.828 | 76.09 | -11 | -166.43 | 14.816 | 57.91 |
| -130 | -1435.48 | 5.713 | 97.56 | -70 | -930.40 | 10.904 | 75.75 | -10 | -151.59 | 14.874 | 57.67 |
| -129 | -1429.72 | 5.810 | 97.20 | -69 | -919.46 | 10.979 | 75.40 | -9 | -136.69 | 14.932 | 57.44 |
| -128 | -1423.86 | 5.907 | 96.84 | -68 | -908.44 | 11.054 | 75.06 | -8 | -121.73 | 14.989 | 57.21 |
| -127 | -1417.90 | 6.004 | 96.47 | -67 | -897.35 | 11.129 | 74.72 | -7 | -106.71 | 15.046 | 56.98 |
| -126 | -1411.85 | 6.100 | 96.11 | -66 | -886.18 | 11.204 | 74.38 | -6 | -91.63 | 15.103 | 56.76 |
| -125 | -1405.70 | 6.196 | 95.74 | -65 | -874.94 | 11.278 | 74.04 | -5 | -76.50 | 15.160 | 56.54 |
| -124 | -1399.46 | 6.292 | 95.37 | -64 | -863.62 | 11.352 | 73.71 | -4 | -61.31 | 15.216 | 56.32 |
| -123 | -1393.12 | 6.387 | 95.00 | -63 | -852.23 | 11.425 | 73.37 | -3 | -46.07 | 15.272 | 56.11 |
| -122 | -1386.69 | 6.482 | 94.63 | -62 | -840.77 | 11.499 | 73.03 | -2 | -30.77 | 15.328 | 55.90 |
| -121 | -1380.16 | 6.576 | 94.26 | -61 | -829.24 | 11.572 | 72.70 | -1 | -15.41 | 15.384 | 55.69 |
| -120 | -1373.53 | 6.670 | 93.88 | -60 | -817.63 | 11.644 | 72.36 | 0 | 0.00 | 15.440 | 55.48 |

TABLE 7.4.4 AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Extended temperature range, 0 to 400 °C.*

| T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 15.440 | 55.48 | 60 | 1018.53 | 18.389 | 43.31 | 120 | 2193.74 | 20.688 | 33.72 |
| 1 | 15.47 | 15.495 | 55.25 | 61 | 1036.94 | 18.433 | 43.13 | 121 | 2214.45 | 20.722 | 33.58 |
| 2 | 30.99 | 15.550 | 55.03 | 62 | 1055.39 | 18.476 | 42.95 | 122 | 2235.18 | 20.756 | 33.44 |
| 3 | 46.57 | 15.605 | 54.80 | 63 | 1073.89 | 18.519 | 42.77 | 123 | 2255.96 | 20.789 | 33.30 |
| 4 | 62.20 | 15.660 | 54.58 | 64 | 1092.43 | 18.561 | 42.59 | 124 | 2276.76 | 20.822 | 33.16 |
| 5 | 77.89 | 15.714 | 54.36 | 65 | 1111.01 | 18.604 | 42.42 | 125 | 2297.60 | 20.855 | 33.02 |
| 6 | 93.63 | 15.769 | 54.14 | 66 | 1129.64 | 18.646 | 42.24 | 126 | 2318.47 | 20.888 | 32.89 |
| 7 | 109.43 | 15.823 | 53.91 | 67 | 1148.31 | 18.688 | 42.06 | 127 | 2339.38 | 20.921 | 32.75 |
| 8 | 125.27 | 15.876 | 53.69 | 68 | 1167.01 | 18.730 | 41.89 | 128 | 2360.31 | 20.954 | 32.61 |
| 9 | 141.18 | 15.930 | 53.47 | 69 | 1185.77 | 18.772 | 41.72 | 129 | 2381.28 | 20.986 | 32.48 |
| 10 | 157.13 | 15.983 | 53.25 | 70 | 1204.56 | 18.814 | 41.54 | 130 | 2402.29 | 21.019 | 32.34 |
| 11 | 173.14 | 16.037 | 53.04 | 71 | 1223.39 | 18.855 | 41.37 | 131 | 2423.32 | 21.051 | 32.21 |
| 12 | 189.21 | 16.089 | 52.82 | 72 | 1242.27 | 18.896 | 41.20 | 132 | 2444.39 | 21.083 | 32.08 |
| 13 | 205.32 | 16.142 | 52.60 | 73 | 1261.19 | 18.938 | 41.03 | 133 | 2465.49 | 21.115 | 31.94 |
| 14 | 221.49 | 16.195 | 52.39 | 74 | 1280.14 | 18.978 | 40.86 | 134 | 2486.62 | 21.147 | 31.81 |
| 15 | 237.71 | 16.247 | 52.17 | 75 | 1299.14 | 19.019 | 40.69 | 135 | 2507.78 | 21.179 | 31.68 |
| 16 | 253.99 | 16.299 | 51.96 | 76 | 1318.18 | 19.060 | 40.52 | 136 | 2528.98 | 21.210 | 31.55 |
| 17 | 270.31 | 16.351 | 51.74 | 77 | 1337.26 | 19.100 | 40.35 | 137 | 2550.20 | 21.242 | 31.41 |
| 18 | 286.69 | 16.403 | 51.53 | 78 | 1356.38 | 19.141 | 40.18 | 138 | 2571.46 | 21.273 | 31.28 |
| 19 | 303.12 | 16.454 | 51.32 | 79 | 1375.54 | 19.181 | 40.01 | 139 | 2592.75 | 21.304 | 31.15 |
| 20 | 319.60 | 16.505 | 51.11 | 80 | 1394.74 | 19.221 | 39.85 | 140 | 2614.07 | 21.336 | 31.03 |
| 21 | 336.13 | 16.556 | 50.90 | 81 | 1413.98 | 19.260 | 39.68 | 141 | 2635.42 | 21.366 | 30.90 |
| 22 | 352.71 | 16.607 | 50.69 | 82 | 1433.26 | 19.300 | 39.51 | 142 | 2656.80 | 21.397 | 30.77 |
| 23 | 369.34 | 16.658 | 50.48 | 83 | 1452.58 | 19.339 | 39.35 | 143 | 2678.21 | 21.428 | 30.64 |
| 24 | 386.02 | 16.708 | 50.27 | 84 | 1471.94 | 19.379 | 39.19 | 144 | 2699.66 | 21.459 | 30.51 |
| 25 | 402.76 | 16.758 | 50.07 | 85 | 1491.34 | 19.418 | 39.02 | 145 | 2721.13 | 21.489 | 30.39 |
| 26 | 419.54 | 16.808 | 49.86 | 86 | 1510.78 | 19.457 | 38.86 | 146 | 2742.64 | 21.519 | 30.26 |
| 27 | 436.37 | 16.858 | 49.66 | 87 | 1530.25 | 19.495 | 38.70 | 147 | 2764.17 | 21.550 | 30.14 |
| 28 | 453.25 | 16.907 | 49.45 | 88 | 1549.77 | 19.534 | 38.54 | 148 | 2785.74 | 21.580 | 30.01 |
| 29 | 470.19 | 16.957 | 49.25 | 89 | 1569.32 | 19.573 | 38.38 | 149 | 2807.33 | 21.610 | 29.89 |
| 30 | 487.17 | 17.006 | 49.04 | 90 | 1588.91 | 19.611 | 38.22 | 150 | 2828.95 | 21.639 | 29.76 |
| 31 | 504.20 | 17.055 | 48.84 | 91 | 1608.54 | 19.649 | 38.06 | 151 | 2850.61 | 21.669 | 29.64 |
| 32 | 521.28 | 17.104 | 48.64 | 92 | 1628.21 | 19.687 | 37.90 | 152 | 2872.29 | 21.699 | 29.52 |
| 33 | 538.41 | 17.152 | 48.44 | 93 | 1647.92 | 19.725 | 37.74 | 153 | 2894.01 | 21.728 | 29.39 |
| 34 | 555.58 | 17.200 | 48.24 | 94 | 1667.66 | 19.762 | 37.58 | 154 | 2915.75 | 21.757 | 29.27 |
| 35 | 572.81 | 17.249 | 48.04 | 95 | 1687.44 | 19.800 | 37.43 | 155 | 2937.52 | 21.787 | 29.15 |
| 36 | 590.08 | 17.297 | 47.84 | 96 | 1707.26 | 19.837 | 37.27 | 156 | 2959.32 | 21.816 | 29.03 |
| 37 | 607.40 | 17.344 | 47.65 | 97 | 1727.12 | 19.874 | 37.12 | 157 | 2981.15 | 21.845 | 28.91 |
| 38 | 624.77 | 17.392 | 47.45 | 98 | 1747.01 | 19.911 | 36.96 | 158 | 3003.01 | 21.874 | 28.79 |
| 39 | 642.18 | 17.439 | 47.25 | 99 | 1766.94 | 19.948 | 36.81 | 159 | 3024.90 | 21.902 | 28.67 |
| 40 | 659.65 | 17.486 | 47.06 | 100 | 1786.91 | 19.985 | 36.65 | 160 | 3046.82 | 21.931 | 28.55 |
| 41 | 677.16 | 17.533 | 46.86 | 101 | 1806.91 | 20.022 | 36.50 | 161 | 3068.76 | 21.959 | 28.44 |
| 42 | 694.71 | 17.580 | 46.67 | 102 | 1826.95 | 20.058 | 36.35 | 162 | 3090.73 | 21.988 | 28.32 |
| 43 | 712.32 | 17.627 | 46.48 | 103 | 1847.03 | 20.094 | 36.20 | 163 | 3112.74 | 22.016 | 28.20 |
| 44 | 729.96 | 17.673 | 46.28 | 104 | 1867.14 | 20.131 | 36.05 | 164 | 3134.77 | 22.044 | 28.09 |
| 45 | 747.66 | 17.719 | 46.09 | 105 | 1887.29 | 20.166 | 35.90 | 165 | 3156.83 | 22.072 | 27.97 |
| 46 | 765.40 | 17.765 | 45.90 | 106 | 1907.47 | 20.202 | 35.75 | 166 | 3178.91 | 22.100 | 27.85 |
| 47 | 783.19 | 17.811 | 45.71 | 107 | 1927.69 | 20.238 | 35.60 | 167 | 3201.03 | 22.128 | 27.74 |
| 48 | 801.03 | 17.857 | 45.52 | 108 | 1947.95 | 20.274 | 35.45 | 168 | 3223.17 | 22.156 | 27.63 |
| 49 | 818.90 | 17.902 | 45.33 | 109 | 1968.24 | 20.309 | 35.30 | 169 | 3245.34 | 22.183 | 27.51 |
| 50 | 836.83 | 17.947 | 45.15 | 110 | 1988.56 | 20.344 | 35.16 | 170 | 3267.53 | 22.211 | 27.40 |
| 51 | 854.80 | 17.992 | 44.96 | 111 | 2008.93 | 20.379 | 35.01 | 171 | 3289.76 | 22.238 | 27.29 |
| 52 | 872.81 | 18.037 | 44.77 | 112 | 2029.32 | 20.414 | 34.86 | 172 | 3312.01 | 22.265 | 27.17 |
| 53 | 890.87 | 18.082 | 44.59 | 113 | 2049.75 | 20.449 | 34.72 | 173 | 3334.29 | 22.292 | 27.06 |
| 54 | 908.98 | 18.126 | 44.40 | 114 | 2070.22 | 20.484 | 34.57 | 174 | 3356.59 | 22.319 | 26.95 |
| 55 | 927.13 | 18.171 | 44.22 | 115 | 2090.72 | 20.518 | 34.43 | 175 | 3378.93 | 22.346 | 26.84 |
| 56 | 945.32 | 18.215 | 44.03 | 116 | 2111.26 | 20.552 | 34.29 | 176 | 3401.29 | 22.373 | 26.73 |
| 57 | 963.56 | 18.259 | 43.85 | 117 | 2131.83 | 20.587 | 34.14 | 177 | 3423.67 | 22.400 | 26.62 |
| 58 | 981.84 | 18.302 | 43.67 | 118 | 2152.43 | 20.621 | 34.00 | 178 | 3446.09 | 22.426 | 26.51 |
| 59 | 1000.16 | 18.346 | 43.49 | 119 | 2173.07 | 20.655 | 33.86 | 179 | 3468.53 | 22.453 | 26.40 |
| 60 | 1018.53 | 18.389 | 43.31 | 120 | 2193.74 | 20.688 | 33.72 | 180 | 3490.99 | 22.479 | 26.29 |

TABLE 7.4.4 AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Extended temperature range, 0 to 400 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 3490.99 | 22.479 | 26.29 | 240 | 4883.42 | 23.878 | 20.60 | 300 | 6350.40 | 24.977 | 16.22 |
| 181 | 3513.48 | 22.505 | 26.18 | 241 | 4907.31 | 23.899 | 20.52 | 301 | 6375.38 | 24.994 | 16.15 |
| 182 | 3536.00 | 22.531 | 26.08 | 242 | 4931.22 | 23.919 | 20.44 | 302 | 6400.39 | 25.010 | 16.09 |
| 183 | 3558.55 | 22.557 | 25.97 | 243 | 4955.14 | 23.940 | 20.35 | 303 | 6425.40 | 25.026 | 16.03 |
| 184 | 3581.12 | 22.583 | 25.86 | 244 | 4979.09 | 23.960 | 20.27 | 304 | 6450.44 | 25.042 | 15.96 |
| 185 | 3603.71 | 22.609 | 25.76 | 245 | 5003.06 | 23.980 | 20.19 | 305 | 6475.49 | 25.058 | 15.90 |
| 186 | 3626.34 | 22.635 | 25.65 | 246 | 5027.06 | 24.000 | 20.11 | 306 | 6500.55 | 25.073 | 15.84 |
| 187 | 3648.98 | 22.661 | 25.55 | 247 | 5051.07 | 24.020 | 20.03 | 307 | 6525.63 | 25.089 | 15.77 |
| 188 | 3671.66 | 22.686 | 25.44 | 248 | 5075.10 | 24.040 | 19.95 | 308 | 6550.73 | 25.105 | 15.71 |
| 189 | 3694.36 | 22.711 | 25.34 | 249 | 5099.15 | 24.060 | 19.87 | 309 | 6575.84 | 25.121 | 15.65 |
| 190 | 3717.08 | 22.737 | 25.23 | 250 | 5123.22 | 24.080 | 19.79 | 310 | 6600.97 | 25.136 | 15.59 |
| 191 | 3739.83 | 22.762 | 25.13 | 251 | 5147.31 | 24.100 | 19.71 | 311 | 6626.12 | 25.152 | 15.52 |
| 192 | 3762.60 | 22.787 | 25.03 | 252 | 5171.42 | 24.120 | 19.63 | 312 | 6651.28 | 25.167 | 15.46 |
| 193 | 3785.40 | 22.812 | 24.93 | 253 | 5195.55 | 24.139 | 19.55 | 313 | 6676.45 | 25.183 | 15.40 |
| 194 | 3808.23 | 22.837 | 24.82 | 254 | 5219.70 | 24.159 | 19.48 | 314 | 6701.64 | 25.198 | 15.34 |
| 195 | 3831.08 | 22.862 | 24.72 | 255 | 5243.86 | 24.178 | 19.40 | 315 | 6726.85 | 25.213 | 15.28 |
| 196 | 3853.95 | 22.886 | 24.62 | 256 | 5268.05 | 24.198 | 19.32 | 316 | 6752.07 | 25.229 | 15.22 |
| 197 | 3876.85 | 22.911 | 24.52 | 257 | 5292.26 | 24.217 | 19.24 | 317 | 6777.30 | 25.244 | 15.16 |
| 198 | 3899.77 | 22.935 | 24.42 | 258 | 5316.48 | 24.236 | 19.17 | 318 | 6802.56 | 25.259 | 15.10 |
| 199 | 3922.72 | 22.960 | 24.32 | 259 | 5340.73 | 24.255 | 19.09 | 319 | 6827.82 | 25.274 | 15.03 |
| 200 | 3945.69 | 22.984 | 24.22 | 260 | 5365.00 | 24.274 | 19.01 | 320 | 6853.10 | 25.289 | 14.97 |
| 201 | 3968.69 | 23.008 | 24.12 | 261 | 5389.28 | 24.293 | 18.94 | 321 | 6878.40 | 25.304 | 14.91 |
| 202 | 3991.71 | 23.032 | 24.03 | 262 | 5413.58 | 24.312 | 18.86 | 322 | 6903.71 | 25.319 | 14.86 |
| 203 | 4014.75 | 23.056 | 23.93 | 263 | 5437.90 | 24.331 | 18.79 | 323 | 6929.04 | 25.334 | 14.80 |
| 204 | 4037.82 | 23.080 | 23.83 | 264 | 5462.24 | 24.350 | 18.71 | 324 | 6954.38 | 25.349 | 14.74 |
| 205 | 4060.91 | 23.104 | 23.73 | 265 | 5486.60 | 24.368 | 18.64 | 325 | 6979.74 | 25.363 | 14.68 |
| 206 | 4084.03 | 23.128 | 23.64 | 266 | 5510.98 | 24.387 | 18.57 | 326 | 7005.11 | 25.378 | 14.62 |
| 207 | 4107.17 | 23.151 | 23.54 | 267 | 5535.38 | 24.405 | 18.49 | 327 | 7030.49 | 25.392 | 14.56 |
| 208 | 4130.33 | 23.175 | 23.45 | 268 | 5559.79 | 24.424 | 18.42 | 328 | 7055.89 | 25.407 | 14.50 |
| 209 | 4153.52 | 23.198 | 23.35 | 269 | 5584.22 | 24.442 | 18.34 | 329 | 7081.31 | 25.421 | 14.44 |
| 210 | 4176.73 | 23.221 | 23.26 | 270 | 5608.68 | 24.461 | 18.27 | 330 | 7106.73 | 25.436 | 14.39 |
| 211 | 4199.96 | 23.245 | 23.16 | 271 | 5633.15 | 24.479 | 18.20 | 331 | 7132.18 | 25.450 | 14.33 |
| 212 | 4223.21 | 23.268 | 23.07 | 272 | 5657.63 | 24.497 | 18.13 | 332 | 7157.63 | 25.465 | 14.27 |
| 213 | 4246.49 | 23.291 | 22.97 | 273 | 5682.14 | 24.515 | 18.06 | 333 | 7183.11 | 25.479 | 14.21 |
| 214 | 4269.80 | 23.314 | 22.88 | 274 | 5706.66 | 24.533 | 17.98 | 334 | 7208.59 | 25.493 | 14.15 |
| 215 | 4293.12 | 23.336 | 22.79 | 275 | 5731.21 | 24.551 | 17.91 | 335 | 7234.09 | 25.507 | 14.10 |
| 216 | 4316.47 | 23.359 | 22.70 | 276 | 5755.77 | 24.569 | 17.84 | 336 | 7259.61 | 25.521 | 14.04 |
| 217 | 4339.84 | 23.382 | 22.60 | 277 | 5780.34 | 24.587 | 17.77 | 337 | 7285.13 | 25.535 | 13.98 |
| 218 | 4363.23 | 23.404 | 22.51 | 278 | 5804.94 | 24.604 | 17.70 | 338 | 7310.68 | 25.549 | 13.93 |
| 219 | 4386.65 | 23.427 | 22.42 | 279 | 5829.55 | 24.622 | 17.63 | 339 | 7336.23 | 25.563 | 13.87 |
| 220 | 4410.09 | 23.449 | 22.33 | 280 | 5854.18 | 24.640 | 17.56 | 340 | 7361.80 | 25.577 | 13.81 |
| 221 | 4433.55 | 23.471 | 22.24 | 281 | 5878.83 | 24.657 | 17.49 | 341 | 7387.39 | 25.591 | 13.76 |
| 222 | 4457.03 | 23.494 | 22.15 | 282 | 5903.50 | 24.675 | 17.42 | 342 | 7412.98 | 25.604 | 13.70 |
| 223 | 4480.53 | 23.516 | 22.06 | 283 | 5928.18 | 24.692 | 17.35 | 343 | 7438.59 | 25.618 | 13.65 |
| 224 | 4504.06 | 23.538 | 21.97 | 284 | 5952.88 | 24.709 | 17.28 | 344 | 7464.22 | 25.632 | 13.59 |
| 225 | 4527.61 | 23.560 | 21.88 | 285 | 5977.60 | 24.727 | 17.21 | 345 | 7489.86 | 25.645 | 13.53 |
| 226 | 4551.18 | 23.582 | 21.80 | 286 | 6002.33 | 24.744 | 17.15 | 346 | 7515.51 | 25.659 | 13.48 |
| 227 | 4574.77 | 23.603 | 21.71 | 287 | 6027.09 | 24.761 | 17.08 | 347 | 7541.18 | 25.672 | 13.42 |
| 228 | 4598.39 | 23.625 | 21.62 | 288 | 6051.86 | 24.778 | 17.01 | 348 | 7566.85 | 25.686 | 13.37 |
| 229 | 4622.02 | 23.647 | 21.53 | 289 | 6076.64 | 24.795 | 16.94 | 349 | 7592.55 | 25.699 | 13.31 |
| 230 | 4645.68 | 23.668 | 21.45 | 290 | 6101.45 | 24.812 | 16.88 | 350 | 7618.25 | 25.712 | 13.26 |
| 231 | 4669.36 | 23.689 | 21.36 | 291 | 6126.27 | 24.829 | 16.81 | 351 | 7643.97 | 25.725 | 13.21 |
| 232 | 4693.06 | 23.711 | 21.27 | 292 | 6151.10 | 24.845 | 16.74 | 352 | 7669.70 | 25.739 | 13.15 |
| 233 | 4716.78 | 23.732 | 21.19 | 293 | 6175.96 | 24.862 | 16.68 | 353 | 7695.45 | 25.752 | 13.10 |
| 234 | 4740.52 | 23.753 | 21.10 | 294 | 6200.83 | 24.879 | 16.61 | 354 | 7721.21 | 25.765 | 13.04 |
| 235 | 4764.29 | 23.774 | 21.02 | 295 | 6225.72 | 24.895 | 16.54 | 355 | 7746.98 | 25.778 | 12.99 |
| 236 | 4788.07 | 23.795 | 20.93 | 296 | 6250.62 | 24.912 | 16.48 | 356 | 7772.76 | 25.791 | 12.93 |
| 237 | 4811.88 | 23.816 | 20.85 | 297 | 6275.54 | 24.928 | 16.41 | 357 | 7798.56 | 25.804 | 12.88 |
| 238 | 4835.70 | 23.837 | 20.77 | 298 | 6300.48 | 24.945 | 16.35 | 358 | 7824.37 | 25.817 | 12.83 |
| 239 | 4859.55 | 23.858 | 20.68 | 299 | 6325.43 | 24.961 | 16.28 | 359 | 7850.19 | 25.829 | 12.77 |
| 240 | 4883.42 | 23.878 | 20.60 | 300 | 6350.40 | 24.977 | 16.22 | 360 | 7876.03 | 25.842 | 12.72 |

TABLE 7.4.4 AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Extended temperature range, 0 to 400 °C*—Continued

| T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ | T<br>°C | E<br>μV | S<br>μV/°C | dS/dT<br>nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 360 | 7876.03 | 25.842 | 12.72 | 375 | 8265.06 | 26.027 | 11.93 | 390 | 8656.78 | 26.200 | 11.17 |
| 361 | 7901.88 | 25.855 | 12.67 | 376 | 8291.09 | 26.039 | 11.88 | 391 | 8682.99 | 26.211 | 11.12 |
| 362 | 7927.74 | 25.867 | 12.61 | 377 | 8317.14 | 26.051 | 11.83 | 392 | 8709.20 | 26.222 | 11.07 |
| 363 | 7953.61 | 25.880 | 12.56 | 378 | 8343.20 | 26.063 | 11.78 | 393 | 8735.43 | 26.234 | 11.02 |
| 364 | 7979.50 | 25.893 | 12.51 | 379 | 8369.26 | 26.074 | 11.73 | 394 | 8761.67 | 26.245 | 10.97 |
| 365 | 8005.40 | 25.905 | 12.46 | 380 | 8395.34 | 26.086 | 11.68 | 395 | 8787.92 | 26.255 | 10.92 |
| 366 | 8031.31 | 25.917 | 12.40 | 381 | 8421.44 | 26.098 | 11.63 | 396 | 8814.18 | 26.266 | 10.87 |
| 367 | 8057.23 | 25.930 | 12.35 | 382 | 8447.54 | 26.109 | 11.58 | 397 | 8840.45 | 26.277 | 10.82 |
| 368 | 8083.17 | 25.942 | 12.30 | 383 | 8473.65 | 26.121 | 11.52 | 398 | 8866.73 | 26.288 | 10.77 |
| 369 | 8109.12 | 25.954 | 12.25 | 384 | 8499.78 | 26.132 | 11.47 | 399 | 8893.03 | 26.299 | 10.72 |
| 370 | 8135.08 | 25.967 | 12.19 | 385 | 8525.92 | 26.144 | 11.42 | 400 | 8919.33 | 26.309 | 10.67 |
| 371 | 8161.05 | 25.979 | 12.14 | 386 | 8552.07 | 26.155 | 11.37 | | | | |
| 372 | 8187.03 | 25.991 | 12.09 | 387 | 8578.23 | 26.167 | 11.32 | | | | |
| 373 | 8213.03 | 26.003 | 12.04 | 388 | 8604.40 | 26.178 | 11.27 | | | | |
| 374 | 8239.04 | 26.015 | 11.99 | 389 | 8630.59 | 26.189 | 11.22 | | | | |
| 375 | 8265.06 | 26.027 | 11.93 | 390 | 8656.78 | 26.200 | 11.17 | | | | |

TABLE 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C.*

| T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 15.421 | 54.95 | 60 | 1016.9 | 18.359 | 43.38 | 120 | 2190.6 | 20.670 | 34.01 |
| 1 | 15.4 | 15.476 | 54.73 | 61 | 1035.2 | 18.402 | 43.21 | 121 | 2211.2 | 20.704 | 33.87 |
| 2 | 31.0 | 15.530 | 54.52 | 62 | 1053.7 | 18.445 | 43.03 | 122 | 2232.0 | 20.738 | 33.73 |
| 3 | 46.5 | 15.585 | 54.31 | 63 | 1072.1 | 18.488 | 42.86 | 123 | 2252.7 | 20.772 | 33.59 |
| 4 | 62.1 | 15.639 | 54.10 | 64 | 1090.6 | 18.531 | 42.69 | 124 | 2273.5 | 20.805 | 33.45 |
| 5 | 77.8 | 15.693 | 53.89 | 65 | 1109.2 | 18.574 | 42.52 | 125 | 2294.3 | 20.839 | 33.32 |
| 6 | 93.5 | 15.747 | 53.68 | 66 | 1127.8 | 18.616 | 42.35 | 126 | 2315.2 | 20.872 | 33.18 |
| 7 | 109.3 | 15.800 | 53.47 | 67 | 1146.4 | 18.658 | 42.18 | 127 | 2336.1 | 20.905 | 33.04 |
| 8 | 125.1 | 15.854 | 53.27 | 68 | 1165.1 | 18.701 | 42.01 | 128 | 2357.0 | 20.938 | 32.91 |
| 9 | 141.0 | 15.907 | 53.06 | 69 | 1183.8 | 18.742 | 41.84 | 129 | 2378.0 | 20.971 | 32.77 |
| 10 | 156.9 | 15.960 | 52.85 | 70 | 1202.6 | 18.784 | 41.67 | 130 | 2398.9 | 21.004 | 32.64 |
| 11 | 172.9 | 16.013 | 52.65 | 71 | 1221.4 | 18.826 | 41.51 | 131 | 2420.0 | 21.036 | 32.50 |
| 12 | 188.9 | 16.065 | 52.44 | 72 | 1240.2 | 18.867 | 41.34 | 132 | 2441.0 | 21.069 | 32.37 |
| 13 | 205.0 | 16.117 | 52.24 | 73 | 1259.1 | 18.908 | 41.17 | 133 | 2462.1 | 21.101 | 32.24 |
| 14 | 221.2 | 16.170 | 52.04 | 74 | 1278.1 | 18.950 | 41.01 | 134 | 2483.2 | 21.133 | 32.11 |
| 15 | 237.4 | 16.222 | 51.83 | 75 | 1297.0 | 18.991 | 40.84 | 135 | 2504.4 | 21.165 | 31.97 |
| 16 | 253.6 | 16.273 | 51.63 | 76 | 1316.0 | 19.031 | 40.68 | 136 | 2525.5 | 21.197 | 31.84 |
| 17 | 269.9 | 16.325 | 51.43 | 77 | 1335.1 | 19.072 | 40.52 | 137 | 2546.8 | 21.229 | 31.71 |
| 18 | 286.3 | 16.376 | 51.23 | 78 | 1354.2 | 19.112 | 40.35 | 138 | 2568.0 | 21.261 | 31.58 |
| 19 | 302.7 | 16.427 | 51.03 | 79 | 1373.3 | 19.153 | 40.19 | 139 | 2589.3 | 21.292 | 31.45 |
| 20 | 319.1 | 16.478 | 50.83 | 80 | 1392.5 | 19.193 | 40.03 | 140 | 2610.6 | 21.323 | 31.32 |
| 21 | 335.6 | 16.529 | 50.63 | 81 | 1411.7 | 19.233 | 39.87 | 141 | 2631.9 | 21.355 | 31.19 |
| 22 | 352.2 | 16.579 | 50.43 | 82 | 1431.0 | 19.272 | 39.71 | 142 | 2653.3 | 21.386 | 31.06 |
| 23 | 368.8 | 16.630 | 50.23 | 83 | 1450.3 | 19.312 | 39.55 | 143 | 2674.7 | 21.417 | 30.93 |
| 24 | 385.4 | 16.680 | 50.04 | 84 | 1469.6 | 19.352 | 39.39 | 144 | 2696.1 | 21.448 | 30.81 |
| 25 | 402.2 | 16.730 | 49.84 | 85 | 1489.0 | 19.391 | 39.23 | 145 | 2717.6 | 21.478 | 30.68 |
| 26 | 418.9 | 16.780 | 49.65 | 86 | 1508.4 | 19.430 | 39.07 | 146 | 2739.1 | 21.509 | 30.55 |
| 27 | 435.7 | 16.829 | 49.45 | 87 | 1527.8 | 19.469 | 38.91 | 147 | 2760.6 | 21.540 | 30.43 |
| 28 | 452.6 | 16.879 | 49.26 | 88 | 1547.3 | 19.508 | 38.75 | 148 | 2782.2 | 21.570 | 30.30 |
| 29 | 469.5 | 16.928 | 49.06 | 89 | 1566.8 | 19.546 | 38.60 | 149 | 2803.8 | 21.600 | 30.18 |
| 30 | 486.4 | 16.977 | 48.87 | 90 | 1586.4 | 19.585 | 38.44 | 150 | 2825.4 | 21.630 | 30.05 |
| 31 | 503.4 | 17.025 | 48.68 | 91 | 1606.0 | 19.623 | 38.28 | 151 | 2847.0 | 21.660 | 29.93 |
| 32 | 520.5 | 17.074 | 48.49 | 92 | 1625.6 | 19.662 | 38.13 | 152 | 2868.7 | 21.690 | 29.80 |
| 33 | 537.6 | 17.122 | 48.30 | 93 | 1645.3 | 19.700 | 37.97 | 153 | 2890.4 | 21.720 | 29.68 |
| 34 | 554.7 | 17.171 | 48.11 | 94 | 1665.0 | 19.737 | 37.82 | 154 | 2912.1 | 21.749 | 29.56 |
| 35 | 571.9 | 17.219 | 47.92 | 95 | 1684.8 | 19.775 | 37.67 | 155 | 2933.9 | 21.779 | 29.44 |
| 36 | 589.2 | 17.266 | 47.73 | 96 | 1704.6 | 19.813 | 37.51 | 156 | 2955.7 | 21.808 | 29.31 |
| 37 | 606.4 | 17.314 | 47.54 | 97 | 1724.4 | 19.850 | 37.36 | 157 | 2977.5 | 21.838 | 29.19 |
| 38 | 623.8 | 17.362 | 47.35 | 98 | 1744.3 | 19.888 | 37.21 | 158 | 2999.4 | 21.867 | 29.07 |
| 39 | 641.2 | 17.409 | 47.16 | 99 | 1764.2 | 19.925 | 37.06 | 159 | 3021.2 | 21.896 | 28.95 |
| 40 | 658.6 | 17.456 | 46.98 | 100 | 1784.1 | 19.962 | 36.91 | 160 | 3043.2 | 21.925 | 28.83 |
| 41 | 676.1 | 17.503 | 46.79 | 101 | 1804.1 | 19.999 | 36.76 | 161 | 3065.1 | 21.953 | 28.71 |
| 42 | 693.6 | 17.549 | 46.61 | 102 | 1824.1 | 20.035 | 36.61 | 162 | 3087.1 | 21.982 | 28.59 |
| 43 | 711.2 | 17.596 | 46.42 | 103 | 1844.2 | 20.072 | 36.46 | 163 | 3109.1 | 22.011 | 28.48 |
| 44 | 728.8 | 17.642 | 46.24 | 104 | 1864.3 | 20.108 | 36.31 | 164 | 3131.1 | 22.039 | 28.36 |
| 45 | 746.5 | 17.688 | 46.05 | 105 | 1884.4 | 20.144 | 36.16 | 165 | 3153.1 | 22.067 | 28.24 |
| 46 | 764.2 | 17.734 | 45.87 | 106 | 1904.6 | 20.180 | 36.02 | 166 | 3175.2 | 22.095 | 28.12 |
| 47 | 781.9 | 17.780 | 45.69 | 107 | 1924.8 | 20.216 | 35.87 | 167 | 3197.3 | 22.124 | 28.01 |
| 48 | 799.7 | 17.826 | 45.51 | 108 | 1945.0 | 20.252 | 35.72 | 168 | 3219.5 | 22.151 | 27.89 |
| 49 | 817.6 | 17.871 | 45.33 | 109 | 1965.3 | 20.288 | 35.58 | 169 | 3241.6 | 22.179 | 27.77 |
| 50 | 835.5 | 17.916 | 45.15 | 110 | 1985.6 | 20.323 | 35.43 | 170 | 3263.8 | 22.207 | 27.66 |
| 51 | 853.4 | 17.961 | 44.97 | 111 | 2005.9 | 20.359 | 35.29 | 171 | 3286.0 | 22.235 | 27.54 |
| 52 | 871.4 | 18.006 | 44.79 | 112 | 2026.3 | 20.394 | 35.14 | 172 | 3308.3 | 22.262 | 27.43 |
| 53 | 889.4 | 18.051 | 44.61 | 113 | 2046.7 | 20.429 | 35.00 | 173 | 3330.6 | 22.290 | 27.32 |
| 54 | 907.5 | 18.096 | 44.43 | 114 | 2067.2 | 20.464 | 34.86 | 174 | 3352.9 | 22.317 | 27.20 |
| 55 | 925.6 | 18.140 | 44.26 | 115 | 2087.6 | 20.499 | 34.71 | 175 | 3375.2 | 22.344 | 27.09 |
| 56 | 943.8 | 18.184 | 44.08 | 116 | 2108.2 | 20.533 | 34.57 | 176 | 3397.6 | 22.371 | 26.98 |
| 57 | 962.0 | 18.228 | 43.90 | 117 | 2128.7 | 20.568 | 34.43 | 177 | 3419.9 | 22.398 | 26.87 |
| 58 | 980.2 | 18.272 | 43.73 | 118 | 2149.3 | 20.602 | 34.29 | 178 | 3442.4 | 22.425 | 26.76 |
| 59 | 998.5 | 18.316 | 43.55 | 119 | 2169.9 | 20.636 | 34.15 | 179 | 3464.8 | 22.451 | 26.64 |
| 60 | 1016.9 | 18.359 | 43.38 | 120 | 2190.6 | 20.670 | 34.01 | 180 | 3487.3 | 22.478 | 26.53 |

Table 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 3487.3 | 22.478 | 26.53 | 240 | 4880.0 | 23.887 | 20.68 | 300 | 6347.5 | 24.987 | 16.19 |
| 181 | 3509.7 | 22.504 | 26.42 | 241 | 4903.9 | 23.908 | 20.59 | 301 | 6372.5 | 25.003 | 16.13 |
| 182 | 3532.3 | 22.531 | 26.31 | 242 | 4927.8 | 23.928 | 20.51 | 302 | 6397.5 | 25.019 | 16.06 |
| 183 | 3554.8 | 22.557 | 26.20 | 243 | 4951.7 | 23.949 | 20.42 | 303 | 6422.5 | 25.035 | 16.00 |
| 184 | 3577.4 | 22.583 | 26.10 | 244 | 4975.7 | 23.969 | 20.34 | 304 | 6447.6 | 25.051 | 15.94 |
| 185 | 3600.0 | 22.609 | 25.99 | 245 | 4999.6 | 23.989 | 20.26 | 305 | 6472.6 | 25.067 | 15.87 |
| 186 | 3622.6 | 22.635 | 25.88 | 246 | 5023.6 | 24.009 | 20.17 | 306 | 6497.7 | 25.083 | 15.81 |
| 187 | 3645.2 | 22.661 | 25.77 | 247 | 5047.7 | 24.030 | 20.09 | 307 | 6522.8 | 25.099 | 15.75 |
| 188 | 3667.9 | 22.687 | 25.67 | 248 | 5071.7 | 24.050 | 20.01 | 308 | 6547.9 | 25.114 | 15.68 |
| 189 | 3690.6 | 22.712 | 25.56 | 249 | 5095.8 | 24.070 | 19.93 | 309 | 6573.0 | 25.130 | 15.62 |
| 190 | 3713.3 | 22.738 | 25.45 | 250 | 5119.8 | 24.089 | 19.84 | 310 | 6598.2 | 25.146 | 15.56 |
| 191 | 3736.1 | 22.763 | 25.35 | 251 | 5143.9 | 24.109 | 19.76 | 311 | 6623.3 | 25.161 | 15.50 |
| 192 | 3758.9 | 22.789 | 25.24 | 252 | 5168.1 | 24.129 | 19.68 | 312 | 6648.5 | 25.177 | 15.44 |
| 193 | 3781.7 | 22.814 | 25.14 | 253 | 5192.2 | 24.149 | 19.60 | 313 | 6673.7 | 25.192 | 15.38 |
| 194 | 3804.5 | 22.839 | 25.03 | 254 | 5216.4 | 24.168 | 19.52 | 314 | 6698.9 | 25.207 | 15.32 |
| 195 | 3827.3 | 22.864 | 24.93 | 255 | 5240.5 | 24.188 | 19.44 | 315 | 6724.1 | 25.223 | 15.25 |
| 196 | 3850.2 | 22.889 | 24.82 | 256 | 5264.7 | 24.207 | 19.36 | 316 | 6749.3 | 25.238 | 15.19 |
| 197 | 3873.1 | 22.913 | 24.72 | 257 | 5289.0 | 24.226 | 19.28 | 317 | 6774.6 | 25.253 | 15.14 |
| 198 | 3896.1 | 22.938 | 24.62 | 258 | 5313.2 | 24.246 | 19.20 | 318 | 6799.8 | 25.268 | 15.08 |
| 199 | 3919.0 | 22.963 | 24.52 | 259 | 5337.4 | 24.265 | 19.12 | 319 | 6825.1 | 25.283 | 15.02 |
| 200 | 3942.0 | 22.987 | 24.42 | 260 | 5361.7 | 24.284 | 19.04 | 320 | 6850.4 | 25.298 | 14.96 |
| 201 | 3965.0 | 23.012 | 24.31 | 261 | 5386.0 | 24.303 | 18.97 | 321 | 6875.7 | 25.313 | 14.90 |
| 202 | 3988.0 | 23.036 | 24.21 | 262 | 5410.3 | 24.322 | 18.89 | 322 | 6901.0 | 25.328 | 14.84 |
| 203 | 4011.0 | 23.060 | 24.11 | 263 | 5434.7 | 24.341 | 18.81 | 323 | 6926.4 | 25.343 | 14.78 |
| 204 | 4034.1 | 23.084 | 24.01 | 264 | 5459.0 | 24.359 | 18.73 | 324 | 6951.7 | 25.357 | 14.73 |
| 205 | 4057.2 | 23.108 | 23.91 | 265 | 5483.4 | 24.378 | 18.66 | 325 | 6977.1 | 25.372 | 14.67 |
| 206 | 4080.3 | 23.132 | 23.81 | 266 | 5507.8 | 24.397 | 18.58 | 326 | 7002.5 | 25.387 | 14.61 |
| 207 | 4103.5 | 23.156 | 23.71 | 267 | 5532.2 | 24.415 | 18.51 | 327 | 7027.9 | 25.401 | 14.55 |
| 208 | 4126.6 | 23.179 | 23.62 | 268 | 5556.6 | 24.434 | 18.43 | 328 | 7053.3 | 25.416 | 14.50 |
| 209 | 4149.8 | 23.203 | 23.52 | 269 | 5581.0 | 24.452 | 18.35 | 329 | 7078.7 | 25.430 | 14.44 |
| 210 | 4173.1 | 23.226 | 23.42 | 270 | 5605.5 | 24.470 | 18.28 | 330 | 7104.1 | 25.445 | 14.39 |
| 211 | 4196.3 | 23.250 | 23.32 | 271 | 5630.0 | 24.489 | 18.21 | 331 | 7129.6 | 25.459 | 14.33 |
| 212 | 4219.6 | 23.273 | 23.23 | 272 | 5654.5 | 24.507 | 18.13 | 332 | 7155.0 | 25.473 | 14.27 |
| 213 | 4242.8 | 23.296 | 23.13 | 273 | 5679.0 | 24.525 | 18.06 | 333 | 7180.5 | 25.488 | 14.22 |
| 214 | 4266.1 | 23.319 | 23.03 | 274 | 5703.5 | 24.543 | 17.98 | 334 | 7206.0 | 25.502 | 14.16 |
| 215 | 4289.5 | 23.342 | 22.94 | 275 | 5728.1 | 24.561 | 17.91 | 335 | 7231.5 | 25.516 | 14.11 |
| 216 | 4312.8 | 23.365 | 22.84 | 276 | 5752.6 | 24.579 | 17.84 | 336 | 7257.0 | 25.530 | 14.06 |
| 217 | 4336.2 | 23.388 | 22.75 | 277 | 5777.2 | 24.597 | 17.77 | 337 | 7282.6 | 25.544 | 14.00 |
| 218 | 4359.6 | 23.411 | 22.65 | 278 | 5801.8 | 24.614 | 17.69 | 338 | 7308.1 | 25.558 | 13.95 |
| 219 | 4383.0 | 23.433 | 22.56 | 279 | 5826.5 | 24.632 | 17.62 | 339 | 7333.7 | 25.572 | 13.89 |
| 220 | 4406.5 | 23.456 | 22.47 | 280 | 5851.1 | 24.650 | 17.55 | 340 | 7359.3 | 25.586 | 13.84 |
| 221 | 4429.9 | 23.478 | 22.37 | 281 | 5875.8 | 24.667 | 17.48 | 341 | 7384.9 | 25.600 | 13.79 |
| 222 | 4453.4 | 23.500 | 22.28 | 282 | 5900.4 | 24.685 | 17.41 | 342 | 7410.5 | 25.613 | 13.74 |
| 223 | 4476.9 | 23.523 | 22.19 | 283 | 5925.1 | 24.702 | 17.34 | 343 | 7436.1 | 25.627 | 13.68 |
| 224 | 4500.5 | 23.545 | 22.10 | 284 | 5949.8 | 24.719 | 17.27 | 344 | 7461.7 | 25.641 | 13.63 |
| 225 | 4524.0 | 23.567 | 22.01 | 285 | 5974.6 | 24.736 | 17.20 | 345 | 7487.4 | 25.654 | 13.58 |
| 226 | 4547.6 | 23.589 | 21.91 | 286 | 5999.3 | 24.754 | 17.13 | 346 | 7513.0 | 25.668 | 13.53 |
| 227 | 4571.2 | 23.611 | 21.82 | 287 | 6024.1 | 24.771 | 17.06 | 347 | 7538.7 | 25.682 | 13.48 |
| 228 | 4594.8 | 23.632 | 21.73 | 288 | 6048.9 | 24.788 | 16.99 | 348 | 7564.4 | 25.695 | 13.43 |
| 229 | 4618.5 | 23.654 | 21.64 | 289 | 6073.7 | 24.805 | 16.92 | 349 | 7590.1 | 25.708 | 13.38 |
| 230 | 4642.1 | 23.676 | 21.55 | 290 | 6098.5 | 24.822 | 16.85 | 350 | 7615.8 | 25.722 | 13.32 |
| 231 | 4665.8 | 23.697 | 21.46 | 291 | 6123.3 | 24.838 | 16.79 | 351 | 7641.6 | 25.735 | 13.27 |
| 232 | 4689.5 | 23.719 | 21.38 | 292 | 6148.1 | 24.855 | 16.72 | 352 | 7667.3 | 25.748 | 13.22 |
| 233 | 4713.3 | 23.740 | 21.29 | 293 | 6173.0 | 24.872 | 16.65 | 353 | 7693.0 | 25.761 | 13.17 |
| 234 | 4737.0 | 23.761 | 21.20 | 294 | 6197.9 | 24.888 | 16.59 | 354 | 7718.8 | 25.775 | 13.13 |
| 235 | 4760.8 | 23.782 | 21.11 | 295 | 6222.8 | 24.905 | 16.52 | 355 | 7744.6 | 25.788 | 13.08 |
| 236 | 4784.6 | 23.804 | 21.02 | 296 | 6247.7 | 24.922 | 16.45 | 356 | 7770.4 | 25.801 | 13.03 |
| 237 | 4808.4 | 23.824 | 20.94 | 297 | 6272.6 | 24.938 | 16.39 | 357 | 7796.2 | 25.814 | 12.98 |
| 238 | 4832.2 | 23.845 | 20.85 | 298 | 6297.6 | 24.954 | 16.32 | 358 | 7822.0 | 25.827 | 12.93 |
| 239 | 4856.1 | 23.866 | 20.77 | 299 | 6322.5 | 24.971 | 16.26 | 359 | 7847.9 | 25.840 | 12.88 |
| 240 | 4880.0 | 23.887 | 20.68 | 300 | 6347.5 | 24.987 | 16.19 | 360 | 7873.7 | 25.853 | 12.83 |

TABLE 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 360 | 7873.7 | 25.853 | 12.83 | 420 | 9446.4 | 26.545 | 10.39 | 480 | 11056.7 | 27.114 | 8.67 |
| 361 | 7899.6 | 25.865 | 12.79 | 421 | 9472.9 | 26.556 | 10.36 | 481 | 11083.8 | 27.123 | 8.65 |
| 362 | 7925.4 | 25.878 | 12.74 | 422 | 9499.5 | 26.566 | 10.33 | 482 | 11110.9 | 27.131 | 8.63 |
| 363 | 7951.3 | 25.891 | 12.69 | 423 | 9526.0 | 26.576 | 10.29 | 483 | 11138.0 | 27.140 | 8.60 |
| 364 | 7977.2 | 25.903 | 12.65 | 424 | 9552.6 | 26.587 | 10.26 | 484 | 11165.2 | 27.149 | 8.58 |
| 365 | 8003.1 | 25.916 | 12.60 | 425 | 9579.2 | 26.597 | 10.23 | 485 | 11192.3 | 27.157 | 8.56 |
| 366 | 8029.0 | 25.929 | 12.55 | 426 | 9605.8 | 26.607 | 10.19 | 486 | 11219.5 | 27.166 | 8.53 |
| 367 | 8055.0 | 25.941 | 12.51 | 427 | 9632.4 | 26.617 | 10.16 | 487 | 11246.7 | 27.174 | 8.51 |
| 368 | 8080.9 | 25.954 | 12.46 | 428 | 9659.1 | 26.627 | 10.13 | 488 | 11273.8 | 27.183 | 8.49 |
| 369 | 8106.9 | 25.966 | 12.41 | 429 | 9685.7 | 26.637 | 10.09 | 489 | 11301.0 | 27.191 | 8.47 |
| 370 | 8132.9 | 25.979 | 12.37 | 430 | 9712.3 | 26.648 | 10.06 | 490 | 11328.2 | 27.200 | 8.45 |
| 371 | 8158.8 | 25.991 | 12.32 | 431 | 9739.0 | 26.658 | 10.03 | 491 | 11355.4 | 27.208 | 8.42 |
| 372 | 8184.8 | 26.003 | 12.28 | 432 | 9765.6 | 26.668 | 10.00 | 492 | 11382.6 | 27.217 | 8.40 |
| 373 | 8210.8 | 26.015 | 12.23 | 433 | 9792.3 | 26.678 | 9.97 | 493 | 11409.9 | 27.225 | 8.38 |
| 374 | 8236.9 | 26.028 | 12.19 | 434 | 9819.0 | 26.688 | 9.93 | 494 | 11437.1 | 27.233 | 8.36 |
| 375 | 8262.9 | 26.040 | 12.15 | 435 | 9845.7 | 26.697 | 9.90 | 495 | 11464.3 | 27.242 | 8.34 |
| 376 | 8289.0 | 26.052 | 12.10 | 436 | 9872.4 | 26.707 | 9.87 | 496 | 11491.6 | 27.250 | 8.31 |
| 377 | 8315.0 | 26.064 | 12.06 | 437 | 9899.1 | 26.717 | 9.84 | 497 | 11518.8 | 27.258 | 8.29 |
| 378 | 8341.1 | 26.076 | 12.02 | 438 | 9925.8 | 26.727 | 9.81 | 498 | 11546.1 | 27.267 | 8.27 |
| 379 | 8367.2 | 26.088 | 11.97 | 439 | 9952.6 | 26.737 | 9.78 | 499 | 11573.4 | 27.275 | 8.25 |
| 380 | 8393.3 | 26.100 | 11.93 | 440 | 9979.3 | 26.747 | 9.75 | 500 | 11600.6 | 27.283 | 8.23 |
| 381 | 8419.4 | 26.112 | 11.89 | 441 | 10006.1 | 26.756 | 9.72 | 501 | 11627.9 | 27.291 | 8.21 |
| 382 | 8445.5 | 26.124 | 11.84 | 442 | 10032.8 | 26.766 | 9.69 | 502 | 11655.2 | 27.299 | 8.19 |
| 383 | 8471.6 | 26.136 | 11.80 | 443 | 10059.6 | 26.776 | 9.66 | 503 | 11682.5 | 27.308 | 8.17 |
| 384 | 8497.7 | 26.147 | 11.76 | 444 | 10086.4 | 26.785 | 9.63 | 504 | 11709.8 | 27.316 | 8.15 |
| 385 | 8523.9 | 26.159 | 11.72 | 445 | 10113.2 | 26.795 | 9.60 | 505 | 11737.2 | 27.324 | 8.13 |
| 386 | 8550.1 | 26.171 | 11.68 | 446 | 10140.0 | 26.805 | 9.57 | 506 | 11764.5 | 27.332 | 8.11 |
| 387 | 8576.2 | 26.182 | 11.63 | 447 | 10166.8 | 26.814 | 9.54 | 507 | 11791.8 | 27.340 | 8.09 |
| 388 | 8602.4 | 26.194 | 11.59 | 448 | 10193.6 | 26.824 | 9.51 | 508 | 11819.2 | 27.348 | 8.07 |
| 389 | 8628.6 | 26.206 | 11.55 | 449 | 10220.4 | 26.833 | 9.48 | 509 | 11846.5 | 27.356 | 8.05 |
| 390 | 8654.8 | 26.217 | 11.51 | 450 | 10247.3 | 26.843 | 9.45 | 510 | 11873.9 | 27.364 | 8.03 |
| 391 | 8681.1 | 26.229 | 11.47 | 451 | 10274.1 | 26.852 | 9.43 | 511 | 11901.3 | 27.372 | 8.01 |
| 392 | 8707.3 | 26.240 | 11.43 | 452 | 10301.0 | 26.861 | 9.40 | 512 | 11928.6 | 27.380 | 7.99 |
| 393 | 8733.5 | 26.252 | 11.39 | 453 | 10327.8 | 26.871 | 9.37 | 513 | 11956.0 | 27.388 | 7.97 |
| 394 | 8759.8 | 26.263 | 11.35 | 454 | 10354.7 | 26.880 | 9.34 | 514 | 11983.4 | 27.396 | 7.95 |
| 395 | 8786.1 | 26.274 | 11.31 | 455 | 10381.6 | 26.889 | 9.31 | 515 | 12010.8 | 27.404 | 7.93 |
| 396 | 8812.4 | 26.286 | 11.27 | 456 | 10408.5 | 26.899 | 9.29 | 516 | 12038.2 | 27.412 | 7.92 |
| 397 | 8838.6 | 26.297 | 11.23 | 457 | 10435.4 | 26.908 | 9.26 | 517 | 12065.6 | 27.420 | 7.90 |
| 398 | 8864.9 | 26.308 | 11.19 | 458 | 10462.3 | 26.917 | 9.23 | 518 | 12093.1 | 27.428 | 7.88 |
| 399 | 8891.3 | 26.319 | 11.16 | 459 | 10489.2 | 26.927 | 9.21 | 519 | 12120.5 | 27.436 | 7.86 |
| 400 | 8917.6 | 26.330 | 11.12 | 460 | 10516.1 | 26.936 | 9.18 | 520 | 12147.9 | 27.444 | 7.84 |
| 401 | 8943.9 | 26.341 | 11.08 | 461 | 10543.1 | 26.945 | 9.15 | 521 | 12175.4 | 27.452 | 7.82 |
| 402 | 8970.3 | 26.352 | 11.04 | 462 | 10570.0 | 26.954 | 9.12 | 522 | 12202.8 | 27.459 | 7.81 |
| 403 | 8996.6 | 26.363 | 11.00 | 463 | 10597.0 | 26.963 | 9.10 | 523 | 12230.3 | 27.467 | 7.79 |
| 404 | 9023.0 | 26.374 | 10.97 | 464 | 10624.0 | 26.972 | 9.07 | 524 | 12257.8 | 27.475 | 7.77 |
| 405 | 9049.4 | 26.385 | 10.93 | 465 | 10650.9 | 26.981 | 9.05 | 525 | 12285.2 | 27.483 | 7.75 |
| 406 | 9075.8 | 26.396 | 10.89 | 466 | 10677.9 | 26.990 | 9.02 | 526 | 12312.7 | 27.490 | 7.74 |
| 407 | 9102.2 | 26.407 | 10.85 | 467 | 10704.9 | 26.999 | 8.99 | 527 | 12340.2 | 27.498 | 7.72 |
| 408 | 9128.6 | 26.418 | 10.82 | 468 | 10731.9 | 27.008 | 8.97 | 528 | 12367.7 | 27.506 | 7.70 |
| 409 | 9155.0 | 26.429 | 10.78 | 469 | 10758.9 | 27.017 | 8.94 | 529 | 12395.2 | 27.514 | 7.68 |
| 410 | 9181.4 | 26.440 | 10.75 | 470 | 10786.0 | 27.026 | 8.92 | 530 | 12422.8 | 27.521 | 7.67 |
| 411 | 9207.9 | 26.450 | 10.71 | 471 | 10813.0 | 27.035 | 8.89 | 531 | 12450.3 | 27.529 | 7.65 |
| 412 | 9234.3 | 26.461 | 10.67 | 472 | 10840.0 | 27.044 | 8.87 | 532 | 12477.8 | 27.537 | 7.63 |
| 413 | 9260.8 | 26.472 | 10.64 | 473 | 10867.1 | 27.053 | 8.84 | 533 | 12505.4 | 27.544 | 7.62 |
| 414 | 9287.3 | 26.482 | 10.60 | 474 | 10894.1 | 27.062 | 8.82 | 534 | 12532.9 | 27.552 | 7.60 |
| 415 | 9313.8 | 26.493 | 10.57 | 475 | 10921.2 | 27.070 | 8.79 | 535 | 12560.5 | 27.559 | 7.58 |
| 416 | 9340.3 | 26.503 | 10.53 | 476 | 10948.3 | 27.079 | 8.77 | 536 | 12588.0 | 27.567 | 7.57 |
| 417 | 9366.8 | 26.514 | 10.50 | 477 | 10975.4 | 27.088 | 8.75 | 537 | 12615.6 | 27.575 | 7.55 |
| 418 | 9393.3 | 26.524 | 10.46 | 478 | 11002.4 | 27.097 | 8.72 | 538 | 12643.2 | 27.582 | 7.53 |
| 419 | 9419.8 | 26.535 | 10.43 | 479 | 11029.5 | 27.105 | 8.70 | 539 | 12670.8 | 27.590 | 7.52 |
| 420 | 9446.4 | 26.545 | 10.39 | 480 | 11056.7 | 27.114 | 8.67 | 540 | 12698.3 | 27.597 | 7.50 |

**Table 7.4.5** AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 540 | 12698.3 | 27.597 | 7.50 | 600 | 14367.2 | 28.022 | 6.73 | 660 | 16060.3 | 28.409 | 6.21 |
| 541 | 12725.9 | 27.605 | 7.49 | 601 | 14395.2 | 28.029 | 6.71 | 661 | 16088.7 | 28.416 | 6.20 |
| 542 | 12753.6 | 27.612 | 7.47 | 602 | 14423.2 | 28.036 | 6.70 | 662 | 16117.1 | 28.422 | 6.19 |
| 543 | 12781.2 | 27.620 | 7.46 | 603 | 14451.3 | 28.042 | 6.69 | 663 | 16145.5 | 28.428 | 6.19 |
| 544 | 12808.8 | 27.627 | 7.44 | 604 | 14479.3 | 28.049 | 6.68 | 664 | 16174.0 | 28.434 | 6.18 |
| 545 | 12836.4 | 27.634 | 7.42 | 605 | 14507.4 | 28.056 | 6.67 | 665 | 16202.4 | 28.440 | 6.17 |
| 546 | 12864.1 | 27.642 | 7.41 | 606 | 14535.4 | 28.062 | 6.66 | 666 | 16230.8 | 28.446 | 6.17 |
| 547 | 12891.7 | 27.649 | 7.39 | 607 | 14563.5 | 28.069 | 6.65 | 667 | 16259.3 | 28.453 | 6.16 |
| 548 | 12919.4 | 27.657 | 7.38 | 608 | 14591.6 | 28.076 | 6.64 | 668 | 16287.7 | 28.459 | 6.15 |
| 549 | 12947.0 | 27.664 | 7.36 | 609 | 14619.6 | 28.082 | 6.63 | 669 | 16316.2 | 28.465 | 6.15 |
| 550 | 12974.7 | 27.671 | 7.35 | 610 | 14647.7 | 28.089 | 6.62 | 670 | 16344.7 | 28.471 | 6.14 |
| 551 | 13002.4 | 27.679 | 7.33 | 611 | 14675.8 | 28.096 | 6.61 | 671 | 16373.1 | 28.477 | 6.13 |
| 552 | 13030.0 | 27.686 | 7.32 | 612 | 14703.9 | 28.102 | 6.60 | 672 | 16401.6 | 28.483 | 6.13 |
| 553 | 13057.7 | 27.693 | 7.31 | 613 | 14732.0 | 28.109 | 6.60 | 673 | 16430.1 | 28.489 | 6.12 |
| 554 | 13085.4 | 27.701 | 7.29 | 614 | 14760.1 | 28.115 | 6.59 | 674 | 16458.6 | 28.496 | 6.11 |
| 555 | 13113.1 | 27.708 | 7.28 | 615 | 14788.2 | 28.122 | 6.58 | 675 | 16487.1 | 28.502 | 6.11 |
| 556 | 13140.8 | 27.715 | 7.26 | 616 | 14816.4 | 28.129 | 6.57 | 676 | 16515.6 | 28.508 | 6.10 |
| 557 | 13168.6 | 27.722 | 7.25 | 617 | 14844.5 | 28.135 | 6.56 | 677 | 16544.1 | 28.514 | 6.09 |
| 558 | 13196.3 | 27.730 | 7.23 | 618 | 14872.6 | 28.142 | 6.55 | 678 | 16572.6 | 28.520 | 6.09 |
| 559 | 13224.0 | 27.737 | 7.22 | 619 | 14900.8 | 28.148 | 6.54 | 679 | 16601.2 | 28.526 | 6.08 |
| 560 | 13251.8 | 27.744 | 7.21 | 620 | 14928.9 | 28.155 | 6.53 | 680 | 16629.7 | 28.532 | 6.07 |
| 561 | 13279.5 | 27.751 | 7.19 | 621 | 14957.1 | 28.161 | 6.52 | 681 | 16658.2 | 28.538 | 6.07 |
| 562 | 13307.3 | 27.758 | 7.18 | 622 | 14985.3 | 28.168 | 6.51 | 682 | 16686.8 | 28.544 | 6.06 |
| 563 | 13335.0 | 27.766 | 7.17 | 623 | 15013.4 | 28.174 | 6.50 | 683 | 16715.3 | 28.550 | 6.06 |
| 564 | 13362.8 | 27.773 | 7.15 | 624 | 15041.6 | 28.181 | 6.49 | 684 | 16743.9 | 28.556 | 6.05 |
| 565 | 13390.6 | 27.780 | 7.14 | 625 | 15069.8 | 28.187 | 6.49 | 685 | 16772.4 | 28.562 | 6.04 |
| 566 | 13418.4 | 27.787 | 7.13 | 626 | 15098.0 | 28.194 | 6.48 | 686 | 16801.0 | 28.568 | 6.04 |
| 567 | 13446.2 | 27.794 | 7.11 | 627 | 15126.2 | 28.200 | 6.47 | 687 | 16829.6 | 28.574 | 6.03 |
| 568 | 13474.0 | 27.801 | 7.10 | 628 | 15154.4 | 28.207 | 6.46 | 688 | 16858.1 | 28.581 | 6.02 |
| 569 | 13501.8 | 27.808 | 7.09 | 629 | 15182.6 | 28.213 | 6.45 | 689 | 16886.7 | 28.587 | 6.02 |
| 570 | 13529.6 | 27.816 | 7.07 | 630 | 15210.8 | 28.220 | 6.44 | 690 | 16915.3 | 28.593 | 6.01 |
| 571 | 13557.4 | 27.823 | 7.06 | 631 | 15239.0 | 28.226 | 6.43 | 691 | 16943.9 | 28.599 | 6.01 |
| 572 | 13585.2 | 27.830 | 7.05 | 632 | 15267.3 | 28.233 | 6.42 | 692 | 16972.5 | 28.605 | 6.00 |
| 573 | 13613.0 | 27.837 | 7.04 | 633 | 15295.5 | 28.239 | 6.42 | 693 | 17001.1 | 28.611 | 5.99 |
| 574 | 13640.9 | 27.844 | 7.02 | 634 | 15323.7 | 28.245 | 6.41 | 694 | 17029.7 | 28.617 | 5.99 |
| 575 | 13668.7 | 27.851 | 7.01 | 635 | 15352.0 | 28.252 | 6.40 | 695 | 17058.3 | 28.623 | 5.98 |
| 576 | 13696.6 | 27.858 | 7.00 | 636 | 15380.2 | 28.258 | 6.39 | 696 | 17087.0 | 28.629 | 5.98 |
| 577 | 13724.4 | 27.865 | 6.99 | 637 | 15408.5 | 28.265 | 6.38 | 697 | 17115.6 | 28.634 | 5.97 |
| 578 | 13752.3 | 27.872 | 6.97 | 638 | 15436.8 | 28.271 | 6.38 | 698 | 17144.2 | 28.640 | 5.96 |
| 579 | 13780.2 | 27.879 | 6.96 | 639 | 15465.0 | 28.277 | 6.37 | 699 | 17172.9 | 28.646 | 5.96 |
| 580 | 13808.1 | 27.886 | 6.95 | 640 | 15493.3 | 28.284 | 6.36 | 700 | 17201.5 | 28.652 | 5.95 |
| 581 | 13836.0 | 27.893 | 6.94 | 641 | 15521.6 | 28.290 | 6.35 | 701 | 17230.2 | 28.658 | 5.95 |
| 582 | 13863.9 | 27.899 | 6.93 | 642 | 15549.9 | 28.296 | 6.34 | 702 | 17258.8 | 28.664 | 5.94 |
| 583 | 13891.8 | 27.906 | 6.91 | 643 | 15578.2 | 28.303 | 6.34 | 703 | 17287.5 | 28.670 | 5.93 |
| 584 | 13919.7 | 27.913 | 6.90 | 644 | 15606.5 | 28.309 | 6.33 | 704 | 17316.2 | 28.676 | 5.93 |
| 585 | 13947.6 | 27.920 | 6.89 | 645 | 15634.8 | 28.315 | 6.32 | 705 | 17344.9 | 28.682 | 5.92 |
| 586 | 13975.5 | 27.927 | 6.88 | 646 | 15663.1 | 28.322 | 6.31 | 706 | 17373.6 | 28.688 | 5.92 |
| 587 | 14003.4 | 27.934 | 6.87 | 647 | 15691.5 | 28.328 | 6.30 | 707 | 17402.2 | 28.694 | 5.91 |
| 588 | 14031.4 | 27.941 | 6.86 | 648 | 15719.8 | 28.334 | 6.30 | 708 | 17430.9 | 28.700 | 5.91 |
| 589 | 14059.3 | 27.948 | 6.84 | 649 | 15748.1 | 28.341 | 6.29 | 709 | 17459.6 | 28.706 | 5.90 |
| 590 | 14087.3 | 27.955 | 6.83 | 650 | 15776.5 | 28.347 | 6.28 | 710 | 17488.4 | 28.712 | 5.90 |
| 591 | 14115.2 | 27.961 | 6.82 | 651 | 15804.8 | 28.353 | 6.27 | 711 | 17517.1 | 28.717 | 5.89 |
| 592 | 14143.2 | 27.968 | 6.81 | 652 | 15833.2 | 28.359 | 6.27 | 712 | 17545.8 | 28.723 | 5.88 |
| 593 | 14171.2 | 27.975 | 6.80 | 653 | 15861.6 | 28.366 | 6.26 | 713 | 17574.5 | 28.729 | 5.88 |
| 594 | 14199.1 | 27.982 | 6.79 | 654 | 15889.9 | 28.372 | 6.25 | 714 | 17603.2 | 28.735 | 5.87 |
| 595 | 14227.1 | 27.989 | 6.78 | 655 | 15918.3 | 28.378 | 6.24 | 715 | 17632.0 | 28.741 | 5.87 |
| 596 | 14255.1 | 27.995 | 6.77 | 656 | 15946.7 | 28.384 | 6.24 | 716 | 17660.7 | 28.747 | 5.86 |
| 597 | 14283.1 | 28.002 | 6.76 | 657 | 15975.1 | 28.391 | 6.23 | 717 | 17689.5 | 28.753 | 5.86 |
| 598 | 14311.1 | 28.009 | 6.75 | 658 | 16003.5 | 28.397 | 6.22 | 718 | 17718.2 | 28.759 | 5.85 |
| 599 | 14339.1 | 28.016 | 6.74 | 659 | 16031.9 | 28.403 | 6.22 | 719 | 17747.0 | 28.764 | 5.85 |
| 600 | 14367.2 | 28.022 | 6.73 | 660 | 16060.3 | 28.409 | 6.21 | 720 | 17775.8 | 28.770 | 5.84 |

TABLE 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 720 | 17775.8 | 28.770 | 5.84 | 780 | 19512.3 | 29.111 | 5.53 | 840 | 21268.7 | 29.433 | 5.19 |
| 721 | 17804.5 | 28.776 | 5.83 | 781 | 19541.4 | 29.117 | 5.52 | 841 | 21298.2 | 29.438 | 5.19 |
| 722 | 17833.3 | 28.782 | 5.83 | 782 | 19570.5 | 29.122 | 5.52 | 842 | 21327.6 | 29.443 | 5.18 |
| 723 | 17862.1 | 28.788 | 5.82 | 783 | 19599.7 | 29.128 | 5.51 | 843 | 21357.0 | 29.449 | 5.18 |
| 724 | 17890.9 | 28.794 | 5.82 | 784 | 19628.8 | 29.133 | 5.50 | 844 | 21386.5 | 29.454 | 5.17 |
| 725 | 17919.7 | 28.799 | 5.81 | 785 | 19657.9 | 29.139 | 5.50 | 845 | 21416.0 | 29.459 | 5.16 |
| 726 | 17948.5 | 28.805 | 5.81 | 786 | 19687.1 | 29.144 | 5.49 | 846 | 21445.4 | 29.464 | 5.16 |
| 727 | 17977.3 | 28.811 | 5.80 | 787 | 19716.2 | 29.150 | 5.49 | 847 | 21474.9 | 29.469 | 5.15 |
| 728 | 18006.1 | 28.817 | 5.80 | 788 | 19745.4 | 29.155 | 5.48 | 848 | 21504.4 | 29.474 | 5.15 |
| 729 | 18034.9 | 28.823 | 5.79 | 789 | 19774.5 | 29.161 | 5.48 | 849 | 21533.8 | 29.480 | 5.14 |
| 730 | 18063.8 | 28.828 | 5.79 | 790 | 19803.7 | 29.166 | 5.47 | 850 | 21563.3 | 29.485 | 5.13 |
| 731 | 18092.6 | 28.834 | 5.78 | 791 | 19832.9 | 29.172 | 5.47 | 851 | 21592.8 | 29.490 | 5.13 |
| 732 | 18121.4 | 28.840 | 5.78 | 792 | 19862.0 | 29.177 | 5.46 | 852 | 21622.3 | 29.495 | 5.12 |
| 733 | 18150.3 | 28.846 | 5.77 | 793 | 19891.2 | 29.183 | 5.46 | 853 | 21651.8 | 29.500 | 5.12 |
| 734 | 18179.1 | 28.851 | 5.76 | 794 | 19920.4 | 29.188 | 5.45 | 854 | 21681.3 | 29.505 | 5.11 |
| 735 | 18208.0 | 28.857 | 5.76 | 795 | 19949.6 | 29.193 | 5.45 | 855 | 21710.8 | 29.510 | 5.10 |
| 736 | 18236.8 | 28.863 | 5.75 | 796 | 19978.8 | 29.199 | 5.44 | 856 | 21740.3 | 29.515 | 5.10 |
| 737 | 18265.7 | 28.869 | 5.75 | 797 | 20008.0 | 29.204 | 5.44 | 857 | 21769.8 | 29.520 | 5.09 |
| 738 | 18294.6 | 28.875 | 5.74 | 798 | 20037.2 | 29.210 | 5.43 | 858 | 21799.4 | 29.526 | 5.08 |
| 739 | 18323.4 | 28.880 | 5.74 | 799 | 20066.4 | 29.215 | 5.43 | 859 | 21828.9 | 29.531 | 5.08 |
| 740 | 18352.3 | 28.886 | 5.73 | 800 | 20095.6 | 29.221 | 5.42 | 860 | 21858.4 | 29.536 | 5.07 |
| 741 | 18381.2 | 28.892 | 5.73 | 801 | 20124.8 | 29.226 | 5.41 | 861 | 21888.0 | 29.541 | 5.06 |
| 742 | 18410.1 | 28.897 | 5.72 | 802 | 20154.1 | 29.231 | 5.41 | 862 | 21917.5 | 29.546 | 5.06 |
| 743 | 18439.0 | 28.903 | 5.72 | 803 | 20183.3 | 29.237 | 5.40 | 863 | 21947.0 | 29.551 | 5.05 |
| 744 | 18467.9 | 28.909 | 5.71 | 804 | 20212.5 | 29.242 | 5.40 | 864 | 21976.6 | 29.556 | 5.04 |
| 745 | 18496.8 | 28.915 | 5.71 | 805 | 20241.8 | 29.248 | 5.39 | 865 | 22006.2 | 29.561 | 5.04 |
| 746 | 18525.7 | 28.920 | 5.70 | 806 | 20271.0 | 29.253 | 5.39 | 866 | 22035.7 | 29.566 | 5.03 |
| 747 | 18554.7 | 28.926 | 5.70 | 807 | 20300.3 | 29.258 | 5.38 | 867 | 22065.3 | 29.571 | 5.03 |
| 748 | 18583.6 | 28.932 | 5.69 | 808 | 20329.6 | 29.264 | 5.38 | 868 | 22094.9 | 29.576 | 5.02 |
| 749 | 18612.5 | 28.937 | 5.69 | 809 | 20358.8 | 29.269 | 5.37 | 869 | 22124.4 | 29.581 | 5.01 |
| 750 | 18641.5 | 28.943 | 5.68 | 810 | 20388.1 | 29.275 | 5.37 | 870 | 22154.0 | 29.586 | 5.01 |
| 751 | 18670.4 | 28.949 | 5.68 | 811 | 20417.4 | 29.280 | 5.36 | 871 | 22183.6 | 29.591 | 5.00 |
| 752 | 18699.4 | 28.954 | 5.67 | 812 | 20446.7 | 29.285 | 5.36 | 872 | 22213.2 | 29.596 | 4.99 |
| 753 | 18728.3 | 28.960 | 5.67 | 813 | 20475.9 | 29.291 | 5.35 | 873 | 22242.8 | 29.601 | 4.99 |
| 754 | 18757.3 | 28.966 | 5.66 | 814 | 20505.2 | 29.296 | 5.34 | 874 | 22272.4 | 29.606 | 4.98 |
| 755 | 18786.3 | 28.971 | 5.65 | 815 | 20534.5 | 29.301 | 5.34 | 875 | 22302.0 | 29.611 | 4.97 |
| 756 | 18815.2 | 28.977 | 5.65 | 816 | 20563.8 | 29.307 | 5.33 | 876 | 22331.6 | 29.616 | 4.97 |
| 757 | 18844.2 | 28.983 | 5.64 | 817 | 20593.1 | 29.312 | 5.33 | 877 | 22361.2 | 29.621 | 4.96 |
| 758 | 18873.2 | 28.988 | 5.64 | 818 | 20622.5 | 29.317 | 5.32 | 878 | 22390.9 | 29.626 | 4.95 |
| 759 | 18902.2 | 28.994 | 5.63 | 819 | 20651.8 | 29.323 | 5.32 | 879 | 22420.5 | 29.631 | 4.94 |
| 760 | 18931.2 | 29.000 | 5.63 | 820 | 20681.1 | 29.328 | 5.31 | 880 | 22450.1 | 29.636 | 4.94 |
| 761 | 18960.2 | 29.005 | 5.62 | 821 | 20710.4 | 29.333 | 5.30 | 881 | 22479.8 | 29.641 | 4.93 |
| 762 | 18989.2 | 29.011 | 5.62 | 822 | 20739.8 | 29.339 | 5.30 | 882 | 22509.4 | 29.646 | 4.92 |
| 763 | 19018.2 | 29.016 | 5.61 | 823 | 20769.1 | 29.344 | 5.29 | 883 | 22539.1 | 29.651 | 4.92 |
| 764 | 19047.2 | 29.022 | 5.61 | 824 | 20798.5 | 29.349 | 5.29 | 884 | 22568.7 | 29.655 | 4.91 |
| 765 | 19076.3 | 29.028 | 5.60 | 825 | 20827.8 | 29.354 | 5.28 | 885 | 22598.4 | 29.660 | 4.90 |
| 766 | 19105.3 | 29.033 | 5.60 | 826 | 20857.2 | 29.360 | 5.28 | 886 | 22628.0 | 29.665 | 4.90 |
| 767 | 19134.3 | 29.039 | 5.59 | 827 | 20886.5 | 29.365 | 5.27 | 887 | 22657.7 | 29.670 | 4.89 |
| 768 | 19163.4 | 29.044 | 5.59 | 828 | 20915.9 | 29.370 | 5.26 | 888 | 22687.4 | 29.675 | 4.88 |
| 769 | 19192.4 | 29.050 | 5.58 | 829 | 20945.3 | 29.376 | 5.26 | 889 | 22717.1 | 29.680 | 4.87 |
| 770 | 19221.5 | 29.056 | 5.58 | 830 | 20974.7 | 29.381 | 5.25 | 890 | 22746.7 | 29.685 | 4.87 |
| 771 | 19250.5 | 29.061 | 5.57 | 831 | 21004.0 | 29.386 | 5.25 | 891 | 22776.4 | 29.690 | 4.86 |
| 772 | 19279.6 | 29.067 | 5.57 | 832 | 21033.4 | 29.391 | 5.24 | 892 | 22806.1 | 29.695 | 4.85 |
| 773 | 19308.7 | 29.072 | 5.56 | 833 | 21062.8 | 29.396 | 5.24 | 893 | 22835.8 | 29.699 | 4.85 |
| 774 | 19337.7 | 29.078 | 5.56 | 834 | 21092.2 | 29.402 | 5.23 | 894 | 22865.5 | 29.704 | 4.84 |
| 775 | 19366.8 | 29.083 | 5.55 | 835 | 21121.6 | 29.407 | 5.22 | 895 | 22895.2 | 29.709 | 4.83 |
| 776 | 19395.9 | 29.089 | 5.55 | 836 | 21151.0 | 29.412 | 5.22 | 896 | 22924.9 | 29.714 | 4.82 |
| 777 | 19425.0 | 29.095 | 5.54 | 837 | 21180.4 | 29.417 | 5.21 | 897 | 22954.6 | 29.719 | 4.82 |
| 778 | 19454.1 | 29.100 | 5.54 | 838 | 21209.9 | 29.423 | 5.21 | 898 | 22984.4 | 29.724 | 4.81 |
| 779 | 19483.2 | 29.106 | 5.53 | 839 | 21239.3 | 29.428 | 5.20 | 899 | 23014.1 | 29.728 | 4.80 |
| 780 | 19512.3 | 29.111 | 5.53 | 840 | 21268.7 | 29.433 | 5.19 | 900 | 23043.8 | 29.733 | 4.79 |

Table 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | 23043.8 | 29.733 | 4.79 | 960 | 24836.2 | 30.006 | 4.29 | 1020 | 26643.9 | 30.246 | 3.68 |
| 901 | 23073.6 | 29.738 | 4.79 | 961 | 24866.2 | 30.011 | 4.28 | 1021 | 26674.2 | 30.250 | 3.67 |
| 902 | 23103.3 | 29.743 | 4.78 | 962 | 24896.2 | 30.015 | 4.27 | 1022 | 26704.4 | 30.253 | 3.66 |
| 903 | 23133.0 | 29.747 | 4.77 | 963 | 24926.2 | 30.019 | 4.26 | 1023 | 26734.7 | 30.257 | 3.65 |
| 904 | 23162.8 | 29.752 | 4.76 | 964 | 24956.2 | 30.023 | 4.26 | 1024 | 26764.9 | 30.261 | 3.63 |
| 905 | 23192.6 | 29.757 | 4.76 | 965 | 24986.2 | 30.028 | 4.25 | 1025 | 26795.2 | 30.264 | 3.62 |
| 906 | 23222.3 | 29.762 | 4.75 | 966 | 25016.3 | 30.032 | 4.24 | 1026 | 26825.4 | 30.268 | 3.61 |
| 907 | 23252.1 | 29.766 | 4.74 | 967 | 25046.3 | 30.036 | 4.23 | 1027 | 26855.7 | 30.271 | 3.60 |
| 908 | 23281.8 | 29.771 | 4.73 | 968 | 25076.3 | 30.040 | 4.22 | 1028 | 26886.0 | 30.275 | 3.59 |
| 909 | 23311.6 | 29.776 | 4.73 | 969 | 25106.4 | 30.045 | 4.21 | 1029 | 26916.3 | 30.279 | 3.58 |
| 910 | 23341.4 | 29.781 | 4.72 | 970 | 25136.4 | 30.049 | 4.20 | 1030 | 26946.5 | 30.282 | 3.57 |
| 911 | 23371.2 | 29.785 | 4.71 | 971 | 25166.5 | 30.053 | 4.19 | 1031 | 26976.8 | 30.286 | 3.55 |
| 912 | 23401.0 | 29.790 | 4.70 | 972 | 25196.5 | 30.057 | 4.18 | 1032 | 27007.1 | 30.289 | 3.54 |
| 913 | 23430.8 | 29.795 | 4.69 | 973 | 25226.6 | 30.061 | 4.17 | 1033 | 27037.4 | 30.293 | 3.53 |
| 914 | 23460.6 | 29.799 | 4.69 | 974 | 25256.7 | 30.065 | 4.16 | 1034 | 27067.7 | 30.296 | 3.52 |
| 915 | 23490.4 | 29.804 | 4.68 | 975 | 25286.7 | 30.070 | 4.15 | 1035 | 27098.0 | 30.300 | 3.51 |
| 916 | 23520.2 | 29.809 | 4.67 | 976 | 25316.8 | 30.074 | 4.14 | 1036 | 27128.3 | 30.303 | 3.50 |
| 917 | 23550.0 | 29.814 | 4.66 | 977 | 25346.9 | 30.078 | 4.13 | 1037 | 27158.6 | 30.307 | 3.49 |
| 918 | 23579.8 | 29.818 | 4.66 | 978 | 25377.0 | 30.082 | 4.12 | 1038 | 27188.9 | 30.310 | 3.47 |
| 919 | 23609.6 | 29.823 | 4.65 | 979 | 25407.0 | 30.086 | 4.11 | 1039 | 27219.2 | 30.314 | 3.46 |
| 920 | 23639.4 | 29.827 | 4.64 | 980 | 25437.1 | 30.090 | 4.10 | 1040 | 27249.5 | 30.317 | 3.45 |
| 921 | 23669.3 | 29.832 | 4.63 | 981 | 25467.2 | 30.094 | 4.09 | 1041 | 27279.9 | 30.321 | 3.44 |
| 922 | 23699.1 | 29.837 | 4.62 | 982 | 25497.3 | 30.098 | 4.08 | 1042 | 27310.2 | 30.324 | 3.43 |
| 923 | 23728.9 | 29.841 | 4.61 | 983 | 25527.4 | 30.102 | 4.07 | 1043 | 27340.5 | 30.328 | 3.42 |
| 924 | 23758.8 | 29.846 | 4.61 | 984 | 25557.5 | 30.107 | 4.06 | 1044 | 27370.8 | 30.331 | 3.40 |
| 925 | 23788.6 | 29.851 | 4.60 | 985 | 25587.6 | 30.111 | 4.05 | 1045 | 27401.2 | 30.334 | 3.39 |
| 926 | 23818.5 | 29.855 | 4.59 | 986 | 25617.7 | 30.115 | 4.04 | 1046 | 27431.5 | 30.338 | 3.38 |
| 927 | 23848.3 | 29.860 | 4.58 | 987 | 25647.9 | 30.119 | 4.03 | 1047 | 27461.9 | 30.341 | 3.37 |
| 928 | 23878.2 | 29.864 | 4.57 | 988 | 25678.0 | 30.123 | 4.02 | 1048 | 27492.2 | 30.344 | 3.36 |
| 929 | 23908.1 | 29.869 | 4.57 | 989 | 25708.1 | 30.127 | 4.01 | 1049 | 27522.5 | 30.348 | 3.34 |
| 930 | 23937.9 | 29.873 | 4.56 | 990 | 25738.2 | 30.131 | 4.00 | 1050 | 27552.9 | 30.351 | 3.33 |
| 931 | 23967.8 | 29.878 | 4.55 | 991 | 25768.4 | 30.135 | 3.99 | 1051 | 27583.2 | 30.355 | 3.32 |
| 932 | 23997.7 | 29.883 | 4.54 | 992 | 25798.5 | 30.139 | 3.98 | 1052 | 27613.6 | 30.358 | 3.31 |
| 933 | 24027.6 | 29.887 | 4.53 | 993 | 25828.6 | 30.143 | 3.97 | 1053 | 27644.0 | 30.361 | 3.30 |
| 934 | 24057.5 | 29.892 | 4.52 | 994 | 25858.8 | 30.147 | 3.96 | 1054 | 27674.3 | 30.364 | 3.28 |
| 935 | 24087.4 | 29.896 | 4.52 | 995 | 25888.9 | 30.151 | 3.95 | 1055 | 27704.7 | 30.368 | 3.27 |
| 936 | 24117.3 | 29.901 | 4.51 | 996 | 25919.1 | 30.155 | 3.94 | 1056 | 27735.1 | 30.371 | 3.26 |
| 937 | 24147.2 | 29.905 | 4.50 | 997 | 25949.2 | 30.158 | 3.93 | 1057 | 27765.4 | 30.374 | 3.25 |
| 938 | 24177.1 | 29.910 | 4.49 | 998 | 25979.4 | 30.162 | 3.92 | 1058 | 27795.8 | 30.377 | 3.24 |
| 939 | 24207.0 | 29.914 | 4.48 | 999 | 26009.6 | 30.166 | 3.91 | 1059 | 27826.2 | 30.381 | 3.22 |
| 940 | 24236.9 | 29.919 | 4.47 | 1000 | 26039.7 | 30.170 | 3.90 | 1060 | 27856.6 | 30.384 | 3.21 |
| 941 | 24266.8 | 29.923 | 4.46 | 1001 | 26069.9 | 30.174 | 3.89 | 1061 | 27887.0 | 30.387 | 3.20 |
| 942 | 24296.7 | 29.928 | 4.45 | 1002 | 26100.1 | 30.178 | 3.87 | 1062 | 27917.3 | 30.390 | 3.19 |
| 943 | 24326.7 | 29.932 | 4.45 | 1003 | 26130.3 | 30.182 | 3.86 | 1063 | 27947.7 | 30.393 | 3.17 |
| 944 | 24356.6 | 29.936 | 4.44 | 1004 | 26160.5 | 30.186 | 3.85 | 1064 | 27978.1 | 30.397 | 3.16 |
| 945 | 24386.6 | 29.941 | 4.43 | 1005 | 26190.6 | 30.190 | 3.84 | 1065 | 28008.5 | 30.400 | 3.15 |
| 946 | 24416.5 | 29.945 | 4.42 | 1006 | 26220.8 | 30.193 | 3.83 | 1066 | 28038.9 | 30.403 | 3.14 |
| 947 | 24446.4 | 29.950 | 4.41 | 1007 | 26251.0 | 30.197 | 3.82 | 1067 | 28069.3 | 30.406 | 3.12 |
| 948 | 24476.4 | 29.954 | 4.40 | 1008 | 26281.2 | 30.201 | 3.81 | 1068 | 28099.7 | 30.409 | 3.11 |
| 949 | 24506.3 | 29.958 | 4.39 | 1009 | 26311.4 | 30.205 | 3.80 | 1069 | 28130.2 | 30.412 | 3.10 |
| 950 | 24536.3 | 29.963 | 4.38 | 1010 | 26341.6 | 30.209 | 3.79 | 1070 | 28160.6 | 30.415 | 3.09 |
| 951 | 24566.3 | 29.967 | 4.37 | 1011 | 26371.8 | 30.212 | 3.78 | 1071 | 28191.0 | 30.418 | 3.08 |
| 952 | 24596.2 | 29.972 | 4.37 | 1012 | 26402.1 | 30.216 | 3.77 | 1072 | 28221.4 | 30.422 | 3.06 |
| 953 | 24626.2 | 29.976 | 4.36 | 1013 | 26432.3 | 30.220 | 3.76 | 1073 | 28251.8 | 30.425 | 3.05 |
| 954 | 24656.2 | 29.980 | 4.35 | 1014 | 26462.5 | 30.224 | 3.75 | 1074 | 28282.3 | 30.428 | 3.04 |
| 955 | 24686.2 | 29.985 | 4.34 | 1015 | 26492.7 | 30.227 | 3.73 | 1075 | 28312.7 | 30.431 | 3.02 |
| 956 | 24716.2 | 29.989 | 4.33 | 1016 | 26523.0 | 30.231 | 3.72 | 1076 | 28343.1 | 30.434 | 3.01 |
| 957 | 24746.2 | 29.993 | 4.32 | 1017 | 26553.2 | 30.235 | 3.71 | 1077 | 28373.5 | 30.437 | 3.00 |
| 958 | 24776.2 | 29.998 | 4.31 | 1018 | 26583.4 | 30.239 | 3.70 | 1078 | 28404.0 | 30.440 | 2.99 |
| 959 | 24806.2 | 30.002 | 4.30 | 1019 | 26613.7 | 30.242 | 3.69 | 1079 | 28434.4 | 30.443 | 2.97 |
| 960 | 24836.2 | 30.006 | 4.29 | 1020 | 26643.9 | 30.246 | 3.68 | 1080 | 28464.9 | 30.446 | 2.96 |

TABLE 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E $\mu$V | S $\mu$V/°C | dS/dT nV/°C$^2$ | T °C | E $\mu$V | S $\mu$V/°C | dS/dT nV/°C$^2$ | T °C | E $\mu$V | S $\mu$V/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1080 | 28464.9 | 30.446 | 2.96 | 1140 | 30296.5 | 30.600 | 2.17 | 1200 | 32135.9 | 30.706 | 1.36 |
| 1081 | 28495.3 | 30.449 | 2.95 | 1141 | 30327.1 | 30.602 | 2.16 | 1201 | 32166.6 | 30.707 | 1.34 |
| 1082 | 28525.8 | 30.452 | 2.94 | 1142 | 30357.7 | 30.604 | 2.14 | 1202 | 32197.3 | 30.708 | 1.33 |
| 1083 | 28556.2 | 30.454 | 2.92 | 1143 | 30388.3 | 30.606 | 2.13 | 1203 | 32228.0 | 30.710 | 1.32 |
| 1084 | 28586.7 | 30.457 | 2.91 | 1144 | 30418.9 | 30.608 | 2.12 | 1204 | 32258.7 | 30.711 | 1.30 |
| 1085 | 28617.1 | 30.460 | 2.90 | 1145 | 30449.5 | 30.611 | 2.10 | 1205 | 32289.4 | 30.712 | 1.29 |
| 1086 | 28647.6 | 30.463 | 2.89 | 1146 | 30480.1 | 30.613 | 2.09 | 1206 | 32320.1 | 30.714 | 1.28 |
| 1087 | 28678.1 | 30.466 | 2.87 | 1147 | 30510.7 | 30.615 | 2.08 | 1207 | 32350.9 | 30.715 | 1.26 |
| 1088 | 28708.5 | 30.469 | 2.86 | 1148 | 30541.3 | 30.617 | 2.06 | 1208 | 32381.6 | 30.716 | 1.25 |
| 1089 | 28739.0 | 30.472 | 2.85 | 1149 | 30572.0 | 30.619 | 2.05 | 1209 | 32412.3 | 30.717 | 1.24 |
| 1090 | 28769.5 | 30.475 | 2.83 | 1150 | 30602.6 | 30.621 | 2.03 | 1210 | 32443.0 | 30.719 | 1.22 |
| 1091 | 28799.9 | 30.477 | 2.82 | 1151 | 30633.2 | 30.623 | 2.02 | 1211 | 32473.7 | 30.720 | 1.21 |
| 1092 | 28830.4 | 30.480 | 2.81 | 1152 | 30663.8 | 30.625 | 2.01 | 1212 | 32504.4 | 30.721 | 1.20 |
| 1093 | 28860.9 | 30.483 | 2.80 | 1153 | 30694.5 | 30.627 | 1.99 | 1213 | 32535.2 | 30.722 | 1.18 |
| 1094 | 28891.4 | 30.486 | 2.78 | 1154 | 30725.1 | 30.629 | 1.98 | 1214 | 32565.9 | 30.723 | 1.17 |
| 1095 | 28921.9 | 30.489 | 2.77 | 1155 | 30755.7 | 30.631 | 1.97 | 1215 | 32596.6 | 30.724 | 1.16 |
| 1096 | 28952.4 | 30.491 | 2.76 | 1156 | 30786.3 | 30.633 | 1.95 | 1216 | 32627.3 | 30.726 | 1.14 |
| 1097 | 28982.9 | 30.494 | 2.74 | 1157 | 30817.0 | 30.635 | 1.94 | 1217 | 32658.1 | 30.727 | 1.13 |
| 1098 | 29013.4 | 30.497 | 2.73 | 1158 | 30847.6 | 30.637 | 1.93 | 1218 | 32688.8 | 30.728 | 1.12 |
| 1099 | 29043.9 | 30.500 | 2.72 | 1159 | 30878.2 | 30.639 | 1.91 | 1219 | 32719.5 | 30.729 | 1.10 |
| 1100 | 29074.4 | 30.502 | 2.70 | 1160 | 30908.9 | 30.641 | 1.90 | 1220 | 32750.3 | 30.730 | 1.09 |
| 1101 | 29104.9 | 30.505 | 2.69 | 1161 | 30939.5 | 30.642 | 1.89 | 1221 | 32781.0 | 30.731 | 1.08 |
| 1102 | 29135.4 | 30.508 | 2.68 | 1162 | 30970.2 | 30.644 | 1.87 | 1222 | 32811.7 | 30.732 | 1.06 |
| 1103 | 29165.9 | 30.510 | 2.67 | 1163 | 31000.8 | 30.646 | 1.86 | 1223 | 32842.4 | 30.733 | 1.05 |
| 1104 | 29196.4 | 30.513 | 2.65 | 1164 | 31031.5 | 30.648 | 1.84 | 1224 | 32873.2 | 30.734 | 1.04 |
| 1105 | 29226.9 | 30.516 | 2.64 | 1165 | 31062.1 | 30.650 | 1.83 | 1225 | 32903.9 | 30.735 | 1.02 |
| 1106 | 29257.4 | 30.518 | 2.63 | 1166 | 31092.8 | 30.652 | 1.82 | 1226 | 32934.7 | 30.736 | 1.01 |
| 1107 | 29287.9 | 30.521 | 2.61 | 1167 | 31123.4 | 30.654 | 1.80 | 1227 | 32965.4 | 30.737 | 1.00 |
| 1108 | 29318.5 | 30.524 | 2.60 | 1168 | 31154.1 | 30.655 | 1.79 | 1228 | 32996.1 | 30.738 | 0.99 |
| 1109 | 29349.0 | 30.526 | 2.59 | 1169 | 31184.7 | 30.657 | 1.78 | 1229 | 33026.9 | 30.739 | 0.97 |
| 1110 | 29379.5 | 30.529 | 2.57 | 1170 | 31215.4 | 30.659 | 1.76 | 1230 | 33057.6 | 30.740 | 0.96 |
| 1111 | 29410.0 | 30.531 | 2.56 | 1171 | 31246.0 | 30.661 | 1.75 | 1231 | 33088.3 | 30.741 | 0.95 |
| 1112 | 29440.6 | 30.534 | 2.55 | 1172 | 31276.7 | 30.662 | 1.74 | 1232 | 33119.1 | 30.742 | 0.93 |
| 1113 | 29471.1 | 30.536 | 2.53 | 1173 | 31307.4 | 30.664 | 1.72 | 1233 | 33149.8 | 30.743 | 0.92 |
| 1114 | 29501.7 | 30.539 | 2.52 | 1174 | 31338.0 | 30.666 | 1.71 | 1234 | 33180.6 | 30.744 | 0.91 |
| 1115 | 29532.2 | 30.541 | 2.51 | 1175 | 31368.7 | 30.668 | 1.69 | 1235 | 33211.3 | 30.745 | 0.90 |
| 1116 | 29562.7 | 30.544 | 2.49 | 1176 | 31399.4 | 30.669 | 1.68 | 1236 | 33242.1 | 30.746 | 0.88 |
| 1117 | 29593.3 | 30.546 | 2.48 | 1177 | 31430.0 | 30.671 | 1.67 | 1237 | 33272.8 | 30.747 | 0.87 |
| 1118 | 29623.8 | 30.549 | 2.47 | 1178 | 31460.7 | 30.673 | 1.65 | 1238 | 33303.6 | 30.748 | 0.86 |
| 1119 | 29654.4 | 30.551 | 2.45 | 1179 | 31491.4 | 30.674 | 1.64 | 1239 | 33334.3 | 30.748 | 0.84 |
| 1120 | 29684.9 | 30.554 | 2.44 | 1180 | 31522.1 | 30.676 | 1.63 | 1240 | 33365.1 | 30.749 | 0.83 |
| 1121 | 29715.5 | 30.556 | 2.43 | 1181 | 31552.7 | 30.677 | 1.61 | 1241 | 33395.8 | 30.750 | 0.82 |
| 1122 | 29746.0 | 30.559 | 2.41 | 1182 | 31583.4 | 30.679 | 1.60 | 1242 | 33426.6 | 30.751 | 0.81 |
| 1123 | 29776.6 | 30.561 | 2.40 | 1183 | 31614.1 | 30.681 | 1.59 | 1243 | 33457.3 | 30.752 | 0.79 |
| 1124 | 29807.2 | 30.563 | 2.39 | 1184 | 31644.8 | 30.682 | 1.57 | 1244 | 33488.1 | 30.753 | 0.78 |
| 1125 | 29837.7 | 30.566 | 2.37 | 1185 | 31675.5 | 30.684 | 1.56 | 1245 | 33518.8 | 30.753 | 0.77 |
| 1126 | 29868.3 | 30.568 | 2.36 | 1186 | 31706.1 | 30.685 | 1.54 | 1246 | 33549.6 | 30.754 | 0.76 |
| 1127 | 29898.9 | 30.571 | 2.35 | 1187 | 31736.8 | 30.687 | 1.53 | 1247 | 33580.3 | 30.755 | 0.74 |
| 1128 | 29929.4 | 30.573 | 2.33 | 1188 | 31767.5 | 30.688 | 1.52 | 1248 | 33611.1 | 30.756 | 0.73 |
| 1129 | 29960.0 | 30.575 | 2.32 | 1189 | 31798.2 | 30.690 | 1.50 | 1249 | 33641.8 | 30.756 | 0.72 |
| 1130 | 29990.6 | 30.578 | 2.31 | 1190 | 31828.9 | 30.691 | 1.49 | 1250 | 33672.6 | 30.757 | 0.71 |
| 1131 | 30021.2 | 30.580 | 2.29 | 1191 | 31859.6 | 30.693 | 1.48 | 1251 | 33703.3 | 30.758 | 0.70 |
| 1132 | 30051.7 | 30.582 | 2.28 | 1192 | 31890.3 | 30.694 | 1.46 | 1252 | 33734.1 | 30.758 | 0.68 |
| 1133 | 30082.3 | 30.584 | 2.27 | 1193 | 31921.0 | 30.696 | 1.45 | 1253 | 33764.9 | 30.759 | 0.67 |
| 1134 | 30112.9 | 30.587 | 2.25 | 1194 | 31951.7 | 30.697 | 1.44 | 1254 | 33795.6 | 30.760 | 0.66 |
| 1135 | 30143.5 | 30.589 | 2.24 | 1195 | 31982.4 | 30.699 | 1.42 | 1255 | 33826.4 | 30.760 | 0.65 |
| 1136 | 30174.1 | 30.591 | 2.22 | 1196 | 32013.1 | 30.700 | 1.41 | 1256 | 33857.1 | 30.761 | 0.63 |
| 1137 | 30204.7 | 30.593 | 2.21 | 1197 | 32043.8 | 30.702 | 1.40 | 1257 | 33887.9 | 30.762 | 0.62 |
| 1138 | 30235.3 | 30.596 | 2.20 | 1198 | 32074.5 | 30.703 | 1.38 | 1258 | 33918.7 | 30.762 | 0.61 |
| 1139 | 30265.9 | 30.598 | 2.18 | 1199 | 32105.2 | 30.704 | 1.37 | 1259 | 33949.4 | 30.763 | 0.60 |
| 1140 | 30296.5 | 30.600 | 2.17 | 1200 | 32135.9 | 30.706 | 1.36 | 1260 | 33980.2 | 30.763 | 0.59 |

TABLE 7.4.5 AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1260 | 33980.2 | 30.763 | | 1275 | 34441.7 | 30.771 | | 1290 | 34903.3 | 30.776 | |
| 1261 | 34011.0 | 30.764 | | 1276 | 34472.5 | 30.771 | | 1291 | 34934.1 | 30.776 | |
| 1262 | 34041.7 | 30.765 | | 1277 | 34503.2 | 30.772 | | 1292 | 34964.9 | 30.776 | |
| 1263 | 34072.5 | 30.765 | | 1278 | 34534.0 | 30.772 | | 1293 | 34995.6 | 30.777 | |
| 1264 | 34103.2 | 30.766 | | 1279 | 34564.8 | 30.772 | | 1294 | 35026.4 | 30.777 | |
| 1265 | 34134.0 | 30.766 | | 1280 | 34595.6 | 30.773 | | 1295 | 35057.2 | 30.777 | |
| 1266 | 34164.8 | 30.767 | | 1281 | 34626.3 | 30.773 | | 1296 | 35088.0 | 30.777 | |
| 1267 | 34195.5 | 30.767 | | 1282 | 34657.1 | 30.774 | | 1297 | 35118.7 | 30.777 | |
| 1268 | 34226.3 | 30.768 | | 1283 | 34687.9 | 30.774 | | 1298 | 35149.5 | 30.777 | |
| 1269 | 34257.1 | 30.768 | | 1284 | 34718.7 | 30.774 | | 1299 | 35180.3 | 30.778 | |
| 1270 | 34287.9 | 30.769 | | 1285 | 34749.4 | 30.774 | | 1300 | 35211.1 | 30.778 | |
| 1271 | 34318.6 | 30.769 | | 1286 | 34780.2 | 30.775 | | | | | |
| 1272 | 34349.4 | 30.770 | | 1287 | 34811.0 | 30.775 | | | | | |
| 1273 | 34380.2 | 30.770 | | 1288 | 34841.8 | 30.775 | | | | | |
| 1274 | 34410.9 | 30.771 | | 1289 | 34872.5 | 30.776 | | | | | |
| 1275 | 34441.7 | 30.771 | | 1290 | 34903.3 | 30.776 | | | | | |

TABLE 7.4.6 *Thermoelectric values at the fixed points for* AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67, *in the cryogenic and extended temperature ranges.*

| Temperature range | Fixed point | Temp.[a] °C | *E* μV | *S* μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|
| —200 to 0 °C | Nitrogen NBP | —195.806 | —1589.79 | —0.974 | 88.38 |
| | Oxygen NBP | —182.962 | —1594.60 | 0.251 | 100.70 |
| | Carbon Dioxide SP | —78.476 | —1020.06 | 10.249 | 78.68 |
| | Mercury FP | —38.836 | —555.51 | 13.103 | 65.56 |
| | Ice point[b] | 0.000 | 0.00 | 15.440 | 55.48 |
| 0 to 400 °C | Ether TP | 26.87 | 434.18 | 16.851 | 49.68 |
| | Water BP | 100.000 | 1786.91 | 19.985 | 36.65 |
| | Benzoic Acid TP | 122.37 | 2242.87 | 20.768 | 33.39 |
| | Indium FP | 156.634 | 2973.16 | 21.834 | 28.96 |
| | Tin FP | 231.968 | 4692.30 | 23.710 | 21.28 |
| | Bismuth FP | 271.442 | 5643.97 | 24.487 | 18.17 |
| | Cadmium FP | 321.108 | 6881.13 | 25.306 | 14.91 |
| | Lead FP | 327.502 | 7043.24 | 25.400 | 14.53 |
| | Mecury BP | 356.66 | 7789.79 | 25.799 | 12.90 |

[a] Values of temperature are from the published text of the IPTS–68 amended edition of 1975 [CIPM, 1976].

[b] Junction point of different functions.

TABLE 7.4.7 *Thermoelectric values at the fixed points for* AWG 14 *Nicrosil thermoelements versus platinum,* P–67, *in the high temperature range.*

| Temperature range | Fixed point | Temp.[a] °C | *E* μV | *S* μV/°C | *dS/dT* nV/°C$^2$ |
|---|---|---|---|---|---|
| 0 to 1300 °C | Ice point | 0.000 | 0.00 | 15.421 | 54.95 |
| | Ether TP | 26.87 | 433.52 | 16.823 | 49.48 |
| | Water BP | 100.000 | 1784.14 | 19.962 | 36.91 |
| | Benzoic Acid TP | 122.37 | 2239.64 | 20.751 | 33.68 |
| | Indium FP | 156.634 | 2969.52 | 21.827 | 29.24 |
| | Tin FP | 231.968 | 4688.77 | 23.718 | 21.38 |
| | Bismuth FP | 271.442 | 5640.80 | 24.497 | 18.17 |
| | Cadmium FP | 321.108 | 6878.44 | 25.315 | 14.89 |
| | Lead FP | 327.502 | 7040.61 | 25.409 | 14.53 |
| | Mercury BP | 356.66 | 7787.42 | 25.809 | 13.00 |
| | Zinc FP | 419.580 | 9435.22 | 26.541 | 10.41 |
| | Sulphur BP | 444.674 | 10104.42 | 26.792 | 9.61 |
| | Cu-Al FP | 548.26 | 12926.55 | 27.659 | 7.38 |
| | Antimony FP | 630.755 | 15232.12 | 28.225 | 6.44 |
| | Aluminum FP | 660.46 | 16073.33 | 28.412 | 6.21 |
| | Silver FP | 961.93 | 24894.08 | 30.015 | 4.27 |
| | Gold FP | 1064.43 | 27991.20 | 30.398 | 3.56 |
| | Copper FP | 1084.88 | 28613.48 | 30.460 | 2.90 |

[a] Values of temperature are from the published text of the IPTS–68 amended edition of 1975 [CIPM, 1976].

Table 7.4.8 *Estimated maximum errors that occur when using reduced-bit arithmetic for the power series expansion for the thermoelectric voltage of* AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67.

| Temperature range | Degree | Estimated maximum error in microvolts | | | | |
|---|---|---|---|---|---|---|
| | | 12 Bit | 16 Bit | 24 Bit | 27 Bit | 36 Bit |
| −200 to 0 °C | 8 | 0.4 | 0.08 | <0.01 | <0.01 | <0.01 |
| 0 to 200 °C | 5 | 1.0 | 0.04 | <0.01 | <0.01 | <0.01 |
| 200 to 400 °C | 5 | 2.4 | 0.1 | <0.01 | <0.01 | <0.01 |

Table 7.4.9 *Estimated maximum errors that occur when using reduced-bit arithmetic for the power series expansion for the thermoelectric voltage of* AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67.

| Temperature range | Degree | Estimated maximum error in microvolts | | | | |
|---|---|---|---|---|---|---|
| | | 12 Bit | 16 Bit | 24 Bit | 27 Bit | 36 Bit |
| 0 to 200 °C | 6 | 0.4 | 0.02 | <0.01 | <0.01 | <0.01 |
| 200 to 400 °C | 6 | 0.4 | 0.05 | <0.01 | <0.01 | <0.01 |
| 400 to 600 °C | 6 | 2 | 0.3 | <0.01 | <0.01 | <0.01 |
| 600 to 800 °C | 6 | 5 | 1 | <0.01 | <0.01 | <0.01 |
| 800 to 1000 °C | 6 | 9 | 2 | <0.01 | <0.01 | <0.01 |
| 1000 to 1200 °C | 6 | 11 | 3 | 0.02 | <0.01 | <0.01 |
| 1200 to 1300 °C | 6 | 11 | 4 | 0.02 | <0.01 | <0.01 |

## 7.5 Reference Functions and Tables for Platinum, Pt-67, versus the Negative Thermoelement Nisil

Nisil wires of different gages, like Nicrosil, also have slightly different effective compositions and thermoelectric properties. Again, the expansion coefficients and tabular values for the two sizes of wire are not quite identical in the temperature ranges where they overlap. As noted in section 6.7, the voltage differences are not as large as they are for Nicrosil, especially below 200 °C.

The numerical analysis is complicated, however, by a rapid change in thermoelectric properties caused by a magnetic transformation near room temperature. The high temperature data are based primarily on Nisil in the paramagnetic state, the low temperature data on Nisil in the ferromagnetic state. Rather than add a complicated transformation term to the two sets of equations, a small difference in the Seebeck coefficients given by them was permitted in the short temperature range, 0 to 37 °C, where the Nisil wire will be in a weakly ferromagnetic state. The differences are significant for precise thermometry and are therefore reflected in the following tables where the wire gage is specified along with the temperatures and thermoelectric values. At the join, 0 °C, of the cryogenic data (fine wire–*AWG 28*) and the high temperature data (heavy wire–*AWG 14*) the voltages are identical, by definition, but the Seebeck coefficients differ by 2 percent. Actual differences between the voltages for different sizes were discussed in section 6.7.

The coefficients for the eighth degree expansion for the thermoelectric voltage of platinum, Pt–67, versus *AWG 28* Nisil thermoelements between −200 and 0 °C are given in table 7.5.1. The coefficients for the seventh degree expansion for *AWG 28* wire between 0 and 400 °C, an extended range, are also given in table 7.5.1. The equivalent coefficients for the ninth degree expansion for the thermoelectric voltage of platinum, Pt–67, versus *AWG 14* Nisil thermoelements are given in table 7.5.2. The errors caused by using reduced-bit arithmetic for calculating values of those functions are given in tables 7.5.8 and 7.5.9 for *AWG 28* and *AWG 14* thermoelements, respectively.

The primary reference values for platinum, Pt–67, versus *AWG 28* Nisil thermoelements in the temperature range from −200 to 0 °C are given in table 7.5.3. Values for the same gage wire in the extended temperature range from 0 to 400 °C are given in table 7.5.4. Values for the larger, *AWG 14*, wire for temperatures from 0 to 1300 °C are given in table 7.5.5. Near the ends of long calibration ranges, mathematical fitting functions become more variable and subject to error. This is especially true for their higher derivatives. Therefore the second derivatives of the thermal voltages are not tabulated above 1260 °C. Values for the smaller, *AWG 28* wire at selected thermometric fixed points are given in table 7.5.6, and for the larger, *AWG 14* wire, in table 7.5.7.

Graphs of the thermoelectric voltage, its first derivative (Seebeck coefficient), and second derivative are given in figures 7.5.1, 7.5.2, and 7.5.3, respectively for *AWG 28* wire between −200 and 400 °C; and in figures 7.5.4, 7.5.5, and 7.5.6 for *AWG 14* wire between 0 and 1300 °C.

It should be stressed that because of the small, but significant, size effect ***Nisil thermoelement material that conforms closely to the high temperature tabular values may not conform closely at low temperatures (below 0 °C) and vice versa.*** If Nisil thermoelements are to be used both above and below 0 °C, then the material must be calibrated in the full temperature range, both above and below 0 °C. Special selection of material will often be required.

TABLE 7.5.1 *Power series expansion for the thermoelectric voltage of platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements in the cryogenic and extended temperature ranges.*

| Wire gage | Temperature range | Degree | Coefficients | Term |
|---|---|---|---|---|
| AWG 28 | −200 to 0 °C | 8 | $+1.0713739063\times10^{1}$ | $T$ |
| | | | $-1.6807370758\times10^{-2}$ | $T^{2}$ |
| | | | $-5.9867683053\times10^{-5}$ | $T^{3}$ |
| | | | $-1.7298294197\times10^{-7}$ | $T^{4}$ |
| | | | $-2.3327903240\times10^{-9}$ | $T^{5}$ |
| | | | $-1.3042514094\times10^{-11}$ | $T^{6}$ |
| | | | $-1.4464420217\times10^{-14}$ | $T^{7}$ |
| | | | $+4.3183110519\times10^{-17}$ | $T^{8}$ |
| AWG 28 | 0 to 400 °C | 7 | $+1.0713739063\times10^{1}$ | $T$ |
| | | | $-1.8423522194\times10^{-2}$ | $T^{2}$ |
| | | | $+1.7287630420\times10^{-4}$ | $T^{3}$ |
| | | | $-8.8615620197\times10^{-7}$ | $T^{4}$ |
| | | | $+2.6017601076\times10^{-9}$ | $T^{5}$ |
| | | | $-3.9887895408\times10^{-12}$ | $T^{6}$ |
| | | | $+2.4633802582\times10^{-15}$ | $T^{7}$ |

TABLE 7.5.2 *Power series expansion for the thermoelectric voltage of platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements in the high temperature range.*

| Wire gage | Temperature range | Degree | Coefficients | Term |
|---|---|---|---|---|
| AWG 14 | 0 to 1300 °C | 9 | $+1.0476882470\times10^{1}$ | $T$ |
| | | | $-1.0816976176\times10^{-2}$ | $T^{2}$ |
| | | | $+6.6694748508\times10^{-5}$ | $T^{3}$ |
| | | | $-2.0150588234\times10^{-7}$ | $T^{4}$ |
| | | | $+3.7786520637\times10^{-10}$ | $T^{5}$ |
| | | | $-4.4608781297\times10^{-13}$ | $T^{6}$ |
| | | | $+3.1553382729\times10^{-16}$ | $T^{7}$ |
| | | | $-1.2150879468\times10^{-19}$ | $T^{8}$ |
| | | | $+1.9557197559\times10^{-23}$ | $T^{9}$ |

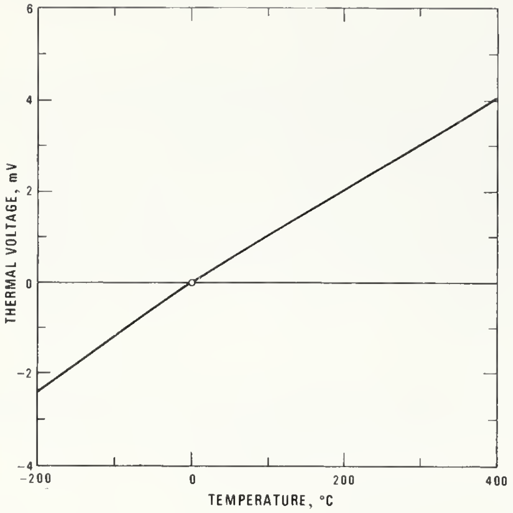

Figure 7.5.1 *Thermoelectric voltage for platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements.*

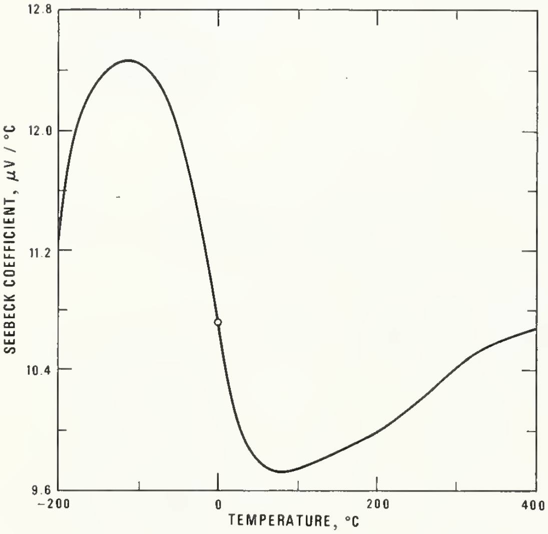

Figure 7.5.2 *Seebeck coefficient for platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements.*

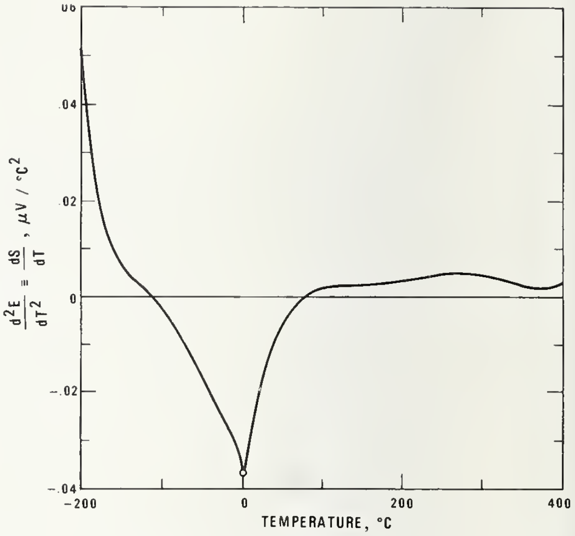

Figure 7.5.3 *Derivative of Seebeck coefficient for platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements.*

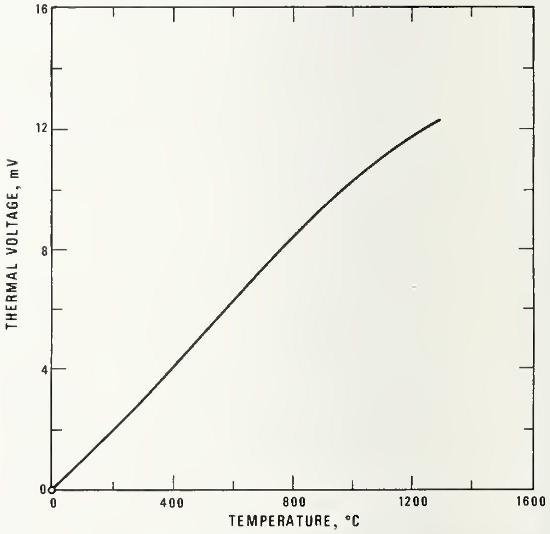

Figure 7.5.4 *Thermoelectric voltage for platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements.*

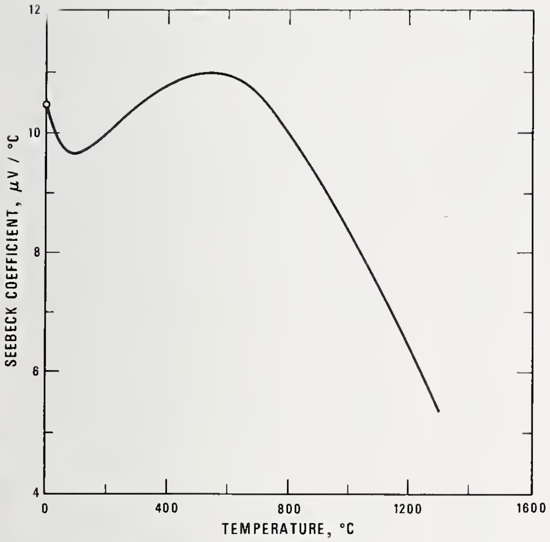

**Figure 7.5.5** *Seebeck coefficient for platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements.*

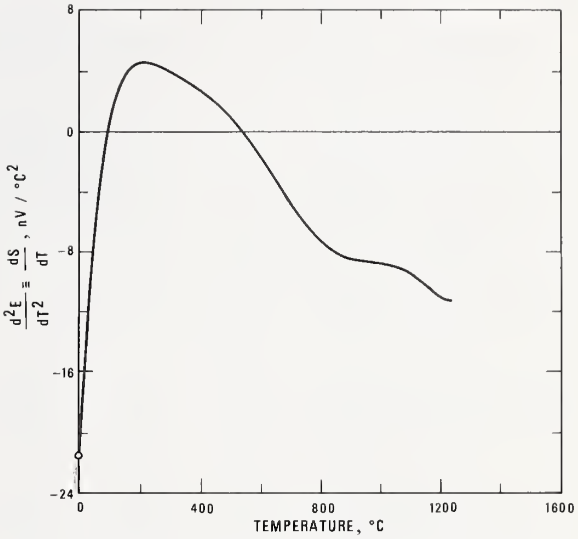

**Figure 7.5.6** *Derivative of Seebeck coefficient for platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements.*

Table 7.5.3 *Platinum, Pt–67, versus* AWG 28 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. Extended temperature range, —200 to 0 °C.*

| T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | -200 | -2405.41 | 11.265 | 51.57 | -190 | -2290.50 | 11.688 | 33.99 |
| | | | | -199 | -2394.12 | 11.316 | 49.50 | -189 | -2278.79 | 11.721 | 32.58 |
| | | | | -198 | -2382.78 | 11.364 | 47.50 | -188 | -2267.06 | 11.753 | 31.22 |
| | | | | -197 | -2371.39 | 11.411 | 45.58 | -187 | -2255.29 | 11.783 | 29.92 |
| | | | | -196 | -2359.96 | 11.456 | 43.73 | -186 | -2243.49 | 11.813 | 28.67 |
| | | | | -195 | -2348.48 | 11.498 | 41.94 | -185 | -2231.66 | 11.841 | 27.47 |
| | | | | -194 | -2336.96 | 11.539 | 40.23 | -184 | -2219.81 | 11.868 | 26.32 |
| | | | | -193 | -2325.40 | 11.579 | 38.57 | -183 | -2207.93 | 11.893 | 25.22 |
| | | | | -192 | -2313.80 | 11.617 | 36.99 | -182 | -2196.02 | 11.918 | 24.16 |
| | | | | -191 | -2302.17 | 11.653 | 35.46 | -181 | -2184.09 | 11.942 | 23.15 |
| -200 | -2405.41 | 11.265 | 51.57 | -190 | -2290.50 | 11.688 | 33.99 | -180 | -2172.14 | 11.964 | 22.18 |

TABLE 7.5.3 *Platinum, Pt–67, versus* AWG 28 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck Coefficients,* dS/dT, *reference junctions at 0 °C. Cryogenic temperature range, —200 to 0 °C.*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -180 | -2172.14 | 11.964 | 22.18 | -120 | -1433.95 | 12.459 | 1.42 | -60 | -691.39 | 12.138 | -13.94 |
| -179 | -2160.17 | 11.986 | 21.25 | -119 | -1421.49 | 12.461 | 1.26 | -59 | -679.26 | 12.123 | -14.27 |
| -178 | -2148.17 | 12.007 | 20.36 | -118 | -1409.03 | 12.462 | 1.09 | -58 | -667.14 | 12.109 | -14.60 |
| -177 | -2136.15 | 12.027 | 19.51 | -117 | -1396.57 | 12.463 | 0.92 | -57 | -655.04 | 12.094 | -14.93 |
| -176 | -2124.12 | 12.046 | 18.70 | -116 | -1384.10 | 12.464 | 0.75 | -56 | -642.95 | 12.079 | -15.25 |
| -175 | -2112.06 | 12.064 | 17.92 | -115 | -1371.64 | 12.464 | 0.58 | -55 | -630.88 | 12.064 | -15.58 |
| -174 | -2099.99 | 12.082 | 17.17 | -114 | -1359.18 | 12.465 | 0.40 | -54 | -618.83 | 12.048 | -15.91 |
| -173 | -2087.90 | 12.099 | 16.46 | -113 | -1346.71 | 12.465 | 0.22 | -53 | -606.79 | 12.032 | -16.24 |
| -172 | -2075.79 | 12.115 | 15.78 | -112 | -1334.24 | 12.465 | 0.04 | -52 | -594.76 | 12.015 | -16.57 |
| -171 | -2063.67 | 12.130 | 15.13 | -111 | -1321.78 | 12.465 | -0.15 | -51 | -582.76 | 11.999 | -16.90 |
| -170 | -2051.53 | 12.145 | 14.51 | -110 | -1309.31 | 12.465 | -0.34 | -50 | -570.76 | 11.982 | -17.23 |
| -169 | -2039.38 | 12.159 | 13.92 | -109 | -1296.85 | 12.465 | -0.53 | -49 | -558.79 | 11.964 | -17.56 |
| -168 | -2027.21 | 12.173 | 13.35 | -108 | -1284.39 | 12.464 | -0.73 | -48 | -546.84 | 11.947 | -17.89 |
| -167 | -2015.03 | 12.186 | 12.81 | -107 | -1271.92 | 12.463 | -0.93 | -47 | -534.90 | 11.928 | -18.22 |
| -166 | -2002.84 | 12.198 | 12.30 | -106 | -1259.46 | 12.462 | -1.13 | -46 | -522.98 | 11.910 | -18.55 |
| -165 | -1990.64 | 12.210 | 11.81 | -105 | -1247.00 | 12.461 | -1.34 | -45 | -511.08 | 11.891 | -18.87 |
| -164 | -1978.42 | 12.222 | 11.34 | -104 | -1234.54 | 12.459 | -1.55 | -44 | -499.20 | 11.872 | -19.20 |
| -163 | -1966.19 | 12.233 | 10.89 | -103 | -1222.08 | 12.458 | -1.76 | -43 | -487.33 | 11.853 | -19.53 |
| -162 | -1953.95 | 12.244 | 10.46 | -102 | -1209.62 | 12.456 | -1.98 | -42 | -475.49 | 11.833 | -19.86 |
| -161 | -1941.71 | 12.254 | 10.06 | -101 | -1197.17 | 12.454 | -2.20 | -41 | -463.67 | 11.813 | -20.18 |
| -160 | -1929.45 | 12.264 | 9.67 | -100 | -1184.71 | 12.451 | -2.43 | -40 | -451.86 | 11.793 | -20.51 |
| -159 | -1917.18 | 12.273 | 9.30 | -99 | -1172.26 | 12.449 | -2.66 | -39 | -440.08 | 11.772 | -20.84 |
| -158 | -1904.90 | 12.283 | 8.94 | -98 | -1159.82 | 12.446 | -2.89 | -38 | -428.32 | 11.751 | -21.16 |
| -157 | -1892.61 | 12.291 | 8.60 | -97 | -1147.37 | 12.443 | -3.13 | -37 | -416.58 | 11.730 | -21.49 |
| -156 | -1880.32 | 12.300 | 8.28 | -96 | -1134.93 | 12.440 | -3.37 | -36 | -404.86 | 11.708 | -21.81 |
| -155 | -1868.01 | 12.308 | 7.97 | -95 | -1122.49 | 12.436 | -3.61 | -35 | -393.16 | 11.686 | -22.14 |
| -154 | -1855.70 | 12.316 | 7.68 | -94 | -1110.06 | 12.433 | -3.86 | -34 | -381.49 | 11.664 | -22.46 |
| -153 | -1843.38 | 12.323 | 7.40 | -93 | -1097.63 | 12.429 | -4.11 | -33 | -369.84 | 11.641 | -22.78 |
| -152 | -1831.06 | 12.330 | 7.13 | -92 | -1085.20 | 12.424 | -4.37 | -32 | -358.21 | 11.618 | -23.10 |
| -151 | -1818.72 | 12.337 | 6.87 | -91 | -1072.78 | 12.420 | -4.63 | -31 | -346.60 | 11.595 | -23.43 |
| -150 | -1806.38 | 12.344 | 6.62 | -90 | -1060.36 | 12.415 | -4.89 | -30 | -335.01 | 11.572 | -23.75 |
| -149 | -1794.03 | 12.351 | 6.38 | -89 | -1047.95 | 12.410 | -5.15 | -29 | -323.46 | 11.548 | -24.07 |
| -148 | -1781.68 | 12.357 | 6.15 | -88 | -1035.54 | 12.405 | -5.42 | -28 | -311.92 | 11.523 | -24.39 |
| -147 | -1769.32 | 12.363 | 5.93 | -87 | -1023.14 | 12.399 | -5.69 | -27 | -300.41 | 11.499 | -24.71 |
| -146 | -1756.95 | 12.369 | 5.72 | -86 | -1010.74 | 12.393 | -5.97 | -26 | -288.92 | 11.474 | -25.03 |
| -145 | -1744.58 | 12.374 | 5.51 | -85 | -998.35 | 12.387 | -6.24 | -25 | -277.46 | 11.449 | -25.35 |
| -144 | -1732.20 | 12.380 | 5.32 | -84 | -985.97 | 12.381 | -6.53 | -24 | -266.02 | 11.423 | -25.67 |
| -143 | -1719.82 | 12.385 | 5.12 | -83 | -973.59 | 12.374 | -6.81 | -23 | -254.61 | 11.398 | -25.99 |
| -142 | -1707.43 | 12.390 | 4.94 | -82 | -961.22 | 12.367 | -7.10 | -22 | -243.23 | 11.371 | -26.31 |
| -141 | -1695.04 | 12.395 | 4.76 | -81 | -948.85 | 12.360 | -7.39 | -21 | -231.87 | 11.345 | -26.63 |
| -140 | -1682.64 | 12.400 | 4.58 | -80 | -936.50 | 12.353 | -7.68 | -20 | -220.54 | 11.318 | -26.95 |
| -139 | -1670.24 | 12.404 | 4.41 | -79 | -924.15 | 12.345 | -7.97 | -19 | -209.24 | 11.291 | -27.27 |
| -138 | -1657.84 | 12.408 | 4.24 | -78 | -911.81 | 12.337 | -8.27 | -18 | -197.96 | 11.264 | -27.59 |
| -137 | -1645.43 | 12.413 | 4.08 | -77 | -899.48 | 12.328 | -8.57 | -17 | -186.71 | 11.236 | -27.91 |
| -136 | -1633.01 | 12.417 | 3.91 | -76 | -887.15 | 12.320 | -8.87 | -16 | -175.49 | 11.208 | -28.23 |
| -135 | -1620.59 | 12.420 | 3.75 | -75 | -874.84 | 12.311 | -9.18 | -15 | -164.29 | 11.179 | -28.56 |
| -134 | -1608.17 | 12.424 | 3.60 | -74 | -862.53 | 12.301 | -9.48 | -14 | -153.13 | 11.151 | -28.88 |
| -133 | -1595.74 | 12.428 | 3.44 | -73 | -850.24 | 12.292 | -9.79 | -13 | -141.99 | 11.122 | -29.20 |
| -132 | -1583.32 | 12.431 | 3.29 | -72 | -837.95 | 12.282 | -10.10 | -12 | -130.88 | 11.092 | -29.53 |
| -131 | -1570.88 | 12.434 | 3.13 | -71 | -825.67 | 12.271 | -10.41 | -11 | -119.81 | 11.063 | -29.86 |
| -130 | -1558.45 | 12.437 | 2.98 | -70 | -813.41 | 12.261 | -10.73 | -10 | -108.76 | 11.033 | -30.19 |
| -129 | -1546.01 | 12.440 | 2.83 | -69 | -801.15 | 12.250 | -11.04 | -9 | -97.74 | 11.002 | -30.52 |
| -128 | -1533.57 | 12.443 | 2.68 | -68 | -788.91 | 12.239 | -11.36 | -8 | -86.76 | 10.971 | -30.85 |
| -127 | -1521.12 | 12.446 | 2.52 | -67 | -776.67 | 12.227 | -11.68 | -7 | -75.80 | 10.940 | -31.19 |
| -126 | -1508.68 | 12.448 | 2.37 | -66 | -764.45 | 12.215 | -12.00 | -6 | -64.87 | 10.909 | -31.52 |
| -125 | -1496.23 | 12.450 | 2.21 | -65 | -752.24 | 12.203 | -12.32 | -5 | -53.98 | 10.877 | -31.87 |
| -124 | -1483.78 | 12.452 | 2.06 | -64 | -740.05 | 12.191 | -12.64 | -4 | -43.12 | 10.845 | -32.21 |
| -123 | -1471.32 | 12.454 | 1.90 | -63 | -727.86 | 12.178 | -12.97 | -3 | -32.29 | 10.813 | -32.55 |
| -122 | -1458.87 | 12.456 | 1.74 | -62 | -715.69 | 12.165 | -13.29 | -2 | -21.49 | 10.780 | -32.90 |
| -121 | -1446.41 | 12.458 | 1.58 | -61 | -703.53 | 12.151 | -13.62 | -1 | -10.73 | 10.747 | -33.26 |
| -120 | -1433.95 | 12.459 | 1.42 | -60 | -691.39 | 12.138 | -13.94 | 0 | 0.00 | 10.714 | -33.61 |

TABLE 7.5.4 *Platinum, Pt–67, versus* AWG 28 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference functions at 0 °C. Extended temperature range, 0 to 400 °C.*

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00 | 10.714 | -36.85 | 60 | 604.20 | 9.755 | -3.12 | 120 | 1189.04 | 9.789 | 2.17 |
| 1 | 10.70 | 10.677 | -35.82 | 61 | 613.95 | 9.752 | -2.90 | 121 | 1198.83 | 9.791 | 2.19 |
| 2 | 21.36 | 10.642 | -34.81 | 62 | 623.70 | 9.749 | -2.69 | 122 | 1208.62 | 9.793 | 2.20 |
| 3 | 31.98 | 10.608 | -33.83 | 63 | 633.45 | 9.747 | -2.48 | 123 | 1218.42 | 9.795 | 2.21 |
| 4 | 42.57 | 10.574 | -32.86 | 64 | 643.20 | 9.744 | -2.27 | 124 | 1228.21 | 9.798 | 2.22 |
| 5 | 53.13 | 10.542 | -31.92 | 65 | 652.94 | 9.742 | -2.08 | 125 | 1238.01 | 9.800 | 2.23 |
| 6 | 63.66 | 10.511 | -31.00 | 66 | 662.68 | 9.740 | -1.89 | 126 | 1247.81 | 9.802 | 2.24 |
| 7 | 74.15 | 10.480 | -30.09 | 67 | 672.42 | 9.738 | -1.71 | 127 | 1257.61 | 9.804 | 2.25 |
| 8 | 84.62 | 10.450 | -29.20 | 68 | 682.16 | 9.737 | -1.53 | 128 | 1267.42 | 9.806 | 2.26 |
| 9 | 95.05 | 10.422 | -28.34 | 69 | 691.90 | 9.735 | -1.36 | 129 | 1277.23 | 9.809 | 2.26 |
| 10 | 105.46 | 10.394 | -27.49 | 70 | 701.63 | 9.734 | -1.20 | 130 | 1287.04 | 9.811 | 2.27 |
| 11 | 115.84 | 10.367 | -26.66 | 71 | 711.36 | 9.733 | -1.04 | 131 | 1296.85 | 9.813 | 2.28 |
| 12 | 126.19 | 10.340 | -25.84 | 72 | 721.10 | 9.732 | -0.88 | 132 | 1306.66 | 9.816 | 2.28 |
| 13 | 136.52 | 10.315 | -25.05 | 73 | 730.83 | 9.731 | -0.74 | 133 | 1316.48 | 9.818 | 2.29 |
| 14 | 146.82 | 10.290 | -24.27 | 74 | 740.56 | 9.731 | -0.59 | 134 | 1326.30 | 9.820 | 2.29 |
| 15 | 157.10 | 10.266 | -23.51 | 75 | 750.29 | 9.730 | -0.46 | 135 | 1336.12 | 9.822 | 2.30 |
| 16 | 167.36 | 10.243 | -22.77 | 76 | 760.02 | 9.730 | -0.32 | 136 | 1345.94 | 9.825 | 2.30 |
| 17 | 177.59 | 10.221 | -22.04 | 77 | 769.75 | 9.729 | -0.20 | 137 | 1355.77 | 9.827 | 2.31 |
| 18 | 187.80 | 10.199 | -21.33 | 78 | 779.48 | 9.729 | -0.07 | 138 | 1365.60 | 9.829 | 2.31 |
| 19 | 197.99 | 10.178 | -20.64 | 79 | 789.21 | 9.729 | 0.04 | 139 | 1375.43 | 9.832 | 2.32 |
| 20 | 208.15 | 10.158 | -19.96 | 80 | 798.94 | 9.729 | 0.16 | 140 | 1385.26 | 9.834 | 2.32 |
| 21 | 218.30 | 10.138 | -19.30 | 81 | 808.67 | 9.730 | 0.27 | 141 | 1395.10 | 9.836 | 2.33 |
| 22 | 228.43 | 10.119 | -18.65 | 82 | 818.39 | 9.730 | 0.37 | 142 | 1404.93 | 9.839 | 2.33 |
| 23 | 238.54 | 10.101 | -18.02 | 83 | 828.12 | 9.730 | 0.47 | 143 | 1414.77 | 9.841 | 2.34 |
| 24 | 248.63 | 10.083 | -17.40 | 84 | 837.86 | 9.731 | 0.57 | 144 | 1424.62 | 9.843 | 2.34 |
| 25 | 258.71 | 10.066 | -16.79 | 85 | 847.59 | 9.731 | 0.66 | 145 | 1434.46 | 9.846 | 2.35 |
| 26 | 268.77 | 10.050 | -16.21 | 86 | 857.32 | 9.732 | 0.75 | 146 | 1444.31 | 9.848 | 2.35 |
| 27 | 278.81 | 10.034 | -15.63 | 87 | 867.05 | 9.733 | 0.83 | 147 | 1454.16 | 9.850 | 2.36 |
| 28 | 288.83 | 10.018 | -15.07 | 88 | 876.78 | 9.734 | 0.91 | 148 | 1464.01 | 9.853 | 2.36 |
| 29 | 298.84 | 10.004 | -14.52 | 89 | 886.52 | 9.735 | 0.99 | 149 | 1473.86 | 9.855 | 2.37 |
| 30 | 308.84 | 9.989 | -13.99 | 90 | 896.25 | 9.736 | 1.07 | 150 | 1483.72 | 9.857 | 2.38 |
| 31 | 318.82 | 9.976 | -13.47 | 91 | 905.99 | 9.737 | 1.14 | 151 | 1493.58 | 9.860 | 2.38 |
| 32 | 328.79 | 9.962 | -12.96 | 92 | 915.73 | 9.738 | 1.20 | 152 | 1503.44 | 9.862 | 2.39 |
| 33 | 338.75 | 9.950 | -12.47 | 93 | 925.47 | 9.739 | 1.27 | 153 | 1513.30 | 9.865 | 2.39 |
| 34 | 348.69 | 9.937 | -11.98 | 94 | 935.21 | 9.741 | 1.33 | 154 | 1523.17 | 9.867 | 2.40 |
| 35 | 358.62 | 9.926 | -11.51 | 95 | 944.95 | 9.742 | 1.39 | 155 | 1533.03 | 9.869 | 2.41 |
| 36 | 368.54 | 9.914 | -11.05 | 96 | 954.69 | 9.743 | 1.45 | 156 | 1542.91 | 9.872 | 2.42 |
| 37 | 378.45 | 9.904 | -10.61 | 97 | 964.43 | 9.745 | 1.50 | 157 | 1552.78 | 9.874 | 2.42 |
| 38 | 388.35 | 9.893 | -10.17 | 98 | 974.18 | 9.746 | 1.55 | 158 | 1562.65 | 9.877 | 2.43 |
| 39 | 398.24 | 9.883 | -9.75 | 99 | 983.93 | 9.748 | 1.60 | 159 | 1572.53 | 9.879 | 2.44 |
| 40 | 408.12 | 9.874 | -9.34 | 100 | 993.67 | 9.749 | 1.64 | 160 | 1582.41 | 9.882 | 2.45 |
| 41 | 417.99 | 9.865 | -8.93 | 101 | 1003.42 | 9.751 | 1.69 | 161 | 1592.29 | 9.884 | 2.46 |
| 42 | 427.85 | 9.856 | -8.54 | 102 | 1013.18 | 9.753 | 1.73 | 162 | 1602.18 | 9.886 | 2.47 |
| 43 | 437.70 | 9.848 | -8.16 | 103 | 1022.93 | 9.755 | 1.77 | 163 | 1612.07 | 9.889 | 2.48 |
| 44 | 447.54 | 9.840 | -7.79 | 104 | 1032.69 | 9.756 | 1.80 | 164 | 1621.96 | 9.891 | 2.49 |
| 45 | 457.38 | 9.832 | -7.43 | 105 | 1042.44 | 9.758 | 1.84 | 165 | 1631.85 | 9.894 | 2.50 |
| 46 | 467.21 | 9.825 | -7.08 | 106 | 1052.20 | 9.760 | 1.87 | 166 | 1641.75 | 9.896 | 2.51 |
| 47 | 477.03 | 9.818 | -6.74 | 107 | 1061.96 | 9.762 | 1.90 | 167 | 1651.64 | 9.899 | 2.52 |
| 48 | 486.84 | 9.811 | -6.41 | 108 | 1071.73 | 9.764 | 1.93 | 168 | 1661.54 | 9.901 | 2.54 |
| 49 | 496.65 | 9.805 | -6.09 | 109 | 1081.49 | 9.766 | 1.96 | 169 | 1671.45 | 9.904 | 2.55 |
| 50 | 506.45 | 9.799 | -5.78 | 110 | 1091.26 | 9.768 | 1.99 | 170 | 1681.35 | 9.907 | 2.56 |
| 51 | 516.25 | 9.793 | -5.48 | 111 | 1101.03 | 9.770 | 2.01 | 171 | 1691.26 | 9.909 | 2.58 |
| 52 | 526.04 | 9.788 | -5.18 | 112 | 1110.80 | 9.772 | 2.03 | 172 | 1701.17 | 9.912 | 2.59 |
| 53 | 535.82 | 9.783 | -4.90 | 113 | 1120.57 | 9.774 | 2.06 | 173 | 1711.08 | 9.914 | 2.61 |
| 54 | 545.60 | 9.778 | -4.62 | 114 | 1130.35 | 9.776 | 2.08 | 174 | 1721.00 | 9.917 | 2.62 |
| 55 | 555.38 | 9.774 | -4.35 | 115 | 1140.12 | 9.778 | 2.10 | 175 | 1730.92 | 9.920 | 2.64 |
| 56 | 565.15 | 9.770 | -4.09 | 116 | 1149.90 | 9.780 | 2.11 | 176 | 1740.84 | 9.922 | 2.65 |
| 57 | 574.92 | 9.766 | -3.84 | 117 | 1159.68 | 9.782 | 2.13 | 177 | 1750.76 | 9.925 | 2.67 |
| 58 | 584.68 | 9.762 | -3.59 | 118 | 1169.47 | 9.784 | 2.15 | 178 | 1760.69 | 9.928 | 2.69 |
| 59 | 594.44 | 9.758 | -3.35 | 119 | 1179.25 | 9.787 | 2.16 | 179 | 1770.62 | 9.930 | 2.70 |
| 60 | 604.20 | 9.755 | -3.12 | 120 | 1189.04 | 9.789 | 2.17 | 180 | 1780.55 | 9.933 | 2.72 |

**TABLE 7.5.4** *Platinum, Pt–67, versus* AWG 28 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *refeernce junctions at 0 °C. Extended temperature range, 0 to 400 °C*—Continued

| T °C | E $\mu$V | S $\mu$V/°C | dS/dT nV/°C$^2$ | T °C | E $\mu$V | S $\mu$V/°C | dS/dT nV/°C$^2$ | T °C | E $\mu$V | S $\mu$V/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 1780.55 | 9.933 | 2.72 | 240 | 2382.29 | 10.141 | 4.29 | 300 | 2998.99 | 10.417 | 4.37 |
| 181 | 1790.48 | 9.936 | 2.74 | 241 | 2392.43 | 10.146 | 4.31 | 301 | 3009.41 | 10.421 | 4.34 |
| 182 | 1800.42 | 9.938 | 2.76 | 242 | 2402.58 | 10.150 | 4.33 | 302 | 3019.83 | 10.425 | 4.31 |
| 183 | 1810.36 | 9.941 | 2.78 | 243 | 2412.73 | 10.154 | 4.36 | 303 | 3030.26 | 10.430 | 4.28 |
| 184 | 1820.30 | 9.944 | 2.80 | 244 | 2422.89 | 10.159 | 4.38 | 304 | 3040.69 | 10.434 | 4.25 |
| 185 | 1830.25 | 9.947 | 2.82 | 245 | 2433.05 | 10.163 | 4.40 | 305 | 3051.13 | 10.438 | 4.22 |
| 186 | 1840.20 | 9.950 | 2.84 | 246 | 2443.21 | 10.167 | 4.42 | 306 | 3061.57 | 10.442 | 4.19 |
| 187 | 1850.15 | 9.952 | 2.86 | 247 | 2453.38 | 10.172 | 4.44 | 307 | 3072.01 | 10.447 | 4.16 |
| 188 | 1860.10 | 9.955 | 2.88 | 248 | 2463.56 | 10.176 | 4.46 | 308 | 3082.46 | 10.451 | 4.12 |
| 189 | 1870.06 | 9.958 | 2.91 | 249 | 2473.73 | 10.181 | 4.48 | 309 | 3092.91 | 10.455 | 4.09 |
| 190 | 1880.02 | 9.961 | 2.93 | 250 | 2483.92 | 10.185 | 4.50 | 310 | 3103.37 | 10.459 | 4.05 |
| 191 | 1889.98 | 9.964 | 2.95 | 251 | 2494.11 | 10.190 | 4.52 | 311 | 3113.83 | 10.463 | 4.02 |
| 192 | 1899.95 | 9.967 | 2.98 | 252 | 2504.30 | 10.194 | 4.54 | 312 | 3124.30 | 10.467 | 3.98 |
| 193 | 1909.91 | 9.970 | 3.00 | 253 | 2514.49 | 10.199 | 4.55 | 313 | 3134.77 | 10.471 | 3.94 |
| 194 | 1919.89 | 9.973 | 3.02 | 254 | 2524.69 | 10.203 | 4.57 | 314 | 3145.24 | 10.475 | 3.90 |
| 195 | 1929.86 | 9.976 | 3.05 | 255 | 2534.90 | 10.208 | 4.59 | 315 | 3155.72 | 10.479 | 3.86 |
| 196 | 1939.84 | 9.979 | 3.07 | 256 | 2545.11 | 10.213 | 4.60 | 316 | 3166.20 | 10.483 | 3.82 |
| 197 | 1949.82 | 9.982 | 3.10 | 257 | 2555.33 | 10.217 | 4.62 | 317 | 3176.68 | 10.486 | 3.78 |
| 198 | 1959.80 | 9.985 | 3.12 | 258 | 2565.55 | 10.222 | 4.63 | 318 | 3187.17 | 10.490 | 3.74 |
| 199 | 1969.79 | 9.989 | 3.15 | 259 | 2575.77 | 10.226 | 4.64 | 319 | 3197.66 | 10.494 | 3.70 |
| 200 | 1979.78 | 9.992 | 3.18 | 260 | 2586.00 | 10.231 | 4.65 | 320 | 3208.16 | 10.497 | 3.65 |
| 201 | 1989.77 | 9.995 | 3.20 | 261 | 2596.23 | 10.236 | 4.66 | 321 | 3218.66 | 10.501 | 3.61 |
| 202 | 1999.77 | 9.998 | 3.23 | 262 | 2606.47 | 10.240 | 4.67 | 322 | 3229.16 | 10.505 | 3.56 |
| 203 | 2009.77 | 10.001 | 3.26 | 263 | 2616.71 | 10.245 | 4.68 | 323 | 3239.67 | 10.508 | 3.52 |
| 204 | 2019.77 | 10.005 | 3.28 | 264 | 2626.96 | 10.250 | 4.69 | 324 | 3250.18 | 10.512 | 3.47 |
| 205 | 2029.78 | 10.008 | 3.31 | 265 | 2637.21 | 10.254 | 4.70 | 325 | 3260.69 | 10.515 | 3.43 |
| 206 | 2039.79 | 10.011 | 3.34 | 266 | 2647.47 | 10.259 | 4.71 | 326 | 3271.21 | 10.519 | 3.38 |
| 207 | 2049.80 | 10.015 | 3.37 | 267 | 2657.73 | 10.264 | 4.71 | 327 | 3281.73 | 10.522 | 3.34 |
| 208 | 2059.82 | 10.018 | 3.40 | 268 | 2668.00 | 10.269 | 4.72 | 328 | 3292.25 | 10.525 | 3.29 |
| 209 | 2069.84 | 10.021 | 3.42 | 269 | 2678.27 | 10.273 | 4.72 | 329 | 3302.78 | 10.529 | 3.24 |
| 210 | 2079.86 | 10.025 | 3.45 | 270 | 2688.54 | 10.278 | 4.73 | 330 | 3313.31 | 10.532 | 3.19 |
| 211 | 2089.89 | 10.028 | 3.48 | 271 | 2698.82 | 10.283 | 4.73 | 331 | 3323.84 | 10.535 | 3.15 |
| 212 | 2099.92 | 10.032 | 3.51 | 272 | 2709.11 | 10.287 | 4.73 | 332 | 3334.38 | 10.538 | 3.10 |
| 213 | 2109.95 | 10.035 | 3.54 | 273 | 2719.40 | 10.292 | 4.73 | 333 | 3344.92 | 10.541 | 3.05 |
| 214 | 2119.99 | 10.039 | 3.57 | 274 | 2729.69 | 10.297 | 4.73 | 334 | 3355.46 | 10.544 | 3.00 |
| 215 | 2130.03 | 10.042 | 3.60 | 275 | 2739.99 | 10.302 | 4.73 | 335 | 3366.00 | 10.547 | 2.95 |
| 216 | 2140.07 | 10.046 | 3.63 | 276 | 2750.30 | 10.306 | 4.73 | 336 | 3376.55 | 10.550 | 2.90 |
| 217 | 2150.12 | 10.050 | 3.66 | 277 | 2760.60 | 10.311 | 4.72 | 337 | 3387.10 | 10.553 | 2.86 |
| 218 | 2160.17 | 10.053 | 3.68 | 278 | 2770.92 | 10.316 | 4.72 | 338 | 3397.66 | 10.556 | 2.81 |
| 219 | 2170.23 | 10.057 | 3.71 | 279 | 2781.24 | 10.321 | 4.71 | 339 | 3408.22 | 10.559 | 2.76 |
| 220 | 2180.29 | 10.061 | 3.74 | 280 | 2791.56 | 10.325 | 4.71 | 340 | 3418.78 | 10.561 | 2.71 |
| 221 | 2190.35 | 10.065 | 3.77 | 281 | 2801.89 | 10.330 | 4.70 | 341 | 3429.34 | 10.564 | 2.66 |
| 222 | 2200.41 | 10.068 | 3.80 | 282 | 2812.22 | 10.335 | 4.69 | 342 | 3439.90 | 10.567 | 2.62 |
| 223 | 2210.48 | 10.072 | 3.83 | 283 | 2822.56 | 10.339 | 4.68 | 343 | 3450.47 | 10.569 | 2.57 |
| 224 | 2220.56 | 10.076 | 3.86 | 284 | 2832.90 | 10.344 | 4.67 | 344 | 3461.04 | 10.572 | 2.52 |
| 225 | 2230.64 | 10.080 | 3.89 | 285 | 2843.24 | 10.349 | 4.66 | 345 | 3471.61 | 10.574 | 2.48 |
| 226 | 2240.72 | 10.084 | 3.91 | 286 | 2853.60 | 10.353 | 4.65 | 346 | 3482.19 | 10.577 | 2.43 |
| 227 | 2250.80 | 10.088 | 3.94 | 287 | 2863.95 | 10.358 | 4.64 | 347 | 3492.77 | 10.579 | 2.38 |
| 228 | 2260.89 | 10.092 | 3.97 | 288 | 2874.31 | 10.363 | 4.62 | 348 | 3503.35 | 10.581 | 2.34 |
| 229 | 2270.99 | 10.096 | 4.00 | 289 | 2884.68 | 10.367 | 4.61 | 349 | 3513.93 | 10.584 | 2.29 |
| 230 | 2281.09 | 10.100 | 4.03 | 290 | 2895.05 | 10.372 | 4.59 | 350 | 3524.52 | 10.586 | 2.25 |
| 231 | 2291.19 | 10.104 | 4.05 | 291 | 2905.42 | 10.376 | 4.57 | 351 | 3535.10 | 10.588 | 2.21 |
| 232 | 2301.29 | 10.108 | 4.08 | 292 | 2915.80 | 10.381 | 4.55 | 352 | 3545.69 | 10.590 | 2.17 |
| 233 | 2311.40 | 10.112 | 4.11 | 293 | 2926.18 | 10.386 | 4.53 | 353 | 3556.28 | 10.593 | 2.13 |
| 234 | 2321.52 | 10.116 | 4.13 | 294 | 2936.57 | 10.390 | 4.51 | 354 | 3566.88 | 10.595 | 2.09 |
| 235 | 2331.63 | 10.120 | 4.16 | 295 | 2946.96 | 10.395 | 4.49 | 355 | 3577.47 | 10.597 | 2.05 |
| 236 | 2341.76 | 10.124 | 4.19 | 296 | 2957.36 | 10.399 | 4.47 | 356 | 3588.07 | 10.599 | 2.01 |
| 237 | 2351.88 | 10.128 | 4.21 | 297 | 2967.76 | 10.403 | 4.45 | 357 | 3598.67 | 10.601 | 1.97 |
| 238 | 2362.01 | 10.133 | 4.24 | 298 | 2978.17 | 10.408 | 4.42 | 358 | 3609.27 | 10.603 | 1.94 |
| 239 | 2372.15 | 10.137 | 4.26 | 299 | 2988.58 | 10.412 | 4.40 | 359 | 3619.88 | 10.605 | 1.91 |
| 240 | 2382.29 | 10.141 | 4.29 | 300 | 2998.99 | 10.417 | 4.37 | 360 | 3630.48 | 10.607 | 1.87 |

TABLE 7.5.4 *Platinum, Pt–67, versus* AWG 28 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference functions at 0 °C. Extended temperature range, 0 to 400 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 360 | 3630.48 | 10.607 | 1.87 | 375 | 3789.78 | 10.632 | 1.63 | 390 | 3949.45 | 10.659 | 2.08 |
| 361 | 3641.09 | 10.608 | 1.84 | 376 | 3800.41 | 10.634 | 1.64 | 391 | 3960.11 | 10.661 | 2.14 |
| 362 | 3651.70 | 10.610 | 1.82 | 377 | 3811.05 | 10.636 | 1.65 | 392 | 3970.78 | 10.663 | 2.21 |
| 363 | 3662.31 | 10.612 | 1.79 | 378 | 3821.68 | 10.637 | 1.66 | 393 | 3981.44 | 10.666 | 2.28 |
| 364 | 3672.92 | 10.614 | 1.76 | 379 | 3832.32 | 10.639 | 1.67 | 394 | 3992.11 | 10.668 | 2.36 |
| 365 | 3683.54 | 10.616 | 1.74 | 380 | 3842.96 | 10.641 | 1.69 | 395 | 4002.78 | 10.670 | 2.44 |
| 366 | 3694.15 | 10.617 | 1.72 | 381 | 3853.60 | 10.642 | 1.71 | 396 | 4013.45 | 10.673 | 2.53 |
| 367 | 3704.77 | 10.619 | 1.70 | 382 | 3864.24 | 10.644 | 1.73 | 397 | 4024.12 | 10.675 | 2.63 |
| 368 | 3715.39 | 10.621 | 1.68 | 383 | 3874.89 | 10.646 | 1.76 | 398 | 4034.80 | 10.678 | 2.73 |
| 369 | 3726.01 | 10.622 | 1.67 | 384 | 3885.54 | 10.647 | 1.79 | 399 | 4045.48 | 10.681 | 2.84 |
| 370 | 3736.64 | 10.624 | 1.66 | 385 | 3896.18 | 10.649 | 1.83 | 400 | 4056.16 | 10.684 | 2.95 |
| 371 | 3747.26 | 10.626 | 1.65 | 386 | 3906.83 | 10.651 | 1.87 | | | | |
| 372 | 3757.89 | 10.627 | 1.64 | 387 | 3917.49 | 10.653 | 1.91 | | | | |
| 373 | 3768.52 | 10.629 | 1.63 | 388 | 3928.14 | 10.655 | 1.96 | | | | |
| 374 | 3779.15 | 10.631 | 1.63 | 389 | 3938.80 | 10.657 | 2.02 | | | | |
| 375 | 3789.78 | 10.632 | 1.63 | 390 | 3949.45 | 10.659 | 2.08 | | | | |

**TABLE 7.5.5** *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C.*

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | .dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 10.477 | -21.63 | 60 | 601.7 | 9.748 | -4.86 | 120 | 1183.1 | 9.701 | 2.16 |
| 1 | 10.5 | 10.455 | -21.24 | 61 | 611.5 | 9.743 | -4.68 | 121 | 1192.8 | 9.703 | 2.23 |
| 2 | 20.9 | 10.434 | -20.84 | 62 | 621.2 | 9.738 | -4.50 | 122 | 1202.5 | 9.705 | 2.29 |
| 3 | 31.3 | 10.414 | -20.46 | 63 | 631.0 | 9.734 | -4.33 | 123 | 1212.2 | 9.707 | 2.35 |
| 4 | 41.7 | 10.393 | -20.07 | 64 | 640.7 | 9.730 | -4.16 | 124 | 1221.9 | 9.710 | 2.42 |
| 5 | 52.1 | 10.374 | -19.69 | 65 | 650.4 | 9.725 | -3.99 | 125 | 1231.6 | 9.712 | 2.48 |
| 6 | 62.5 | 10.354 | -19.32 | 66 | 660.1 | 9.722 | -3.82 | 126 | 1241.3 | 9.715 | 2.54 |
| 7 | 72.8 | 10.335 | -18.95 | 67 | 669.9 | 9.718 | -3.66 | 127 | 1251.1 | 9.717 | 2.60 |
| 8 | 83.2 | 10.316 | -18.58 | 68 | 679.6 | 9.714 | -3.49 | 128 | 1260.8 | 9.720 | 2.65 |
| 9 | 93.5 | 10.298 | -18.22 | 69 | 689.3 | 9.711 | -3.34 | 129 | 1270.5 | 9.723 | 2.71 |
| 10 | 103.8 | 10.280 | -17.87 | 70 | 699.0 | 9.708 | -3.18 | 130 | 1280.2 | 9.725 | 2.76 |
| 11 | 114.0 | 10.262 | -17.51 | 71 | 708.7 | 9.704 | -3.02 | 131 | 1290.0 | 9.728 | 2.82 |
| 12 | 124.3 | 10.245 | -17.17 | 72 | 718.4 | 9.702 | -2.87 | 132 | 1299.7 | 9.731 | 2.87 |
| 13 | 134.5 | 10.228 | -16.82 | 73 | 728.1 | 9.699 | -2.72 | 133 | 1309.4 | 9.734 | 2.92 |
| 14 | 144.7 | 10.211 | -16.49 | 74 | 737.8 | 9.696 | -2.57 | 134 | 1319.2 | 9.737 | 2.97 |
| 15 | 154.9 | 10.195 | -16.15 | 75 | 747.5 | 9.694 | -2.43 | 135 | 1328.9 | 9.740 | 3.02 |
| 16 | 165.1 | 10.179 | -15.82 | 76 | 757.2 | 9.691 | -2.28 | 136 | 1338.6 | 9.743 | 3.07 |
| 17 | 175.3 | 10.163 | -15.49 | 77 | 766.9 | 9.689 | -2.14 | 137 | 1348.4 | 9.746 | 3.12 |
| 18 | 185.4 | 10.148 | -15.17 | 78 | 776.6 | 9.687 | -2.00 | 138 | 1358.1 | 9.749 | 3.16 |
| 19 | 195.6 | 10.133 | -14.85 | 79 | 786.3 | 9.685 | -1.87 | 139 | 1367.9 | 9.752 | 3.21 |
| 20 | 205.7 | 10.118 | -14.54 | 80 | 795.9 | 9.683 | -1.73 | 140 | 1377.6 | 9.756 | 3.25 |
| 21 | 215.8 | 10.104 | -14.23 | 81 | 805.6 | 9.682 | -1.60 | 141 | 1387.4 | 9.759 | 3.30 |
| 22 | 225.9 | 10.090 | -13.92 | 82 | 815.3 | 9.680 | -1.47 | 142 | 1397.1 | 9.762 | 3.34 |
| 23 | 236.0 | 10.076 | -13.62 | 83 | 825.0 | 9.679 | -1.34 | 143 | 1406.9 | 9.765 | 3.38 |
| 24 | 246.1 | 10.062 | -13.32 | 84 | 834.7 | 9.677 | -1.22 | 144 | 1416.7 | 9.769 | 3.42 |
| 25 | 256.1 | 10.049 | -13.03 | 85 | 844.3 | 9.676 | -1.09 | 145 | 1426.4 | 9.772 | 3.46 |
| 26 | 266.2 | 10.036 | -12.74 | 86 | 854.0 | 9.675 | -0.97 | 146 | 1436.2 | 9.776 | 3.50 |
| 27 | 276.2 | 10.024 | -12.45 | 87 | 863.7 | 9.674 | -0.85 | 147 | 1446.0 | 9.779 | 3.54 |
| 28 | 286.2 | 10.011 | -12.17 | 88 | 873.4 | 9.673 | -0.73 | 148 | 1455.8 | 9.783 | 3.58 |
| 29 | 296.2 | 9.999 | -11.89 | 89 | 883.0 | 9.673 | -0.61 | 149 | 1465.6 | 9.786 | 3.61 |
| 30 | 306.2 | 9.988 | -11.61 | 90 | 892.7 | 9.672 | -0.50 | 150 | 1475.4 | 9.790 | 3.65 |
| 31 | 316.2 | 9.976 | -11.34 | 91 | 902.4 | 9.672 | -0.39 | 151 | 1485.1 | 9.794 | 3.68 |
| 32 | 326.2 | 9.965 | -11.07 | 92 | 912.1 | 9.671 | -0.28 | 152 | 1494.9 | 9.797 | 3.71 |
| 33 | 336.1 | 9.954 | -10.81 | 93 | 921.7 | 9.671 | -0.17 | 153 | 1504.7 | 9.801 | 3.75 |
| 34 | 346.1 | 9.943 | -10.54 | 94 | 931.4 | 9.671 | -0.06 | 154 | 1514.5 | 9.805 | 3.78 |
| 35 | 356.0 | 9.933 | -10.29 | 95 | 941.1 | 9.671 | 0.05 | 155 | 1524.4 | 9.809 | 3.81 |
| 36 | 365.9 | 9.923 | -10.03 | 96 | 950.7 | 9.671 | 0.15 | 156 | 1534.2 | 9.813 | 3.84 |
| 37 | 375.9 | 9.913 | -9.78 | 97 | 960.4 | 9.671 | 0.25 | 157 | 1544.0 | 9.816 | 3.87 |
| 38 | 385.8 | 9.903 | -9.53 | 98 | 970.1 | 9.672 | 0.35 | 158 | 1553.8 | 9.820 | 3.90 |
| 39 | 395.7 | 9.894 | -9.29 | 99 | 979.8 | 9.672 | 0.45 | 159 | 1563.6 | 9.824 | 3.93 |
| 40 | 405.6 | 9.885 | -9.05 | 100 | 989.4 | 9.673 | 0.55 | 160 | 1573.4 | 9.828 | 3.95 |
| 41 | 415.4 | 9.876 | -8.81 | 101 | 999.1 | 9.673 | 0.64 | 161 | 1583.3 | 9.832 | 3.98 |
| 42 | 425.3 | 9.867 | -8.57 | 102 | 1008.8 | 9.674 | 0.74 | 162 | 1593.1 | 9.836 | 4.01 |
| 43 | 435.2 | 9.859 | -8.34 | 103 | 1018.4 | 9.675 | 0.83 | 163 | 1602.9 | 9.840 | 4.03 |
| 44 | 445.0 | 9.850 | -8.11 | 104 | 1028.1 | 9.676 | 0.92 | 164 | 1612.8 | 9.844 | 4.06 |
| 45 | 454.9 | 9.842 | -7.89 | 105 | 1037.8 | 9.676 | 1.01 | 165 | 1622.6 | 9.848 | 4.08 |
| 46 | 464.7 | 9.835 | -7.66 | 106 | 1047.5 | 9.678 | 1.09 | 166 | 1632.5 | 9.852 | 4.10 |
| 47 | 474.5 | 9.827 | -7.45 | 107 | 1057.2 | 9.679 | 1.18 | 167 | 1642.3 | 9.856 | 4.12 |
| 48 | 484.4 | 9.820 | -7.23 | 108 | 1066.8 | 9.680 | 1.26 | 168 | 1652.2 | 9.861 | 4.15 |
| 49 | 494.2 | 9.813 | -7.02 | 109 | 1076.5 | 9.681 | 1.35 | 169 | 1662.1 | 9.865 | 4.17 |
| 50 | 504.0 | 9.806 | -6.81 | 110 | 1086.2 | 9.683 | 1.43 | 170 | 1671.9 | 9.869 | 4.19 |
| 51 | 513.8 | 9.799 | -6.60 | 111 | 1095.9 | 9.684 | 1.51 | 171 | 1681.8 | 9.873 | 4.21 |
| 52 | 523.6 | 9.792 | -6.39 | 112 | 1105.6 | 9.686 | 1.58 | 172 | 1691.7 | 9.877 | 4.23 |
| 53 | 533.4 | 9.786 | -6.19 | 113 | 1115.2 | 9.687 | 1.66 | 173 | 1701.6 | 9.882 | 4.24 |
| 54 | 543.2 | 9.780 | -5.99 | 114 | 1124.9 | 9.689 | 1.74 | 174 | 1711.4 | 9.886 | 4.26 |
| 55 | 552.9 | 9.774 | -5.80 | 115 | 1134.6 | 9.691 | 1.81 | 175 | 1721.3 | 9.890 | 4.28 |
| 56 | 562.7 | 9.768 | -5.60 | 116 | 1144.3 | 9.693 | 1.88 | 176 | 1731.2 | 9.894 | 4.30 |
| 57 | 572.5 | 9.763 | -5.41 | 117 | 1154.0 | 9.694 | 1.95 | 177 | 1741.1 | 9.899 | 4.31 |
| 58 | 582.2 | 9.758 | -5.23 | 118 | 1163.7 | 9.696 | 2.02 | 178 | 1751.0 | 9.903 | 4.33 |
| 59 | 592.0 | 9.753 | -5.04 | 119 | 1173.4 | 9.699 | 2.09 | 179 | 1760.9 | 9.907 | 4.34 |
| 60 | 601.7 | 9.748 | -4.86 | 120 | 1183.1 | 9.701 | 2.16 | 180 | 1770.8 | 9.912 | 4.36 |

**Table 7.5.5** *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 180 | 1770.8 | 9.912 | 4.36 | 240 | 2373.7 | 10.184 | 4.51 | 300 | 2992.5 | 10.440 | 3.99 |
| 181 | 1780.7 | 9.916 | 4.37 | 241 | 2383.8 | 10.188 | 4.51 | 301 | 3003.0 | 10.444 | 3.98 |
| 182 | 1790.7 | 9.920 | 4.39 | 242 | 2394.0 | 10.193 | 4.50 | 302 | 3013.4 | 10.448 | 3.97 |
| 183 | 1800.6 | 9.925 | 4.40 | 243 | 2404.2 | 10.197 | 4.50 | 303 | 3023.9 | 10.452 | 3.96 |
| 184 | 1810.5 | 9.929 | 4.41 | 244 | 2414.4 | 10.202 | 4.49 | 304 | 3034.3 | 10.456 | 3.95 |
| 185 | 1820.4 | 9.934 | 4.42 | 245 | 2424.6 | 10.206 | 4.49 | 305 | 3044.8 | 10.460 | 3.93 |
| 186 | 1830.4 | 9.938 | 4.43 | 246 | 2434.8 | 10.211 | 4.48 | 306 | 3055.2 | 10.464 | 3.92 |
| 187 | 1840.3 | 9.943 | 4.44 | 247 | 2445.0 | 10.215 | 4.47 | 307 | 3065.7 | 10.468 | 3.91 |
| 188 | 1850.3 | 9.947 | 4.46 | 248 | 2455.3 | 10.220 | 4.47 | 308 | 3076.2 | 10.472 | 3.90 |
| 189 | 1860.2 | 9.951 | 4.47 | 249 | 2465.5 | 10.224 | 4.46 | 309 | 3086.7 | 10.476 | 3.89 |
| 190 | 1870.2 | 9.956 | 4.47 | 250 | 2475.7 | 10.229 | 4.45 | 310 | 3097.1 | 10.480 | 3.88 |
| 191 | 1880.1 | 9.960 | 4.48 | 251 | 2485.9 | 10.233 | 4.45 | 311 | 3107.6 | 10.484 | 3.87 |
| 192 | 1890.1 | 9.965 | 4.49 | 252 | 2496.2 | 10.237 | 4.44 | 312 | 3118.1 | 10.487 | 3.86 |
| 193 | 1900.1 | 9.969 | 4.50 | 253 | 2506.4 | 10.242 | 4.43 | 313 | 3128.6 | 10.491 | 3.85 |
| 194 | 1910.0 | 9.974 | 4.51 | 254 | 2516.7 | 10.246 | 4.42 | 314 | 3139.1 | 10.495 | 3.83 |
| 195 | 1920.0 | 9.978 | 4.52 | 255 | 2526.9 | 10.251 | 4.42 | 315 | 3149.6 | 10.499 | 3.82 |
| 196 | 1930.0 | 9.983 | 4.52 | 256 | 2537.2 | 10.255 | 4.41 | 316 | 3160.1 | 10.503 | 3.81 |
| 197 | 1940.0 | 9.987 | 4.53 | 257 | 2547.4 | 10.260 | 4.40 | 317 | 3170.6 | 10.507 | 3.80 |
| 198 | 1950.0 | 9.992 | 4.54 | 258 | 2557.7 | 10.264 | 4.39 | 318 | 3181.1 | 10.510 | 3.79 |
| 199 | 1960.0 | 9.997 | 4.54 | 259 | 2567.9 | 10.268 | 4.38 | 319 | 3191.6 | 10.514 | 3.78 |
| 200 | 1970.0 | 10.001 | 4.55 | 260 | 2578.2 | 10.273 | 4.38 | 320 | 3202.1 | 10.518 | 3.77 |
| 201 | 1980.0 | 10.006 | 4.55 | 261 | 2588.5 | 10.277 | 4.37 | 321 | 3212.6 | 10.522 | 3.75 |
| 202 | 1990.0 | 10.010 | 4.56 | 262 | 2598.8 | 10.281 | 4.36 | 322 | 3223.2 | 10.525 | 3.74 |
| 203 | 2000.0 | 10.015 | 4.56 | 263 | 2609.1 | 10.286 | 4.35 | 323 | 3233.7 | 10.529 | 3.73 |
| 204 | 2010.0 | 10.019 | 4.56 | 264 | 2619.3 | 10.290 | 4.34 | 324 | 3244.2 | 10.533 | 3.72 |
| 205 | 2020.0 | 10.024 | 4.57 | 265 | 2629.6 | 10.294 | 4.33 | 325 | 3254.8 | 10.537 | 3.71 |
| 206 | 2030.0 | 10.028 | 4.57 | 266 | 2639.9 | 10.299 | 4.33 | 326 | 3265.3 | 10.540 | 3.70 |
| 207 | 2040.1 | 10.033 | 4.57 | 267 | 2650.2 | 10.303 | 4.32 | 327 | 3275.8 | 10.544 | 3.68 |
| 208 | 2050.1 | 10.038 | 4.58 | 268 | 2660.5 | 10.307 | 4.31 | 328 | 3286.4 | 10.548 | 3.67 |
| 209 | 2060.1 | 10.042 | 4.58 | 269 | 2670.8 | 10.312 | 4.30 | 329 | 3296.9 | 10.551 | 3.66 |
| 210 | 2070.2 | 10.047 | 4.58 | 270 | 2681.2 | 10.316 | 4.29 | 330 | 3307.5 | 10.555 | 3.65 |
| 211 | 2080.2 | 10.051 | 4.58 | 271 | 2691.5 | 10.320 | 4.28 | 331 | 3318.0 | 10.559 | 3.64 |
| 212 | 2090.3 | 10.056 | 4.58 | 272 | 2701.8 | 10.325 | 4.27 | 332 | 3328.6 | 10.562 | 3.63 |
| 213 | 2100.4 | 10.060 | 4.58 | 273 | 2712.1 | 10.329 | 4.26 | 333 | 3339.2 | 10.566 | 3.61 |
| 214 | 2110.4 | 10.065 | 4.58 | 274 | 2722.5 | 10.333 | 4.25 | 334 | 3349.7 | 10.569 | 3.60 |
| 215 | 2120.5 | 10.070 | 4.58 | 275 | 2732.8 | 10.337 | 4.24 | 335 | 3360.3 | 10.573 | 3.59 |
| 216 | 2130.6 | 10.074 | 4.58 | 276 | 2743.1 | 10.342 | 4.23 | 336 | 3370.9 | 10.577 | 3.58 |
| 217 | 2140.6 | 10.079 | 4.58 | 277 | 2753.5 | 10.346 | 4.23 | 337 | 3381.5 | 10.580 | 3.57 |
| 218 | 2150.7 | 10.083 | 4.58 | 278 | 2763.8 | 10.350 | 4.22 | 338 | 3392.0 | 10.584 | 3.55 |
| 219 | 2160.8 | 10.088 | 4.58 | 279 | 2774.2 | 10.354 | 4.21 | 339 | 3402.6 | 10.587 | 3.54 |
| 220 | 2170.9 | 10.093 | 4.58 | 280 | 2784.5 | 10.358 | 4.20 | 340 | 3413.2 | 10.591 | 3.53 |
| 221 | 2181.0 | 10.097 | 4.58 | 281 | 2794.9 | 10.363 | 4.19 | 341 | 3423.8 | 10.594 | 3.52 |
| 222 | 2191.1 | 10.102 | 4.58 | 282 | 2805.3 | 10.367 | 4.18 | 342 | 3434.4 | 10.598 | 3.51 |
| 223 | 2201.2 | 10.106 | 4.58 | 283 | 2815.6 | 10.371 | 4.17 | 343 | 3445.0 | 10.601 | 3.49 |
| 224 | 2211.3 | 10.111 | 4.58 | 284 | 2826.0 | 10.375 | 4.16 | 344 | 3455.6 | 10.605 | 3.48 |
| 225 | 2221.4 | 10.115 | 4.57 | 285 | 2836.4 | 10.379 | 4.15 | 345 | 3466.2 | 10.608 | 3.47 |
| 226 | 2231.5 | 10.120 | 4.57 | 286 | 2846.8 | 10.383 | 4.14 | 346 | 3476.8 | 10.612 | 3.46 |
| 227 | 2241.6 | 10.125 | 4.57 | 287 | 2857.1 | 10.388 | 4.13 | 347 | 3487.4 | 10.615 | 3.45 |
| 228 | 2251.8 | 10.129 | 4.57 | 288 | 2867.5 | 10.392 | 4.12 | 348 | 3498.1 | 10.619 | 3.43 |
| 229 | 2261.9 | 10.134 | 4.56 | 289 | 2877.9 | 10.396 | 4.11 | 349 | 3508.7 | 10.622 | 3.42 |
| 230 | 2272.0 | 10.138 | 4.56 | 290 | 2888.3 | 10.400 | 4.10 | 350 | 3519.3 | 10.626 | 3.41 |
| 231 | 2282.2 | 10.143 | 4.56 | 291 | 2898.7 | 10.404 | 4.08 | 351 | 3529.9 | 10.629 | 3.40 |
| 232 | 2292.3 | 10.147 | 4.55 | 292 | 2909.1 | 10.408 | 4.07 | 352 | 3540.6 | 10.632 | 3.38 |
| 233 | 2302.5 | 10.152 | 4.55 | 293 | 2919.5 | 10.412 | 4.06 | 353 | 3551.2 | 10.636 | 3.37 |
| 234 | 2312.6 | 10.157 | 4.54 | 294 | 2930.0 | 10.416 | 4.05 | 354 | 3561.8 | 10.639 | 3.36 |
| 235 | 2322.8 | 10.161 | 4.54 | 295 | 2940.4 | 10.420 | 4.04 | 355 | 3572.5 | 10.642 | 3.35 |
| 236 | 2333.0 | 10.166 | 4.53 | 296 | 2950.8 | 10.424 | 4.03 | 356 | 3583.1 | 10.646 | 3.34 |
| 237 | 2343.1 | 10.170 | 4.53 | 297 | 2961.2 | 10.428 | 4.02 | 357 | 3593.8 | 10.649 | 3.32 |
| 238 | 2353.3 | 10.175 | 4.52 | 298 | 2971.7 | 10.432 | 4.01 | 358 | 3604.4 | 10.652 | 3.31 |
| 239 | 2363.5 | 10.179 | 4.52 | 299 | 2982.1 | 10.436 | 4.00 | 359 | 3615.1 | 10.656 | 3.30 |
| 240 | 2373.7 | 10.184 | 4.51 | 300 | 2992.5 | 10.440 | 3.99 | 360 | 3625.7 | 10.659 | 3.29 |

**TABLE 7.5.5** *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ | T °C | E μV | S μV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 360 | 3625.7 | 10.659 | 3.29 | 420 | 4270.7 | 10.832 | 2.46 | 480 | 4924.5 | 10.950 | 1.42 |
| 361 | 3636.4 | 10.662 | 3.27 | 421 | 4281.5 | 10.835 | 2.45 | 481 | 4935.4 | 10.951 | 1.40 |
| 362 | 3647.1 | 10.666 | 3.26 | 422 | 4292.4 | 10.837 | 2.43 | 482 | 4946.4 | 10.953 | 1.38 |
| 363 | 3657.7 | 10.669 | 3.25 | 423 | 4303.2 | 10.840 | 2.42 | 483 | 4957.4 | 10.954 | 1.36 |
| 364 | 3668.4 | 10.672 | 3.23 | 424 | 4314.1 | 10.842 | 2.40 | 484 | 4968.3 | 10.955 | 1.34 |
| 365 | 3679.1 | 10.675 | 3.22 | 425 | 4324.9 | 10.844 | 2.38 | 485 | 4979.3 | 10.957 | 1.31 |
| 366 | 3689.7 | 10.679 | 3.21 | 426 | 4335.8 | 10.847 | 2.37 | 486 | 4990.2 | 10.958 | 1.29 |
| 367 | 3700.4 | 10.682 | 3.20 | 427 | 4346.6 | 10.849 | 2.35 | 487 | 5001.2 | 10.959 | 1.27 |
| 368 | 3711.1 | 10.685 | 3.18 | 428 | 4357.4 | 10.851 | 2.34 | 488 | 5012.1 | 10.961 | 1.25 |
| 369 | 3721.8 | 10.688 | 3.17 | 429 | 4368.3 | 10.854 | 2.32 | 489 | 5023.1 | 10.962 | 1.23 |
| 370 | 3732.5 | 10.691 | 3.16 | 430 | 4379.2 | 10.856 | 2.31 | 490 | 5034.1 | 10.963 | 1.21 |
| 371 | 3743.2 | 10.694 | 3.15 | 431 | 4390.0 | 10.858 | 2.29 | 491 | 5045.0 | 10.964 | 1.19 |
| 372 | 3753.9 | 10.698 | 3.13 | 432 | 4400.9 | 10.861 | 2.27 | 492 | 5056.0 | 10.966 | 1.17 |
| 373 | 3764.6 | 10.701 | 3.12 | 433 | 4411.7 | 10.863 | 2.26 | 493 | 5067.0 | 10.967 | 1.15 |
| 374 | 3775.3 | 10.704 | 3.11 | 434 | 4422.6 | 10.865 | 2.24 | 494 | 5077.9 | 10.968 | 1.13 |
| 375 | 3786.0 | 10.707 | 3.09 | 435 | 4433.5 | 10.867 | 2.23 | 495 | 5088.9 | 10.969 | 1.11 |
| 376 | 3796.7 | 10.710 | 3.08 | 436 | 4444.3 | 10.870 | 2.21 | 496 | 5099.9 | 10.970 | 1.09 |
| 377 | 3807.4 | 10.713 | 3.07 | 437 | 4455.2 | 10.872 | 2.19 | 497 | 5110.8 | 10.971 | 1.06 |
| 378 | 3818.1 | 10.716 | 3.05 | 438 | 4466.1 | 10.874 | 2.18 | 498 | 5121.8 | 10.972 | 1.04 |
| 379 | 3828.8 | 10.719 | 3.04 | 439 | 4477.0 | 10.876 | 2.16 | 499 | 5132.8 | 10.973 | 1.02 |
| 380 | 3839.5 | 10.722 | 3.03 | 440 | 4487.8 | 10.878 | 2.14 | 500 | 5143.8 | 10.974 | 1.00 |
| 381 | 3850.3 | 10.725 | 3.01 | 441 | 4498.7 | 10.881 | 2.13 | 501 | 5154.7 | 10.975 | 0.98 |
| 382 | 3861.0 | 10.728 | 3.00 | 442 | 4509.6 | 10.883 | 2.11 | 502 | 5165.7 | 10.976 | 0.96 |
| 383 | 3871.7 | 10.731 | 2.99 | 443 | 4520.5 | 10.885 | 2.09 | 503 | 5176.7 | 10.977 | 0.93 |
| 384 | 3882.5 | 10.734 | 2.97 | 444 | 4531.4 | 10.887 | 2.08 | 504 | 5187.7 | 10.978 | 0.91 |
| 385 | 3893.2 | 10.737 | 2.96 | 445 | 4542.2 | 10.889 | 2.06 | 505 | 5198.6 | 10.979 | 0.89 |
| 386 | 3903.9 | 10.740 | 2.95 | 446 | 4553.1 | 10.891 | 2.04 | 506 | 5209.6 | 10.980 | 0.87 |
| 387 | 3914.7 | 10.743 | 2.93 | 447 | 4564.0 | 10.893 | 2.03 | 507 | 5220.6 | 10.981 | 0.85 |
| 388 | 3925.4 | 10.746 | 2.92 | 448 | 4574.9 | 10.895 | 2.01 | 508 | 5231.6 | 10.982 | 0.82 |
| 389 | 3936.2 | 10.749 | 2.91 | 449 | 4585.8 | 10.897 | 1.99 | 509 | 5242.6 | 10.982 | 0.80 |
| 390 | 3946.9 | 10.752 | 2.89 | 450 | 4596.7 | 10.899 | 1.97 | 510 | 5253.5 | 10.983 | 0.78 |
| 391 | 3957.7 | 10.755 | 2.88 | 451 | 4607.6 | 10.901 | 1.96 | 511 | 5264.5 | 10.984 | 0.76 |
| 392 | 3968.4 | 10.758 | 2.87 | 452 | 4618.5 | 10.903 | 1.94 | 512 | 5275.5 | 10.985 | 0.73 |
| 393 | 3979.2 | 10.760 | 2.85 | 453 | 4629.4 | 10.905 | 1.92 | 513 | 5286.5 | 10.985 | 0.71 |
| 394 | 3989.9 | 10.763 | 2.84 | 454 | 4640.3 | 10.907 | 1.90 | 514 | 5297.5 | 10.986 | 0.69 |
| 395 | 4000.7 | 10.766 | 2.82 | 455 | 4651.2 | 10.909 | 1.89 | 515 | 5308.5 | 10.987 | 0.66 |
| 396 | 4011.5 | 10.769 | 2.81 | 456 | 4662.1 | 10.910 | 1.87 | 516 | 5319.5 | 10.987 | 0.64 |
| 397 | 4022.3 | 10.772 | 2.80 | 457 | 4673.1 | 10.912 | 1.85 | 517 | 5330.4 | 10.988 | 0.62 |
| 398 | 4033.0 | 10.775 | 2.78 | 458 | 4684.0 | 10.914 | 1.83 | 518 | 5341.4 | 10.989 | 0.59 |
| 399 | 4043.8 | 10.777 | 2.77 | 459 | 4694.9 | 10.916 | 1.81 | 519 | 5352.4 | 10.989 | 0.57 |
| 400 | 4054.6 | 10.780 | 2.75 | 460 | 4705.8 | 10.918 | 1.80 | 520 | 5363.4 | 10.990 | 0.55 |
| 401 | 4065.4 | 10.783 | 2.74 | 461 | 4716.7 | 10.920 | 1.78 | 521 | 5374.4 | 10.990 | 0.52 |
| 402 | 4076.1 | 10.786 | 2.73 | 462 | 4727.6 | 10.921 | 1.76 | 522 | 5385.4 | 10.991 | 0.50 |
| 403 | 4086.9 | 10.788 | 2.71 | 463 | 4738.6 | 10.923 | 1.74 | 523 | 5396.4 | 10.991 | 0.48 |
| 404 | 4097.7 | 10.791 | 2.70 | 464 | 4749.5 | 10.925 | 1.72 | 524 | 5407.4 | 10.992 | 0.45 |
| 405 | 4108.5 | 10.794 | 2.68 | 465 | 4760.4 | 10.927 | 1.70 | 525 | 5418.4 | 10.992 | 0.43 |
| 406 | 4119.3 | 10.796 | 2.67 | 466 | 4771.3 | 10.928 | 1.69 | 526 | 5429.4 | 10.993 | 0.41 |
| 407 | 4130.1 | 10.799 | 2.65 | 467 | 4782.3 | 10.930 | 1.67 | 527 | 5440.3 | 10.993 | 0.38 |
| 408 | 4140.9 | 10.802 | 2.64 | 468 | 4793.2 | 10.932 | 1.65 | 528 | 5451.3 | 10.993 | 0.36 |
| 409 | 4151.7 | 10.804 | 2.63 | 469 | 4804.1 | 10.933 | 1.63 | 529 | 5462.3 | 10.994 | 0.33 |
| 410 | 4162.5 | 10.807 | 2.61 | 470 | 4815.1 | 10.935 | 1.61 | 530 | 5473.3 | 10.994 | 0.31 |
| 411 | 4173.3 | 10.810 | 2.60 | 471 | 4826.0 | 10.936 | 1.59 | 531 | 5484.3 | 10.994 | 0.28 |
| 412 | 4184.1 | 10.812 | 2.58 | 472 | 4836.9 | 10.938 | 1.57 | 532 | 5495.3 | 10.995 | 0.26 |
| 413 | 4194.9 | 10.815 | 2.57 | 473 | 4847.9 | 10.940 | 1.55 | 533 | 5506.3 | 10.995 | 0.23 |
| 414 | 4205.8 | 10.817 | 2.55 | 474 | 4858.8 | 10.941 | 1.53 | 534 | 5517.3 | 10.995 | 0.21 |
| 415 | 4216.6 | 10.820 | 2.54 | 475 | 4869.8 | 10.943 | 1.51 | 535 | 5528.3 | 10.995 | 0.19 |
| 416 | 4227.4 | 10.822 | 2.52 | 476 | 4880.7 | 10.944 | 1.49 | 536 | 5539.3 | 10.995 | 0.16 |
| 417 | 4238.2 | 10.825 | 2.51 | 477 | 4891.7 | 10.946 | 1.47 | 537 | 5550.3 | 10.996 | 0.14 |
| 418 | 4249.1 | 10.827 | 2.49 | 478 | 4902.6 | 10.947 | 1.46 | 538 | 5561.3 | 10.996 | 0.11 |
| 419 | 4259.9 | 10.830 | 2.48 | 479 | 4913.5 | 10.949 | 1.44 | 539 | 5572.3 | 10.996 | 0.08 |
| 420 | 4270.7 | 10.832 | 2.46 | 480 | 4924.5 | 10.950 | 1.42 | 540 | 5583.3 | 10.996 | 0.06 |

**Table 7.5.5** *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² | T °C | E µV | S µV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 540 | 5583.3 | 10.996 | 0.06 | 600 | 6242.2 | 10.951 | -1.59 | 660 | 6895.3 | 10.801 | -3.42 |
| 541 | 5594.3 | 10.996 | 0.03 | 601 | 6253.1 | 10.950 | -1.62 | 661 | 6906.1 | 10.798 | -3.45 |
| 542 | 5605.3 | 10.996 | 0.01 | 602 | 6264.1 | 10.948 | -1.65 | 662 | 6916.9 | 10.794 | -3.48 |
| 543 | 5616.3 | 10.996 | -0.02 | 603 | 6275.0 | 10.946 | -1.68 | 663 | 6927.7 | 10.791 | -3.51 |
| 544 | 5627.3 | 10.996 | -0.04 | 604 | 6286.0 | 10.945 | -1.71 | 664 | 6938.5 | 10.787 | -3.54 |
| 545 | 5638.3 | 10.996 | -0.07 | 605 | 6296.9 | 10.943 | -1.74 | 665 | 6949.3 | 10.784 | -3.57 |
| 546 | 5649.3 | 10.996 | -0.09 | 606 | 6307.9 | 10.941 | -1.77 | 666 | 6960.0 | 10.780 | -3.60 |
| 547 | 5660.2 | 10.996 | -0.12 | 607 | 6318.8 | 10.939 | -1.80 | 667 | 6970.8 | 10.776 | -3.63 |
| 548 | 5671.2 | 10.996 | -0.15 | 608 | 6329.7 | 10.937 | -1.83 | 668 | 6981.6 | 10.773 | -3.66 |
| 549 | 5682.2 | 10.995 | -0.17 | 609 | 6340.7 | 10.936 | -1.86 | 669 | 6992.4 | 10.769 | -3.69 |
| 550 | 5693.2 | 10.995 | -0.20 | 610 | 6351.6 | 10.934 | -1.89 | 670 | 7003.1 | 10.765 | -3.73 |
| 551 | 5704.2 | 10.995 | -0.22 | 611 | 6362.5 | 10.932 | -1.92 | 671 | 7013.9 | 10.762 | -3.76 |
| 552 | 5715.2 | 10.995 | -0.25 | 612 | 6373.5 | 10.930 | -1.95 | 672 | 7024.7 | 10.758 | -3.79 |
| 553 | 5726.2 | 10.994 | -0.28 | 613 | 6384.4 | 10.928 | -1.98 | 673 | 7035.4 | 10.754 | -3.82 |
| 554 | 5737.2 | 10.994 | -0.30 | 614 | 6395.3 | 10.926 | -2.01 | 674 | 7046.2 | 10.750 | -3.85 |
| 555 | 5748.2 | 10.994 | -0.33 | 615 | 6406.3 | 10.924 | -2.04 | 675 | 7056.9 | 10.746 | -3.88 |
| 556 | 5759.2 | 10.994 | -0.36 | 616 | 6417.2 | 10.922 | -2.07 | 676 | 7067.7 | 10.743 | -3.91 |
| 557 | 5770.2 | 10.993 | -0.38 | 617 | 6428.1 | 10.920 | -2.10 | 677 | 7078.4 | 10.739 | -3.94 |
| 558 | 5781.2 | 10.993 | -0.41 | 618 | 6439.0 | 10.918 | -2.13 | 678 | 7089.1 | 10.735 | -3.97 |
| 559 | 5792.2 | 10.992 | -0.44 | 619 | 6449.9 | 10.915 | -2.16 | 679 | 7099.9 | 10.731 | -4.00 |
| 560 | 5803.2 | 10.992 | -0.46 | 620 | 6460.8 | 10.913 | -2.19 | 680 | 7110.6 | 10.727 | -4.03 |
| 561 | 5814.2 | 10.991 | -0.49 | 621 | 6471.8 | 10.911 | -2.22 | 681 | 7121.3 | 10.723 | -4.06 |
| 562 | 5825.2 | 10.991 | -0.52 | 622 | 6482.7 | 10.909 | -2.25 | 682 | 7132.0 | 10.719 | -4.09 |
| 563 | 5836.1 | 10.990 | -0.54 | 623 | 6493.6 | 10.907 | -2.28 | 683 | 7142.8 | 10.714 | -4.12 |
| 564 | 5847.1 | 10.990 | -0.57 | 624 | 6504.5 | 10.904 | -2.31 | 684 | 7153.5 | 10.710 | -4.15 |
| 565 | 5858.1 | 10.989 | -0.60 | 625 | 6515.4 | 10.902 | -2.34 | 685 | 7164.2 | 10.706 | -4.18 |
| 566 | 5869.1 | 10.989 | -0.63 | 626 | 6526.3 | 10.900 | -2.37 | 686 | 7174.9 | 10.702 | -4.21 |
| 567 | 5880.1 | 10.988 | -0.65 | 627 | 6537.2 | 10.897 | -2.40 | 687 | 7185.6 | 10.698 | -4.24 |
| 568 | 5891.1 | 10.987 | -0.68 | 628 | 6548.1 | 10.895 | -2.44 | 688 | 7196.3 | 10.693 | -4.27 |
| 569 | 5902.1 | 10.987 | -0.71 | 629 | 6559.0 | 10.892 | -2.47 | 689 | 7207.0 | 10.689 | -4.30 |
| 570 | 5913.1 | 10.986 | -0.74 | 630 | 6569.9 | 10.890 | -2.50 | 690 | 7217.7 | 10.685 | -4.33 |
| 571 | 5924.1 | 10.985 | -0.76 | 631 | 6580.8 | 10.887 | -2.53 | 691 | 7228.3 | 10.680 | -4.36 |
| 572 | 5935.0 | 10.984 | -0.79 | 632 | 6591.6 | 10.885 | -2.56 | 692 | 7239.0 | 10.676 | -4.39 |
| 573 | 5946.0 | 10.984 | -0.82 | 633 | 6602.5 | 10.882 | -2.59 | 693 | 7249.7 | 10.672 | -4.42 |
| 574 | 5957.0 | 10.983 | -0.85 | 634 | 6613.4 | 10.880 | -2.62 | 694 | 7260.4 | 10.667 | -4.45 |
| 575 | 5968.0 | 10.982 | -0.87 | 635 | 6624.3 | 10.877 | -2.65 | 695 | 7271.0 | 10.663 | -4.48 |
| 576 | 5979.0 | 10.981 | -0.90 | 636 | 6635.2 | 10.874 | -2.68 | 696 | 7281.7 | 10.658 | -4.51 |
| 577 | 5989.9 | 10.980 | -0.93 | 637 | 6646.0 | 10.872 | -2.71 | 697 | 7292.3 | 10.654 | -4.54 |
| 578 | 6000.9 | 10.979 | -0.96 | 638 | 6656.9 | 10.869 | -2.74 | 698 | 7303.0 | 10.649 | -4.57 |
| 579 | 6011.9 | 10.978 | -0.99 | 639 | 6667.8 | 10.866 | -2.77 | 699 | 7313.6 | 10.645 | -4.60 |
| 580 | 6022.9 | 10.977 | -1.02 | 640 | 6678.6 | 10.863 | -2.80 | 700 | 7324.3 | 10.640 | -4.63 |
| 581 | 6033.9 | 10.976 | -1.04 | 641 | 6689.5 | 10.861 | -2.83 | 701 | 7334.9 | 10.635 | -4.66 |
| 582 | 6044.8 | 10.975 | -1.07 | 642 | 6700.4 | 10.858 | -2.86 | 702 | 7345.6 | 10.631 | -4.69 |
| 583 | 6055.8 | 10.974 | -1.10 | 643 | 6711.2 | 10.855 | -2.90 | 703 | 7356.2 | 10.626 | -4.72 |
| 584 | 6066.8 | 10.973 | -1.13 | 644 | 6722.1 | 10.852 | -2.93 | 704 | 7366.8 | 10.621 | -4.75 |
| 585 | 6077.8 | 10.972 | -1.16 | 645 | 6732.9 | 10.849 | -2.96 | 705 | 7377.4 | 10.617 | -4.78 |
| 586 | 6088.7 | 10.971 | -1.19 | 646 | 6743.8 | 10.846 | -2.99 | 706 | 7388.0 | 10.612 | -4.80 |
| 587 | 6099.7 | 10.969 | -1.22 | 647 | 6754.6 | 10.843 | -3.02 | 707 | 7398.7 | 10.607 | -4.83 |
| 588 | 6110.7 | 10.968 | -1.24 | 648 | 6765.5 | 10.840 | -3.05 | 708 | 7409.3 | 10.602 | -4.86 |
| 589 | 6121.6 | 10.967 | -1.27 | 649 | 6776.3 | 10.837 | -3.08 | 709 | 7419.9 | 10.597 | -4.89 |
| 590 | 6132.6 | 10.966 | -1.30 | 650 | 6787.1 | 10.834 | -3.11 | 710 | 7430.5 | 10.592 | -4.92 |
| 591 | 6143.6 | 10.964 | -1.33 | 651 | 6798.0 | 10.831 | -3.14 | 711 | 7441.0 | 10.587 | -4.95 |
| 592 | 6154.5 | 10.963 | -1.36 | 652 | 6808.8 | 10.828 | -3.17 | 712 | 7451.6 | 10.582 | -4.98 |
| 593 | 6165.5 | 10.962 | -1.39 | 653 | 6819.6 | 10.824 | -3.20 | 713 | 7462.2 | 10.577 | -5.01 |
| 594 | 6176.5 | 10.960 | -1.42 | 654 | 6830.4 | 10.821 | -3.23 | 714 | 7472.8 | 10.572 | -5.04 |
| 595 | 6187.4 | 10.959 | -1.45 | 655 | 6841.3 | 10.818 | -3.26 | 715 | 7483.4 | 10.567 | -5.06 |
| 596 | 6198.4 | 10.957 | -1.48 | 656 | 6852.1 | 10.815 | -3.30 | 716 | 7493.9 | 10.562 | -5.09 |
| 597 | 6209.3 | 10.956 | -1.51 | 657 | 6862.9 | 10.811 | -3.33 | 717 | 7504.5 | 10.557 | -5.12 |
| 598 | 6220.3 | 10.954 | -1.54 | 658 | 6873.7 | 10.808 | -3.36 | 718 | 7515.0 | 10.552 | -5.15 |
| 599 | 6231.2 | 10.953 | -1.56 | 659 | 6884.5 | 10.805 | -3.39 | 719 | 7525.6 | 10.547 | -5.18 |
| 600 | 6242.2 | 10.951 | -1.59 | 660 | 6895.3 | 10.801 | -3.42 | 720 | 7536.1 | 10.542 | -5.21 |

TABLE 7.5.5 *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 720 | 7536.1 | 10.542 | -5.21 | 780 | 8158.3 | 10.182 | -6.73 | 840 | 8756.3 | 9.742 | -7.83 |
| 721 | 7546.7 | 10.536 | -5.23 | 781 | 8168.5 | 10.175 | -6.75 | 841 | 8766.1 | 9.735 | -7.85 |
| 722 | 7557.2 | 10.531 | -5.26 | 782 | 8178.6 | 10.168 | -6.78 | 842 | 8775.8 | 9.727 | -7.86 |
| 723 | 7567.7 | 10.526 | -5.29 | 783 | 8188.8 | 10.161 | -6.80 | 843 | 8785.5 | 9.719 | -7.87 |
| 724 | 7578.2 | 10.521 | -5.32 | 784 | 8199.0 | 10.155 | -6.82 | 844 | 8795.2 | 9.711 | -7.89 |
| 725 | 7588.8 | 10.515 | -5.35 | 785 | 8209.1 | 10.148 | -6.84 | 845 | 8804.9 | 9.703 | -7.90 |
| 726 | 7599.3 | 10.510 | -5.37 | 786 | 8219.2 | 10.141 | -6.86 | 846 | 8814.6 | 9.695 | -7.91 |
| 727 | 7609.8 | 10.505 | -5.40 | 787 | 8229.4 | 10.134 | -6.88 | 847 | 8824.3 | 9.687 | -7.93 |
| 728 | 7620.3 | 10.499 | -5.43 | 788 | 8239.5 | 10.127 | -6.91 | 848 | 8834.0 | 9.679 | -7.94 |
| 729 | 7630.8 | 10.494 | -5.46 | 789 | 8249.6 | 10.120 | -6.93 | 849 | 8843.7 | 9.671 | -7.95 |
| 730 | 7641.3 | 10.488 | -5.48 | 790 | 8259.8 | 10.113 | -6.95 | 850 | 8853.4 | 9.663 | -7.97 |
| 731 | 7651.8 | 10.483 | -5.51 | 791 | 8269.9 | 10.106 | -6.97 | 851 | 8863.0 | 9.655 | -7.98 |
| 732 | 7662.2 | 10.477 | -5.54 | 792 | 8280.0 | 10.099 | -6.99 | 852 | 8872.7 | 9.647 | -7.99 |
| 733 | 7672.7 | 10.472 | -5.57 | 793 | 8290.1 | 10.092 | -7.01 | 853 | 8882.3 | 9.639 | -8.01 |
| 734 | 7683.2 | 10.466 | -5.59 | 794 | 8300.2 | 10.085 | -7.03 | 854 | 8892.0 | 9.631 | -8.02 |
| 735 | 7693.6 | 10.460 | -5.62 | 795 | 8310.2 | 10.078 | -7.05 | 855 | 8901.6 | 9.623 | -8.03 |
| 736 | 7704.1 | 10.455 | -5.65 | 796 | 8320.3 | 10.071 | -7.07 | 856 | 8911.2 | 9.615 | -8.04 |
| 737 | 7714.6 | 10.449 | -5.67 | 797 | 8330.4 | 10.064 | -7.09 | 857 | 8920.8 | 9.607 | -8.05 |
| 738 | 7725.0 | 10.443 | -5.70 | 798 | 8340.4 | 10.057 | -7.11 | 858 | 8930.4 | 9.599 | -8.07 |
| 739 | 7735.4 | 10.438 | -5.73 | 799 | 8350.5 | 10.050 | -7.13 | 859 | 8940.0 | 9.591 | -8.08 |
| 740 | 7745.9 | 10.432 | -5.75 | 800 | 8360.5 | 10.043 | -7.15 | 860 | 8949.6 | 9.583 | -8.09 |
| 741 | 7756.3 | 10.426 | -5.78 | 801 | 8370.6 | 10.036 | -7.17 | 861 | 8959.2 | 9.575 | -8.10 |
| 742 | 7766.7 | 10.420 | -5.81 | 802 | 8380.6 | 10.028 | -7.19 | 862 | 8968.7 | 9.567 | -8.11 |
| 743 | 7777.1 | 10.415 | -5.83 | 803 | 8390.6 | 10.021 | -7.21 | 863 | 8978.3 | 9.559 | -8.12 |
| 744 | 7787.6 | 10.409 | -5.86 | 804 | 8400.7 | 10.014 | -7.23 | 864 | 8987.9 | 9.551 | -8.14 |
| 745 | 7798.0 | 10.403 | -5.89 | 805 | 8410.7 | 10.007 | -7.25 | 865 | 8997.4 | 9.542 | -8.15 |
| 746 | 7808.4 | 10.397 | -5.91 | 806 | 8420.7 | 9.999 | -7.27 | 866 | 9006.9 | 9.534 | -8.16 |
| 747 | 7818.8 | 10.391 | -5.94 | 807 | 8430.7 | 9.992 | -7.29 | 867 | 9016.5 | 9.526 | -8.17 |
| 748 | 7829.1 | 10.385 | -5.96 | 808 | 8440.7 | 9.985 | -7.30 | 868 | 9026.0 | 9.518 | -8.18 |
| 749 | 7839.5 | 10.379 | -5.99 | 809 | 8450.6 | 9.978 | -7.32 | 869 | 9035.5 | 9.510 | -8.19 |
| 750 | 7849.9 | 10.373 | -6.01 | 810 | 8460.6 | 9.970 | -7.34 | 870 | 9045.0 | 9.502 | -8.20 |
| 751 | 7860.3 | 10.367 | -6.04 | 811 | 8470.6 | 9.963 | -7.36 | 871 | 9054.5 | 9.493 | -8.21 |
| 752 | 7870.6 | 10.361 | -6.07 | 812 | 8480.5 | 9.956 | -7.38 | 872 | 9064.0 | 9.485 | -8.22 |
| 753 | 7881.0 | 10.355 | -6.09 | 813 | 8490.5 | 9.948 | -7.40 | 873 | 9073.5 | 9.477 | -8.23 |
| 754 | 7891.3 | 10.349 | -6.12 | 814 | 8500.4 | 9.941 | -7.41 | 874 | 9083.0 | 9.469 | -8.24 |
| 755 | 7901.7 | 10.343 | -6.14 | 815 | 8510.4 | 9.933 | -7.43 | 875 | 9092.4 | 9.460 | -8.25 |
| 756 | 7912.0 | 10.337 | -6.17 | 816 | 8520.3 | 9.926 | -7.45 | 876 | 9101.9 | 9.452 | -8.26 |
| 757 | 7922.4 | 10.330 | -6.19 | 817 | 8530.2 | 9.918 | -7.47 | 877 | 9111.3 | 9.444 | -8.27 |
| 758 | 7932.7 | 10.324 | -6.22 | 818 | 8540.1 | 9.911 | -7.48 | 878 | 9120.8 | 9.436 | -8.28 |
| 759 | 7943.0 | 10.318 | -6.24 | 819 | 8550.0 | 9.903 | -7.50 | 879 | 9130.2 | 9.427 | -8.29 |
| 760 | 7953.3 | 10.312 | -6.27 | 820 | 8559.9 | 9.896 | -7.52 | 880 | 9139.6 | 9.419 | -8.30 |
| 761 | 7963.6 | 10.305 | -6.29 | 821 | 8569.8 | 9.888 | -7.54 | 881 | 9149.0 | 9.411 | -8.31 |
| 762 | 7973.9 | 10.299 | -6.31 | 822 | 8579.7 | 9.881 | -7.55 | 882 | 9158.4 | 9.403 | -8.32 |
| 763 | 7984.2 | 10.293 | -6.34 | 823 | 8589.6 | 9.873 | -7.57 | 883 | 9167.8 | 9.394 | -8.32 |
| 764 | 7994.5 | 10.286 | -6.36 | 824 | 8599.5 | 9.866 | -7.59 | 884 | 9177.2 | 9.386 | -8.33 |
| 765 | 8004.8 | 10.280 | -6.39 | 825 | 8609.3 | 9.858 | -7.60 | 885 | 9186.6 | 9.378 | -8.34 |
| 766 | 8015.1 | 10.274 | -6.41 | 826 | 8619.2 | 9.851 | -7.62 | 886 | 9196.0 | 9.369 | -8.35 |
| 767 | 8025.4 | 10.267 | -6.43 | 827 | 8629.0 | 9.843 | -7.63 | 887 | 9205.4 | 9.361 | -8.36 |
| 768 | 8035.6 | 10.261 | -6.46 | 828 | 8638.9 | 9.835 | -7.65 | 888 | 9214.7 | 9.352 | -8.37 |
| 769 | 8045.9 | 10.254 | -6.48 | 829 | 8648.7 | 9.828 | -7.67 | 889 | 9224.1 | 9.344 | -8.37 |
| 770 | 8056.1 | 10.248 | -6.50 | 830 | 8658.5 | 9.820 | -7.68 | 890 | 9233.4 | 9.336 | -8.38 |
| 771 | 8066.4 | 10.241 | -6.53 | 831 | 8668.3 | 9.812 | -7.70 | 891 | 9242.7 | 9.327 | -8.39 |
| 772 | 8076.6 | 10.235 | -6.55 | 832 | 8678.1 | 9.805 | -7.71 | 892 | 9252.1 | 9.319 | -8.40 |
| 773 | 8086.8 | 10.228 | -6.57 | 833 | 8687.9 | 9.797 | -7.73 | 893 | 9261.4 | 9.311 | -8.41 |
| 774 | 8097.1 | 10.222 | -6.60 | 834 | 8697.7 | 9.789 | -7.74 | 894 | 9270.7 | 9.302 | -8.41 |
| 775 | 8107.3 | 10.215 | -6.62 | 835 | 8707.5 | 9.781 | -7.76 | 895 | 9280.0 | 9.294 | -8.42 |
| 776 | 8117.5 | 10.208 | -6.64 | 836 | 8717.3 | 9.774 | -7.77 | 896 | 9289.3 | 9.285 | -8.43 |
| 777 | 8127.7 | 10.202 | -6.67 | 837 | 8727.1 | 9.766 | -7.79 | 897 | 9298.5 | 9.277 | -8.44 |
| 778 | 8137.9 | 10.195 | -6.69 | 838 | 8736.8 | 9.758 | -7.80 | 898 | 9307.8 | 9.268 | -8.44 |
| 779 | 8148.1 | 10.188 | -6.71 | 839 | 8746.6 | 9.750 | -7.82 | 899 | 9317.1 | 9.260 | -8.45 |
| 780 | 8158.3 | 10.182 | -6.73 | 840 | 8756.3 | 9.742 | -7.83 | 900 | 9326.3 | 9.252 | -8.46 |

TABLE 7.5.5 *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ | T °C | E µV | S µV/°C | dS/dT nV/°C$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 900 | 9326.3 | 9.252 | -8.46 | 960 | 9866.0 | 8.735 | -8.72 | 1020 | 10374.3 | 8.207 | -8.88 |
| 901 | 9335.6 | 9.243 | -8.46 | 961 | 9874.7 | 8.726 | -8.72 | 1021 | 10382.5 | 8.198 | -8.88 |
| 902 | 9344.8 | 9.235 | -8.47 | 962 | 9883.5 | 8.717 | -8.73 | 1022 | 10390.7 | 8.189 | -8.89 |
| 903 | 9354.1 | 9.226 | -8.48 | 963 | 9892.2 | 8.709 | -8.73 | 1023 | 10398.9 | 8.180 | -8.89 |
| 904 | 9363.3 | 9.218 | -8.48 | 964 | 9900.9 | 8.700 | -8.73 | 1024 | 10407.1 | 8.171 | -8.89 |
| 905 | 9372.5 | 9.209 | -8.49 | 965 | 9909.6 | 8.691 | -8.74 | 1025 | 10415.2 | 8.163 | -8.90 |
| 906 | 9381.7 | 9.201 | -8.50 | 966 | 9918.3 | 8.682 | -8.74 | 1026 | 10423.4 | 8.154 | -8.90 |
| 907 | 9390.9 | 9.192 | -8.50 | 967 | 9926.9 | 8.674 | -8.74 | 1027 | 10431.5 | 8.145 | -8.91 |
| 908 | 9400.1 | 9.184 | -8.51 | 968 | 9935.6 | 8.665 | -8.74 | 1028 | 10439.7 | 8.136 | -8.91 |
| 909 | 9409.3 | 9.175 | -8.51 | 969 | 9944.3 | 8.656 | -8.75 | 1029 | 10447.8 | 8.127 | -8.91 |
| 910 | 9418.4 | 9.167 | -8.52 | 970 | 9952.9 | 8.648 | -8.75 | 1030 | 10455.9 | 8.118 | -8.92 |
| 911 | 9427.6 | 9.158 | -8.53 | 971 | 9961.6 | 8.639 | -8.75 | 1031 | 10464.0 | 8.109 | -8.92 |
| 912 | 9436.7 | 9.150 | -8.53 | 972 | 9970.2 | 8.630 | -8.75 | 1032 | 10472.2 | 8.100 | -8.93 |
| 913 | 9445.9 | 9.141 | -8.54 | 973 | 9978.8 | 8.621 | -8.75 | 1033 | 10480.2 | 8.091 | -8.93 |
| 914 | 9455.0 | 9.132 | -8.54 | 974 | 9987.4 | 8.612 | -8.76 | 1034 | 10488.3 | 8.082 | -8.94 |
| 915 | 9464.2 | 9.124 | -8.55 | 975 | 9996.0 | 8.604 | -8.76 | 1035 | 10496.4 | 8.073 | -8.94 |
| 916 | 9473.3 | 9.115 | -8.55 | 976 | 10004.6 | 8.595 | -8.76 | 1036 | 10504.5 | 8.064 | -8.94 |
| 917 | 9482.4 | 9.107 | -8.56 | 977 | 10013.2 | 8.586 | -8.76 | 1037 | 10512.5 | 8.056 | -8.95 |
| 918 | 9491.5 | 9.098 | -8.57 | 978 | 10021.8 | 8.577 | -8.77 | 1038 | 10520.6 | 8.047 | -8.95 |
| 919 | 9500.6 | 9.090 | -8.57 | 979 | 10030.4 | 8.569 | -8.77 | 1039 | 10528.6 | 8.038 | -8.96 |
| 920 | 9509.7 | 9.081 | -8.58 | 980 | 10039.0 | 8.560 | -8.77 | 1040 | 10536.7 | 8.029 | -8.96 |
| 921 | 9518.7 | 9.073 | -8.58 | 981 | 10047.5 | 8.551 | -8.77 | 1041 | 10544.7 | 8.020 | -8.97 |
| 922 | 9527.8 | 9.064 | -8.59 | 982 | 10056.1 | 8.542 | -8.78 | 1042 | 10552.7 | 8.011 | -8.97 |
| 923 | 9536.9 | 9.055 | -8.59 | 983 | 10064.6 | 8.534 | -8.78 | 1043 | 10560.7 | 8.002 | -8.98 |
| 924 | 9545.9 | 9.047 | -8.59 | 984 | 10073.1 | 8.525 | -8.78 | 1044 | 10568.7 | 7.993 | -8.98 |
| 925 | 9555.0 | 9.038 | -8.60 | 985 | 10081.6 | 8.516 | -8.78 | 1045 | 10576.7 | 7.984 | -8.99 |
| 926 | 9564.0 | 9.030 | -8.60 | 986 | 10090.2 | 8.507 | -8.79 | 1046 | 10584.7 | 7.975 | -9.00 |
| 927 | 9573.0 | 9.021 | -8.61 | 987 | 10098.7 | 8.498 | -8.79 | 1047 | 10592.6 | 7.966 | -9.00 |
| 928 | 9582.0 | 9.012 | -8.61 | 988 | 10107.2 | 8.490 | -8.79 | 1048 | 10600.6 | 7.957 | -9.01 |
| 929 | 9591.0 | 9.004 | -8.62 | 989 | 10115.6 | 8.481 | -8.79 | 1049 | 10608.6 | 7.948 | -9.01 |
| 930 | 9600.0 | 8.995 | -8.62 | 990 | 10124.1 | 8.472 | -8.79 | 1050 | 10616.5 | 7.939 | -9.02 |
| 931 | 9609.0 | 8.987 | -8.63 | 991 | 10132.6 | 8.463 | -8.80 | 1051 | 10624.4 | 7.930 | -9.02 |
| 932 | 9618.0 | 8.978 | -8.63 | 992 | 10141.0 | 8.454 | -8.80 | 1052 | 10632.4 | 7.921 | -9.03 |
| 933 | 9627.0 | 8.969 | -8.63 | 993 | 10149.5 | 8.446 | -8.80 | 1053 | 10640.3 | 7.912 | -9.04 |
| 934 | 9636.0 | 8.961 | -8.64 | 994 | 10157.9 | 8.437 | -8.80 | 1054 | 10648.2 | 7.903 | -9.04 |
| 935 | 9644.9 | 8.952 | -8.64 | 995 | 10166.4 | 8.428 | -8.81 | 1055 | 10656.1 | 7.894 | -9.05 |
| 936 | 9653.9 | 8.943 | -8.65 | 996 | 10174.8 | 8.419 | -8.81 | 1056 | 10664.0 | 7.885 | -9.06 |
| 937 | 9662.8 | 8.935 | -8.65 | 997 | 10183.2 | 8.410 | -8.81 | 1057 | 10671.9 | 7.875 | -9.06 |
| 938 | 9671.7 | 8.926 | -8.65 | 998 | 10191.6 | 8.402 | -8.81 | 1058 | 10679.7 | 7.866 | -9.07 |
| 939 | 9680.7 | 8.917 | -8.66 | 999 | 10200.0 | 8.393 | -8.82 | 1059 | 10687.6 | 7.857 | -9.08 |
| 940 | 9689.6 | 8.909 | -8.66 | 1000 | 10208.4 | 8.384 | -8.82 | 1060 | 10695.4 | 7.848 | -9.08 |
| 941 | 9698.5 | 8.900 | -8.66 | 1001 | 10216.8 | 8.375 | -8.82 | 1061 | 10703.3 | 7.839 | -9.09 |
| 942 | 9707.4 | 8.891 | -8.67 | 1002 | 10225.1 | 8.366 | -8.83 | 1062 | 10711.1 | 7.830 | -9.10 |
| 943 | 9716.3 | 8.883 | -8.67 | 1003 | 10233.5 | 8.358 | -8.83 | 1063 | 10718.9 | 7.821 | -9.10 |
| 944 | 9725.1 | 8.874 | -8.67 | 1004 | 10241.9 | 8.349 | -8.83 | 1064 | 10726.8 | 7.812 | -9.11 |
| 945 | 9734.0 | 8.865 | -8.68 | 1005 | 10250.2 | 8.340 | -8.83 | 1065 | 10734.6 | 7.803 | -9.12 |
| 946 | 9742.9 | 8.857 | -8.68 | 1006 | 10258.5 | 8.331 | -8.84 | 1066 | 10742.4 | 7.794 | -9.13 |
| 947 | 9751.7 | 8.848 | -8.68 | 1007 | 10266.9 | 8.322 | -8.84 | 1067 | 10750.2 | 7.785 | -9.13 |
| 948 | 9760.6 | 8.839 | -8.69 | 1008 | 10275.2 | 8.313 | -8.84 | 1068 | 10757.9 | 7.775 | -9.14 |
| 949 | 9769.4 | 8.831 | -8.69 | 1009 | 10283.5 | 8.305 | -8.84 | 1069 | 10765.7 | 7.766 | -9.15 |
| 950 | 9778.2 | 8.822 | -8.69 | 1010 | 10291.8 | 8.296 | -8.85 | 1070 | 10773.5 | 7.757 | -9.16 |
| 951 | 9787.0 | 8.813 | -8.70 | 1011 | 10300.1 | 8.287 | -8.85 | 1071 | 10781.2 | 7.748 | -9.16 |
| 952 | 9795.8 | 8.805 | -8.70 | 1012 | 10308.4 | 8.278 | -8.85 | 1072 | 10789.0 | 7.739 | -9.17 |
| 953 | 9804.6 | 8.796 | -8.70 | 1013 | 10316.6 | 8.269 | -8.86 | 1073 | 10796.7 | 7.730 | -9.18 |
| 954 | 9813.4 | 8.787 | -8.71 | 1014 | 10324.9 | 8.260 | -8.86 | 1074 | 10804.4 | 7.720 | -9.19 |
| 955 | 9822.2 | 8.778 | -8.71 | 1015 | 10333.2 | 8.251 | -8.86 | 1075 | 10812.1 | 7.711 | -9.20 |
| 956 | 9831.0 | 8.770 | -8.71 | 1016 | 10341.4 | 8.243 | -8.87 | 1076 | 10819.8 | 7.702 | -9.21 |
| 957 | 9839.8 | 8.761 | -8.71 | 1017 | 10349.6 | 8.234 | -8.87 | 1077 | 10827.5 | 7.693 | -9.22 |
| 958 | 9848.5 | 8.752 | -8.72 | 1018 | 10357.9 | 8.225 | -8.87 | 1078 | 10835.2 | 7.684 | -9.22 |
| 959 | 9857.3 | 8.744 | -8.72 | 1019 | 10366.1 | 8.216 | -8.88 | 1079 | 10842.9 | 7.674 | -9.23 |
| 960 | 9866.0 | 8.735 | -8.72 | 1020 | 10374.3 | 8.207 | -8.88 | 1080 | 10850.6 | 7.665 | -9.24 |

TABLE 7.5.5 *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² | T °C | E μV | S μV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1080 | 10850.6 | 7.665 | -9.24 | 1140 | 11293.5 | 7.090 | -10.00 | 1200 | 11700.2 | 6.460 | -10.96 |
| 1081 | 10858.2 | 7.656 | -9.25 | 1141 | 11300.5 | 7.080 | -10.02 | 1201 | 11706.7 | 6.449 | -10.98 |
| 1082 | 10865.9 | 7.647 | -9.26 | 1142 | 11307.6 | 7.070 | -10.04 | 1202 | 11713.1 | 6.438 | -10.99 |
| 1083 | 10873.5 | 7.637 | -9.27 | 1143 | 11314.7 | 7.060 | -10.05 | 1203 | 11719.6 | 6.427 | -11.00 |
| 1084 | 10881.2 | 7.628 | -9.28 | 1144 | 11321.7 | 7.050 | -10.07 | 1204 | 11726.0 | 6.416 | -11.01 |
| 1085 | 10888.8 | 7.619 | -9.29 | 1145 | 11328.8 | 7.039 | -10.08 | 1205 | 11732.4 | 6.405 | -11.03 |
| 1086 | 10896.4 | 7.609 | -9.30 | 1146 | 11335.8 | 7.029 | -10.10 | 1206 | 11738.8 | 6.394 | -11.04 |
| 1087 | 10904.0 | 7.600 | -9.31 | 1147 | 11342.8 | 7.019 | -10.12 | 1207 | 11745.2 | 6.383 | -11.05 |
| 1088 | 10911.6 | 7.591 | -9.32 | 1148 | 11349.8 | 7.009 | -10.13 | 1208 | 11751.6 | 6.372 | -11.06 |
| 1089 | 10919.2 | 7.582 | -9.33 | 1149 | 11356.9 | 6.999 | -10.15 | 1209 | 11757.9 | 6.361 | -11.08 |
| 1090 | 10926.8 | 7.572 | -9.34 | 1150 | 11363.8 | 6.989 | -10.17 | 1210 | 11764.3 | 6.350 | -11.09 |
| 1091 | 10934.3 | 7.563 | -9.35 | 1151 | 11370.8 | 6.979 | -10.18 | 1211 | 11770.6 | 6.339 | -11.10 |
| 1092 | 10941.9 | 7.553 | -9.36 | 1152 | 11377.8 | 6.968 | -10.20 | 1212 | 11777.0 | 6.328 | -11.11 |
| 1093 | 10949.4 | 7.544 | -9.37 | 1153 | 11384.8 | 6.958 | -10.21 | 1213 | 11783.3 | 6.317 | -11.12 |
| 1094 | 10957.0 | 7.535 | -9.38 | 1154 | 11391.7 | 6.948 | -10.23 | 1214 | 11789.6 | 6.305 | -11.13 |
| 1095 | 10964.5 | 7.525 | -9.39 | 1155 | 11398.7 | 6.938 | -10.25 | 1215 | 11795.9 | 6.294 | -11.14 |
| 1096 | 10972.0 | 7.516 | -9.41 | 1156 | 11405.6 | 6.928 | -10.26 | 1216 | 11802.2 | 6.283 | -11.15 |
| 1097 | 10979.5 | 7.507 | -9.42 | 1157 | 11412.5 | 6.917 | -10.28 | 1217 | 11808.5 | 6.272 | -11.16 |
| 1098 | 10987.0 | 7.497 | -9.43 | 1158 | 11419.4 | 6.907 | -10.30 | 1218 | 11814.7 | 6.261 | -11.17 |
| 1099 | 10994.5 | 7.488 | -9.44 | 1159 | 11426.3 | 6.897 | -10.31 | 1219 | 11821.0 | 6.250 | -11.18 |
| 1100 | 11002.0 | 7.478 | -9.45 | 1160 | 11433.2 | 6.886 | -10.33 | 1220 | 11827.2 | 6.238 | -11.18 |
| 1101 | 11009.5 | 7.469 | -9.46 | 1161 | 11440.1 | 6.876 | -10.35 | 1221 | 11833.5 | 6.227 | -11.19 |
| 1102 | 11017.0 | 7.459 | -9.47 | 1162 | 11447.0 | 6.866 | -10.36 | 1222 | 11839.7 | 6.216 | -11.20 |
| 1103 | 11024.4 | 7.450 | -9.49 | 1163 | 11453.8 | 6.855 | -10.38 | 1223 | 11845.9 | 6.205 | -11.21 |
| 1104 | 11031.9 | 7.440 | -9.50 | 1164 | 11460.7 | 6.845 | -10.40 | 1224 | 11852.1 | 6.194 | -11.21 |
| 1105 | 11039.3 | 7.431 | -9.51 | 1165 | 11467.5 | 6.835 | -10.41 | 1225 | 11858.3 | 6.182 | -11.22 |
| 1106 | 11046.7 | 7.421 | -9.52 | 1166 | 11474.4 | 6.824 | -10.43 | 1226 | 11864.5 | 6.171 | -11.22 |
| 1107 | 11054.1 | 7.412 | -9.53 | 1167 | 11481.2 | 6.814 | -10.45 | 1227 | 11870.6 | 6.160 | -11.23 |
| 1108 | 11061.5 | 7.402 | -9.55 | 1168 | 11488.0 | 6.803 | -10.46 | 1228 | 11876.8 | 6.149 | -11.24 |
| 1109 | 11068.9 | 7.393 | -9.56 | 1169 | 11494.8 | 6.793 | -10.48 | 1229 | 11882.9 | 6.138 | -11.24 |
| 1110 | 11076.3 | 7.383 | -9.57 | 1170 | 11501.6 | 6.782 | -10.50 | 1230 | 11889.1 | 6.126 | -11.24 |
| 1111 | 11083.7 | 7.374 | -9.59 | 1171 | 11508.3 | 6.772 | -10.51 | 1231 | 11895.2 | 6.115 | -11.25 |
| 1112 | 11091.1 | 7.364 | -9.60 | 1172 | 11515.1 | 6.761 | -10.53 | 1232 | 11901.3 | 6.104 | -11.25 |
| 1113 | 11098.4 | 7.354 | -9.61 | 1173 | 11521.9 | 6.751 | -10.55 | 1233 | 11907.4 | 6.093 | -11.25 |
| 1114 | 11105.8 | 7.345 | -9.62 | 1174 | 11528.6 | 6.740 | -10.56 | 1234 | 11913.5 | 6.081 | -11.26 |
| 1115 | 11113.1 | 7.335 | -9.64 | 1175 | 11535.3 | 6.730 | -10.58 | 1235 | 11919.5 | 6.070 | -11.26 |
| 1116 | 11120.5 | 7.325 | -9.65 | 1176 | 11542.1 | 6.719 | -10.60 | 1236 | 11925.6 | 6.059 | -11.26 |
| 1117 | 11127.8 | 7.316 | -9.67 | 1177 | 11548.8 | 6.708 | -10.61 | 1237 | 11931.7 | 6.048 | -11.26 |
| 1118 | 11135.1 | 7.306 | -9.68 | 1178 | 11555.5 | 6.698 | -10.63 | 1238 | 11937.7 | 6.036 | -11.26 |
| 1119 | 11142.4 | 7.296 | -9.69 | 1179 | 11562.2 | 6.687 | -10.65 | 1239 | 11943.7 | 6.025 | -11.26 |
| 1120 | 11149.7 | 7.287 | -9.71 | 1180 | 11568.9 | 6.676 | -10.66 | 1240 | 11949.8 | 6.014 | -11.26 |
| 1121 | 11157.0 | 7.277 | -9.72 | 1181 | 11575.5 | 6.666 | -10.68 | 1241 | 11955.8 | 6.002 | -11.26 |
| 1122 | 11164.2 | 7.267 | -9.73 | 1182 | 11582.2 | 6.655 | -10.69 | 1242 | 11961.8 | 5.991 | -11.26 |
| 1123 | 11171.5 | 7.258 | -9.75 | 1183 | 11588.8 | 6.644 | -10.71 | 1243 | 11967.7 | 5.980 | -11.25 |
| 1124 | 11178.7 | 7.248 | -9.76 | 1184 | 11595.5 | 6.634 | -10.73 | 1244 | 11973.7 | 5.969 | -11.25 |
| 1125 | 11186.0 | 7.238 | -9.78 | 1185 | 11602.1 | 6.623 | -10.74 | 1245 | 11979.7 | 5.957 | -11.25 |
| 1126 | 11193.2 | 7.228 | -9.79 | 1186 | 11608.7 | 6.612 | -10.76 | 1246 | 11985.6 | 5.946 | -11.24 |
| 1127 | 11200.4 | 7.218 | -9.81 | 1187 | 11615.3 | 6.601 | -10.77 | 1247 | 11991.6 | 5.935 | -11.24 |
| 1128 | 11207.7 | 7.209 | -9.82 | 1188 | 11621.9 | 6.591 | -10.79 | 1248 | 11997.5 | 5.924 | -11.23 |
| 1129 | 11214.9 | 7.199 | -9.84 | 1189 | 11628.5 | 6.580 | -10.80 | 1249 | 12003.4 | 5.913 | -11.22 |
| 1130 | 11222.1 | 7.189 | -9.85 | 1190 | 11635.1 | 6.569 | -10.82 | 1250 | 12009.3 | 5.901 | -11.22 |
| 1131 | 11229.2 | 7.179 | -9.87 | 1191 | 11641.7 | 6.558 | -10.83 | 1251 | 12015.2 | 5.890 | -11.21 |
| 1132 | 11236.4 | 7.169 | -9.88 | 1192 | 11648.2 | 6.547 | -10.85 | 1252 | 12021.1 | 5.879 | -11.20 |
| 1133 | 11243.6 | 7.159 | -9.90 | 1193 | 11654.8 | 6.536 | -10.86 | 1253 | 12027.0 | 5.868 | -11.19 |
| 1134 | 11250.7 | 7.149 | -9.91 | 1194 | 11661.3 | 6.526 | -10.88 | 1254 | 12032.8 | 5.857 | -11.18 |
| 1135 | 11257.9 | 7.140 | -9.93 | 1195 | 11667.8 | 6.515 | -10.89 | 1255 | 12038.7 | 5.845 | -11.17 |
| 1136 | 11265.0 | 7.130 | -9.94 | 1196 | 11674.3 | 6.504 | -10.91 | 1256 | 12044.5 | 5.834 | -11.16 |
| 1137 | 11272.1 | 7.120 | -9.96 | 1197 | 11680.8 | 6.493 | -10.92 | 1257 | 12050.4 | 5.823 | -11.14 |
| 1138 | 11279.3 | 7.110 | -9.97 | 1198 | 11687.3 | 6.482 | -10.94 | 1258 | 12056.2 | 5.812 | -11.13 |
| 1139 | 11286.4 | 7.100 | -9.99 | 1199 | 11693.8 | 6.471 | -10.95 | 1259 | 12062.0 | 5.801 | -11.12 |
| 1140 | 11293.5 | 7.090 | -10.00 | 1200 | 11700.2 | 6.460 | -10.96 | 1260 | 12067.8 | 5.790 | -11.10 |

Table 7.5.5 *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltages,* E(T), *Seebeck coefficients,* S(T), *and first derivatives of the Seebeck coefficients,* dS/dT, *reference junctions at 0 °C. High temperature range, 0 to 1300 °C*—Continued

| T<br>°C | E<br>µV | S<br>µV/°C | dS/dT<br>nV/°C² | T<br>°C | E<br>µV | S<br>µV/°C | dS/dT<br>nV/°C² | T<br>°C | E<br>µV | S<br>µV/°C | dS/dT<br>nV/°C² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1260 | 12067.8 | 5.790 | | 1275 | 12153.4 | 5.625 | | 1290 | 12236.6 | 5.468 | |
| 1261 | 12073.6 | 5.779 | | 1276 | 12159.0 | 5.615 | | 1291 | 12242.0 | 5.458 | |
| 1262 | 12079.3 | 5.767 | | 1277 | 12164.6 | 5.604 | | 1292 | 12247.5 | 5.447 | |
| 1263 | 12085.1 | 5.756 | | 1278 | 12170.2 | 5.593 | | 1293 | 12252.9 | 5.437 | |
| 1264 | 12090.9 | 5.745 | | 1279 | 12175.8 | 5.582 | | 1294 | 12258.4 | 5.427 | |
| 1265 | 12096.6 | 5.734 | | 1280 | 12181.4 | 5.572 | | 1295 | 12263.8 | 5.417 | |
| 1266 | 12102.3 | 5.723 | | 1281 | 12186.9 | 5.561 | | 1296 | 12269.2 | 5.408 | |
| 1267 | 12108.0 | 5.712 | | 1282 | 12192.5 | 5.551 | | 1297 | 12274.6 | 5.398 | |
| 1268 | 12113.7 | 5.701 | | 1283 | 12198.1 | 5.540 | | 1298 | 12280.0 | 5.388 | |
| 1269 | 12119.4 | 5.690 | | 1284 | 12203.6 | 5.530 | | 1299 | 12285.4 | 5.378 | |
| 1270 | 12125.1 | 5.680 | | 1285 | 12209.1 | 5.519 | | 1300 | 12290.8 | 5.368 | |
| 1271 | 12130.8 | 5.669 | | 1286 | 12214.6 | 5.509 | | | | | |
| 1272 | 12136.5 | 5.658 | | 1287 | 12220.1 | 5.499 | | | | | |
| 1273 | 12142.1 | 5.647 | | 1288 | 12225.6 | 5.488 | | | | | |
| 1274 | 12147.8 | 5.636 | | 1289 | 12231.1 | 5.478 | | | | | |
| 1275 | 12153.4 | 5.625 | | 1290 | 12236.6 | 5.468 | | | | | |

Table 7.5.6 *Thermoelectric values at the fixed points for platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements in the cryogenic and extended temperature ranges.*

| Temperature range | Fixed point | Temp.[a]<br>°C | *E*<br>µV | *S*<br>µV/°C | *dS/dT*<br>nV/°C² |
|---|---|---|---|---|---|
| −200 to 0 °C | Nitrogen NBP | −195.806 | −2357.73 | 11.464 | 43.38 |
| | Oxygen NBP | −182.962 | −2207.48 | 11.894 | 25.18 |
| | Carbon Dioxide SP | −78.476 | −917.68 | 12.341 | −8.13 |
| | Mercury FP | −38.836 | −438.15 | 11.769 | −20.89 |
| | Ice point[b] | 0.000 | 0.00 | 10.714 | −33.61 |
| 0 to 400 °C | Ether TP | 26.87 | 277.50 | 10.036 | −15.70 |
| | Water BP | 100.000 | 993.67 | 9.749 | 1.64 |
| | Benzoic Acid TP | 122.37 | 1212.24 | 9.794 | 2.20 |
| | Indium FP | 156.634 | 1549.16 | 9.873 | 2.42 |
| | Tin FP | 231.968 | 2300.97 | 10.108 | 4.08 |
| | Bismuth FP | 271.442 | 2703.37 | 10.285 | 4.73 |
| | Cadmium FP | 321.108 | 3219.79 | 10.502 | 3.60 |
| | Lead FP | 327.502 | 3287.01 | 10.524 | 3.31 |
| | Mercury BP | 356.66 | 3595.07 | 10.600 | 1.99 |

[a] Values of temperature are from the published text of the IPTS-68 amended edition of 1975 [CIPM, 1976].
[b] Junction point of different functions.

Table 7.5.7 *Thermoelectric values at the fixed points for platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements in the high temperature range.*

| Temperature range | Fixed point | Temp.[a] °C | E μV | S μV/°C | dS/dT nV/°C² |
|---|---|---|---|---|---|
| 0 to 1300 °C | Ice Point | 0.000 | 0.00 | 10.477 | −21.63 |
| | Ether TP | 26.87 | 274.90 | 10.025 | −12.49 |
| | Water BP | 100.000 | 989.43 | 9.673 | 0.55 |
| | Benzoic Acid TP | 122.37 | 1206.10 | 9.706 | 2.31 |
| | Indium FP | 156.634 | 1540.38 | 9.815 | 3.86 |
| | Tin FP | 231.968 | 2292.00 | 10.147 | 4.55 |
| | Bismuth FP | 271.442 | 2696.04 | 10.322 | 4.28 |
| | Cadmium FP | 321.108 | 3213.78 | 10.522 | 3.75 |
| | Lead FP | 327.502 | 3281.13 | 10.546 | 3.68 |
| | Mercury BP | 356.66 | 3590.14 | 10.648 | 3.33 |
| | Zinc FP | 419.580 | 4266.16 | 10.831 | 2.47 |
| | Sulphur BP | 444.674 | 4538.70 | 10.888 | 2.06 |
| | Cu–Al FP | 548.26 | 5674.10 | 10.996 | −0.15 |
| | Antimony FP | 630.755 | 6578.09 | 10.888 | −2.52 |
| | Aluminum FP | 660.46 | 6900.27 | 10.800 | −3.43 |
| | Silver FP | 961.93 | 9882.85 | 8.718 | −8.73 |
| | Gold FP | 1064.43 | 10730.12 | 7.808 | −9.11 |
| | Copper FP | 1084.88 | 10887.88 | 7.620 | −9.29 |

[a] Values of temperature are from the published text of the I PTS–68 amended edition of 1975 [CIPM, 1976].

Table 7.5.8 *Estimated maximum errors that occur when using reduced-bit arithmetic for the power series expansion for the thermoelectric voltage of platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements*

| Temperature range | Degree | Estimated maximum error in microvolts | | | | |
|---|---|---|---|---|---|---|
| | | 12 Bit | 16 Bit | 24 Bit | 27 Bit | 36 Bit |
| −200 to 0 °C | 8 | 0.7 | 0.09 | <0.01 | <0.01 | <0.01 |
| 0 to 200 °C | 7 | 1.0 | 0.04 | <0.01 | <0.01 | <0.01 |
| 200 to 400 °C | 7 | [a] | 0.6 | <0.01 | <0.01 | <0.01 |

[a] A high order polynomial with a low-bit machine causes extreme error.

Table 7.5.9 *Estimated maximum errors that occur when using reduced-bit arithmetic for the power series expansion for the thermoelectric voltage of platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements.*

| Temperature range | Degree | Estimated maximum error in microvolts | | | | |
|---|---|---|---|---|---|---|
| | | 12 Bit | 16 Bit | 24 Bit | 27 Bit | 36 Bit |
| 0 to 200 °C | 9 | 0.7 | 0.02 | <0.01 | <0.01 | <0.01 |
| 200 to 400 °C | 9 | 0.8 | 0.06 | <0.01 | <0.01 | <0.01 |
| 400 to 600 °C | 9 | 5 | 0.2 | <0.01 | <0.01 | <0.01 |
| 600 to 800 °C | 9 | [a] | 0.2 | 0.03 | <0.01 | <0.01 |
| 800 to 1000 °C | 9 | [a] | 1 | 0.1 | <0.01 | <0.01 |
| 1000 to 1200 °C | 9 | [a] | 9 | 0.4 | 0.02 | <0.01 |
| 1200 to 1300 °C | 9 | [a] | [a] | 0.6 | 0.03 | <0.01 |

[a] A high order polynomial with a low-bit machine causes extreme error.

## 8. Acknowledgments

The authors wish to acknowledge the support afforded them by the U.S. and Australian Governments during the joint NBS–MRL research project on Nicrosil/Nisil which was conducted under the terms of an Arrangement under the U.S./Australia Agreement for Scientific and Technical Co-operation (1968).

They also desire to thank R.P. Hudson, H.H. Plumb and J.F. Schooley of the Heat Division of NBS, Gaithersburg, and R.H. Kropschot of the Cryogenics Division of NBS, Boulder, for their helpful and generous support throughout the joint project. One of them (NAB) also wishes to acknowledge the consistent support, advice, and encouragement given him by L.E. Samuels, Superintendent, Metallurgy Division, MRL, since the inception of research on Nicrosil/Nisil.

The authors would also like to thank the following:

(i) J.A. Wise and W.S. Hurst of Heat Division NBS for advice in thermometric and instrumental measurements,

(ii) J.G. Hust and L.L. Sparks of Cryogenics Division NBS for their advice and assistance in carrying out the cryogenic experiments,

(iii) J.M. Tucker and others of the NOAA Computer Services Division, Boulder, Colorado, for assistance, (particularly de-bugging) with the many computer programs and print-outs, and

(iv) T.P. Royston and W.A. Willard of Metallurgy Division NBS for their assistance with the heat treatment of test wires and with the preparation of specimens for strain-anneal experiments.

One of them (NAB) wishes to thank J.A. Coleman of Metallurgy Division, MRL, for invaluable assistance during the research work in Australia.

The complex auxiliary tables and much of the text were typed most efficiently by Mildred Birchfield of NBS and Rene Gibson of MRL.

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# 10. Appendixes

## Appendix A. Supplementary Functional Approximations for Nicrosil versus Nisil Thermocouples

For many applications, such as those using on-line controllers, minicomputers, desk calculators, etc., functional approximations are valuable for saving computing time or memory storage. A selection of approximations for different temperature ranges are included in this appendix. Sets of overlapping approximations are also tabulated. As before, the values for *AWG 28* and *AWG 14* wires are tabulated separately.

For the overlapping approximation equations, the approximations have been calculated to fit the primary data with an error spread that is less than 0.05 percent of the absolute temperature. If a data point is more than about 3 °C from the extreme value of any range, then the error is less than 0.02 percent. The temperature ranges for each fit overlap each other by about 10 percent of the absolute temperature. The temperature ranges have been made as wide as possible consistent with the above criteria.

It is difficult to make good low order approximations to the curves where the sensitivity, $dE/dT$, is small or varying rapidly. Therefore quadratic approximations are not given for two of the selected temperature ranges below 0 °C.

Table A1. AWG 28 *Nicrosil versus Nisil thermocouples—quadratic, cubic, and quartic approximations to the temperature data as a function of voltage in selected temperature ranges. The expansion is of the form* $T=A_1E+A_2E^2+A_3E^3+A_4E^4$, *where* T *is in degrees Celsius and* E *is in microvolts.*

| Temperature range (°C) | $A_1$ |  | $A_2$ |  | $A_3$ |  | $A_4$ |  | Error range (°C) |
|---|---|---|---|---|---|---|---|---|---|
|  | Argument | Exp. | Argument | Exp. | Argument | Exp. | Argument | Exp. |  |
| I. Quadratic equations |  |  |  |  |  |  |  |  |  |
| −200 to 0 | 3.143455 | −2 | −4.375508 | −6 | -- | -- | -- | -- | −5 to 4 |
| 0 to 50 | 3.833763 | −2 | −8.255147 | −7 | -- | -- | -- | -- | <0.01 |
| 0 to 400 | 3.645264 | −2 | −4.480891 | −7 | -- | -- | -- | -- | −2 to 3 |
| II. Cubic equations |  |  |  |  |  |  |  |  |  |
| −200 to 0 | 4.262622 | −2 | 4.276051 | −6 | 1.520918 | −9 | -- | -- | −1.5 to 1.3 |
| −200 to 400 | 4.074915 | −2 | −1.503463 | −6 | 5.816619 | −11 | -- | -- | −10 to 8 |
| 0 to 50 | 3.826460 | −2 | −6.512970 | −7 | −9.331708 | −11 | -- | -- | <0.01 |
| 0 to 400 | 3.812049 | −2 | −8.711717 | −7 | 2.396423 | −11 | -- | -- | −0.3 to 0.3 |
| III. Quartic equations |  |  |  |  |  |  |  |  |  |
| −200 to 0 | 3.523634 | −2 | −6.080743 | −6 | −2.748231 | −9 | −5.396201 | −13 | −0.4 to 0.7 |
| −200 to 400 | 3.920032 | −2 | −1.650547 | −6 | 1.469131 | −10 | −5.394067 | −15 | −7 to 6 |
| 0 to 50 | 3.823891 | −2 | −5.403608 | −7 | −2.328326 | −10 | 5.340190 | −14 | <0.01 |
| 0 to 400 | 3.857711 | −2 | −1.080822 | −6 | 5.182122 | −11 | −1.122986 | −15 | −0.06 to 0.05 |

TABLE A2. AWG 28 *Nicrosil versus Nisil thermocouples—quadratic, cubic, and quartic approximations to the voltage data as a function of temperature for variable reference junctiion corrections. The expansion is of the form* $E=A_1T+A_2T^2+A_3T^3+A_4T^4$,*where* T *is in degrees Celsius and* E *is in microvolts.*

| Temperature range (°C) | $A_1$ Argument | Exp. | $A_2$ Argument | Exp. | $A_3$ Argument | Exp. | $A_4$ Argument | Exp. | Error range (μV) |
|---|---|---|---|---|---|---|---|---|---|
| I. Quadratic equation<br>0 to 50 | 2.606406 | 1 | 1.589325 | −2 | -- | -- | -- | -- | −0.3 to 0.4 |
| II. Cubic Equation<br>0 to 50 | 2.613796 | 1 | 1.116942 | −2 | 6.789227 | −5 | -- | -- | −0.03 to 0.04 |
| III. Quartic equation<br>0 to 50 | 2.615230 | 1 | 9.510055 | −3 | 1.238615 | −4 | −5.749568 | −7 | <0.01 |

TABLE A3. AWG 28 *Nicrosil versus Nisil thermocouples—overlapping cubic approximations to the temperature data as a function of voltage. The expansion is of the form* $T=A_0+A_1E+A_2E^2+A_3E^3$, *where* T *is in kelvin and* E *is in microvolts. Over most of each range the temperature error is less than 0.02 percent.*

Range from 70 to 110 K (−203 to −163 °C)
The coefficients (argument and exponent) are

| | |
|---|---|
| 1.72602467 +3 | Constant |
| 1.26848043 +0 | *E* |
| 3.49442124 −4 | $E^2$ |
| 3.39220068 −8 | $E^3$ |

Range from 98 to 162 K (−175 to −111 °C)
The coefficients are

| | |
|---|---|
| 3.75946549 +2 | Constant |
| 1.48775894 −1 | *E* |
| 3.98017292 −5 | $E^2$ |
| 5.37110795 −9 | $E^3$ |

Range from 146 to 246 K (−127 to −27 °C)
The coefficients are

| | |
|---|---|
| 2.74210569 +2 | Constant |
| 4.08919110 −2 | *E* |
| 1.54189597 −6 | $E^2$ |
| 8.32439718 −10 | $E^3$ |

Range from 222 to 394 K (−51 to 121°C)
The coefficients are

| | |
|---|---|
| 2.73192235 +2 | Constant |
| 3.83120481 −2 | *E* |
| −8.54180147 −7 | $E^2$ |
| 2.60298671 −12 | $E^3$ |

Range from 358 to 673 K (85 to 400°C)
The coefficients are

| | |
|---|---|
| 2.75649120 +2 | Constant |
| 3.68894533 −2 | *E* |
| −6.99142610 −7 | $E^2$ |
| 1.67755019 −11 | $E^3$ |

TABLE A4. AWG 28 *Nicrosil versus Nisil thermocouples—overlapping quartic approximations to the temperature data as a function of voltage. The expansion is of the form* $T=A_0+A_1E+A_2E^2+A_3E^3+A_4E^4$, *where* T *is in kelvins and* E *is in microvolts. Over most of each range, the temperature error is less than 0.02 percent.*

Range from 70 to 86 K (−203 to −187 °C)
The coefficients (argument and exponent) are

| | |
|---|---|
| −2.33597900 +4 | Constant |
| −2.47706024 +1 | *E* |
| −9.78542830 −3 | $E^2$ |
| −1.71909958 −6 | $E^3$ |
| −1.13695184 −10 | $E^4$ |

Range from 78 to 154 K (−195 to −119 °C)
The coefficients are

| | |
|---|---|
| −3.30022140 +2 | Constant |
| −7.38038652 −1 | *E* |
| −3.76381509 −4 | $E^2$ |
| −8.11117201 −8 | $E^3$ |
| −6.71418860 −12 | $E^4$ |

Range from 138 to 290 K (−135 to 17 °C)
The coefficients are

| | |
|---|---|
| 2.73177142 +2 | Constant |
| 3.82354887 −2 | *E* |
| −8.77780173 −7 | $E^2$ |
| −1.00379382 −10 | $E^3$ |
| −1.29079177 −13 | $E^4$ |

Range from 262 to 673 K (−11 to 400 °C)
The coefficients are

| | |
|---|---|
| 2.73158004 +2 | Constant |
| 3.85720309 −2 | *E* |
| −1.08073298 −6 | $E^2$ |
| 5.19720128 −11 | $E^3$ |
| −1.13424988 −15 | $E^4$ |

TABLE A5. AWG 14 *Nicrosil versus Nisil thermocouples—quadratic, cubic, and quartic approximations to the temperature data as a function of voltage in selected temperature ranges. The expansion is of the form* $T=A_1E+A_2E^2+A_3E^3+A_4E^4$, *where* T *is in degrees Celsius and* E *is in microvolts.*

| Temperature range (°C) | $A_1$ |  | $A_2$ |  | $A_3$ |  | $A_4$ |  | Error range (°C) |
|---|---|---|---|---|---|---|---|---|---|
|  | Argument | Exp. | Argument | Exp. | Argument | Exp. | Argument | Exp. |  |
| I. Quadratic equation |  |  |  |  |  |  |  |  |  |
| 0 to 50 | 3.860831 | −2 | −9.570146 | −7 | -- | -- | -- | -- | <0.01 |
| 0 to 400 | 3.656723 | −2 | −4.566896 | −7 | -- | -- | -- | -- | −1.7 to 2.5 |
| 450 to 1000 | 3.141413 | −2 | −1.105032 | −7 | -- | -- | -- | -- | −5 to 8 |
| 850 to 1000 | 2.873831 | −2 | −3.054420 | −8 | -- | -- | -- | -- | −3 to 4 |
| 1000 to 1300 | 2.820624 | −2 | −1.847854 | −8 | -- | -- | -- | -- | −1 to 2 |
| II. Cubic equation |  |  |  |  |  |  |  |  |  |
| 0 to 50 | 3.861843 | −2 | −9.812299 | −7 | 1.300932 | −11 | -- | -- | <0.01 |
| 0 to 400 | 3.825962 | −2 | −8.862736 | −7 | 2.434387 | −11 | -- | -- | −0.3 to 0.3 |
| 450 to 1000 | 3.445072 | −2 | −3.482337 | −7 | 4.397892 | −12 | -- | -- | −0.6 to 1.0 |
| 850 to 1000 | 3.240401 | −2 | −2.192067 | −7 | 2.382986 | −12 | -- | -- | −0.1 to 0.1 |
| 1000 to 1300 | 3.226729 | −2 | −2.126340 | −7 | 2.304693 | −12 | -- | -- | −0.01 to 0.01 |
| III. Quartic equation |  |  |  |  |  |  |  |  |  |
| 0 to 50 | 3.861153 | −2 | −9.513633 | −7 | −2.466762 | −11 | 1.446443 | −14 | <0.01 |
| 0 to 400 | 3.868881 | −2 | −1.083431 | −6 | 5.055108 | −11 | −1.056823 | −15 | −0.02 to 0.02 |
| 450 to 1000 | 3.593932 | −2 | −5.313789 | −7 | 1.158359 | −11 | −9.053322 | −17 | −0.1 to 0.1 |
| 850 to 1000 | 3.308804 | −2 | −2.726068 | −7 | 3.756099 | −12 | −1.163691 | −17 | −0.05 to 0.04 |
| 1000 to 1300 | 3.184042 | −2 | −1.819054 | −7 | 1.570465 | −12 | 5.823682 | −18 | <0.01 |

TABLE A6. AWG 14 *Nicrosil versus Nisil thermocouples—quadratic, cubic, and quartic approximations to the voltage data as a function of temperature for variable reference junction corrections. The expansion is of the form* $E=A_1T+A_2T^2+A_3T^3+A_4T^4$, *where* T *is in degrees Celsius and* E *is in microvolts.*

| Temperature range (°C) | $A_1$ |  | $A_2$ |  | $A_3$ |  | $A_4$ |  | Error range (μV) |
|---|---|---|---|---|---|---|---|---|---|
|  | Argument | Exp. | Argument | Exp. | Argument | Exp. | Argument | Exp. |  |
| I. Quadratic equation |  |  |  |  |  |  |  |  |  |
| 0 to 50 | 2.587482 | 1 | 1.826214 | −2 | -- | -- | -- | -- | −0.09 to 0.1 |
| II. Cubic equation |  |  |  |  |  |  |  |  |  |
| 0 to 50 | 2.589489 | 1 | 1.697919 | −2 | 1.843898 | −5 | -- | -- | −0.04 to 0.06 |
| III. Quartic equation |  |  |  |  |  |  |  |  |  |
| 0 to 50 | 2.589943 | 1 | 1.645332 | −2 | 3.617621 | −5 | −1.822097 | −7 | −0.03 to 0.05 |

TABLE A7. AWG 14 *Nicrosil versus Nisil thermocouples—overlapping quadratic approximations to the temperature data as a function of voltage. The expansion is of the form* $T=A_0+A_1E+A_2E^2$, *where* T *is in kelvins and* E *is in microvolts. Over most of each range the temperature error is less than 0.02 percent.*

Range from 273 to 394 K (0 to 91 °C)
The coefficients (argument and exponent) are

| | |
|---|---|
| 2.73195897 +2 | Constant |
| 3.84234905 −2 | $E$ |
| −8.56002843 −7 | $E^2$ |

Range from 358 to 510 K (85 to 237 °C)
The coefficients are

| | |
|---|---|
| 2.76356401 +2 | Constant |
| 3.63148831 −2 | $E$ |
| −5.09733325 −7 | $E^2$ |

Range from 462 to 658 K (189 to 385 °C)
The coefficients are

| | |
|---|---|
| 2.87166063 +2 | Constant |
| 3.29364427 −2 | $E$ |
| −2.47604989 −7 | $E^2$ |

Range from 598 to 886 K (325 to 613 °C)
The coefficients are

| | |
|---|---|
| 3.06929499 +2 | Constant |
| 2.94999352 −2 | $E$ |
| −9.86158543 −8 | $E^2$ |

Range from 802 to 1182 K (529 to 909 °C)
The coefficients are

| | |
|---|---|
| 3.42522337 +2 | Constant |
| 2.58934339 −2 | $E$ |
| −7.44508115 −9 | $E^2$ |

Range from 1074 to 1573 K (801 to 1300 °C)
The coefficients are

| | |
|---|---|
| 4.02432540 +2 | Constant |
| 2.20306185 −2 | $E$ |
| 5.47686632 −8 | $E^2$ |

TABLE A8. AWG 14 *Nicrosil versus Nisil thermocouples—overlapping cubic approximations to the temperature data as a function of voltage. The expansion is of the form* $T=A_0+A_1E+A_2E^2+A_3E^3$, *where* T *is in kelvins and* E *is in microvolts. Over most of each range the temperature error is less than 0.02 percent.*

Range from 273 to 474 K (0 to 201 °C)
The coefficients (argument and exponent) are

| | |
|---|---|
| 2.73147117 +2 | Constant |
| 3.86594460 −2 | $E$ |
| −1.04623626 −6 | $E^2$ |
| 3.88528636 −11 | $E^3$ |

Range from 430 to 802 K (157 to 529 °C)
The coefficients are

| | |
|---|---|
| 2.80700025 +2 | Constant |
| 3.51607022 −2 | $E$ |
| −4.97641434 −7 | $E^2$ |
| 9.20465614 −12 | $E^3$ |

Range from 726 to 1573 K (453 to 1300 °C)
The coefficients are

| | |
|---|---|
| 3.14791658 +2 | Constant |
| 2.92239025 −2 | $E$ |
| −1.39229018 −7 | $E^2$ |
| 1.71985311 −12 | $E^3$ |

TABLE A9. AWG 14 *Nicrosil versus Nisil thermocouples—overlapping quartic approximations to the temperature data as a function of voltage. The expansion is of the form* $T=A_0+A_1E+A_2E^2+A_3E^3+A_4E^4$, *where* T *is in kelvins and* E *is in microvolts. Over most of each range the temperature error is less than 0.02 percent.*

Range from 273 to 638 K (0 to 365 °C)
The coefficients (argument and exponent) are

| | |
|---|---|
| 2.73134350 +2 | Constant |
| 3.87205729 −2 | $E$ |
| −1.09710024 −6 | $E^2$ |
| 5.25218480 −11 | $E^3$ |
| −1.14636136 −15 | $E^4$ |

Range from 578 to 1573 K (305 to 1300 °C)
The coefficients are

| | |
|---|---|
| 2.94724845 +2 | Constant |
| 3.21321378 −2 | $E$ |
| −2.89538382 −2 | $E^2$ |
| 5.02114728 −12 | $E^3$ |
| −2.61445196 −17 | $E^4$ |

## Appendix B. Supplementary Reference Tables for Nicrosil versus Nisil Thermocouples: Temperature (°C) and (°F) as a Function of Thermoelectric Voltage

The full precision coefficients given in the main text are used to generate the voltage as a function of temperature data given in section 7. The tables in this appendix give the reverse dependence—temperature as a function of voltage. Table B1 presents the data in degrees Celsius for *AWG 28* wire; and table B2, for *AWG 14* wire. Table B3 presents the data in degrees Fahrenheit for *AWG 28* wire; and table B4, for *AWG 14* wire.

The temperature as a function of voltage data given in the following tables were obtained by iteration in the primary equations for voltage as a function of temperature.

TABLE B1. AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C.*

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -4.30 | -245.86 | -248.90 | -252.43 | -256.79 | -263.10 |  |  |  |  |  |  | -4.30 |
| -4.20 | -225.63 | -227.23 | -228.88 | -230.61 | -232.41 | -234.30 | -236.30 | -238.42 | -240.69 | -243.16 | -245.86 | -4.20 |
| -4.10 | -212.02 | -213.24 | -214.48 | -215.75 | -217.05 | -218.39 | -219.75 | -221.16 | -222.60 | -224.09 | -225.63 | -4.10 |
| -4.00 | -200.98 | -202.00 | -203.05 | -204.10 | -205.18 | -206.27 | -207.38 | -208.51 | -209.66 | -210.83 | -212.02 | -4.00 |
| -3.90 | -191.40 | -192.31 | -193.22 | -194.15 | -195.09 | -196.04 | -197.00 | -197.98 | -198.96 | -199.96 | -200.98 | -3.90 |
| -3.80 | -182.79 | -183.62 | -184.45 | -185.29 | -186.14 | -186.99 | -187.86 | -188.73 | -189.61 | -190.50 | -191.40 | -3.80 |
| -3.70 | -174.89 | -175.65 | -176.42 | -177.20 | -177.98 | -178.76 | -179.56 | -180.36 | -181.16 | -181.97 | -182.79 | -3.70 |
| -3.60 | -167.53 | -168.25 | -168.97 | -169.69 | -170.42 | -171.15 | -171.89 | -172.63 | -173.38 | -174.13 | -174.89 | -3.60 |
| -3.50 | -160.61 | -161.28 | -161.96 | -162.65 | -163.33 | -164.02 | -164.72 | -165.41 | -166.12 | -166.82 | -167.53 | -3.50 |
| -3.40 | -154.04 | -154.68 | -155.33 | -155.97 | -156.63 | -157.28 | -157.94 | -158.60 | -159.27 | -159.94 | -160.61 | -3.40 |
| -3.30 | -147.76 | -148.38 | -149.00 | -149.62 | -150.24 | -150.87 | -151.49 | -152.13 | -152.76 | -153.40 | -154.04 | -3.30 |
| -3.20 | -141.74 | -142.33 | -142.93 | -143.52 | -144.12 | -144.72 | -145.33 | -145.93 | -146.54 | -147.15 | -147.76 | -3.20 |
| -3.10 | -135.94 | -136.51 | -137.09 | -137.66 | -138.24 | -138.82 | -139.40 | -139.98 | -140.57 | -141.15 | -141.74 | -3.10 |
| -3.00 | -130.33 | -130.89 | -131.44 | -132.00 | -132.56 | -133.12 | -133.68 | -134.24 | -134.81 | -135.37 | -135.94 | -3.00 |
| -2.90 | -124.90 | -125.43 | -125.97 | -126.51 | -127.05 | -127.60 | -128.14 | -128.69 | -129.23 | -129.78 | -130.33 | -2.90 |
| -2.80 | -119.61 | -120.13 | -120.66 | -121.18 | -121.71 | -122.23 | -122.76 | -123.30 | -123.83 | -124.36 | -124.90 | -2.80 |
| -2.70 | -114.46 | -114.97 | -115.48 | -115.99 | -116.50 | -117.02 | -117.53 | -118.05 | -118.57 | -119.09 | -119.61 | -2.70 |
| -2.60 | -109.43 | -109.92 | -110.42 | -110.92 | -111.43 | -111.93 | -112.43 | -112.94 | -113.44 | -113.95 | -114.46 | -2.60 |
| -2.50 | -104.51 | -104.99 | -105.48 | -105.97 | -106.46 | -106.95 | -107.45 | -107.94 | -108.43 | -108.93 | -109.43 | -2.50 |
| -2.40 | -99.69 | -100.16 | -100.64 | -101.12 | -101.60 | -102.08 | -102.57 | -103.05 | -103.53 | -104.02 | -104.51 | -2.40 |
| -2.30 | -94.96 | -95.43 | -95.90 | -96.37 | -96.84 | -97.31 | -97.78 | -98.26 | -98.73 | -99.21 | -99.69 | -2.30 |
| -2.20 | -90.31 | -90.77 | -91.24 | -91.70 | -92.16 | -92.63 | -93.09 | -93.56 | -94.02 | -94.49 | -94.96 | -2.20 |
| -2.10 | -85.74 | -86.20 | -86.65 | -87.11 | -87.56 | -88.02 | -88.48 | -88.93 | -89.39 | -89.85 | -90.31 | -2.10 |
| -2.00 | -81.24 | -81.69 | -82.14 | -82.59 | -83.04 | -83.49 | -83.94 | -84.39 | -84.84 | -85.29 | -85.74 | -2.00 |
| -1.90 | -76.81 | -77.25 | -77.69 | -78.13 | -78.58 | -79.02 | -79.46 | -79.91 | -80.35 | -80.80 | -81.24 | -1.90 |
| -1.80 | -72.43 | -72.87 | -73.30 | -73.74 | -74.18 | -74.61 | -75.05 | -75.49 | -75.93 | -76.37 | -76.81 | -1.80 |
| -1.70 | -68.11 | -68.54 | -68.97 | -69.40 | -69.84 | -70.27 | -70.70 | -71.13 | -71.57 | -72.00 | -72.43 | -1.70 |
| -1.60 | -63.84 | -64.27 | -64.69 | -65.12 | -65.55 | -65.97 | -66.40 | -66.83 | -67.26 | -67.68 | -68.11 | -1.60 |
| -1.50 | -59.62 | -60.04 | -60.46 | -60.88 | -61.30 | -61.73 | -62.15 | -62.57 | -63.00 | -63.42 | -63.84 | -1.50 |
| -1.40 | -55.44 | -55.86 | -56.27 | -56.69 | -57.11 | -57.53 | -57.94 | -58.36 | -58.78 | -59.20 | -59.62 | -1.40 |
| -1.30 | -51.30 | -51.71 | -52.13 | -52.54 | -52.95 | -53.37 | -53.78 | -54.19 | -54.61 | -55.03 | -55.44 | -1.30 |
| -1.20 | -47.20 | -47.61 | -48.02 | -48.42 | -48.83 | -49.24 | -49.66 | -50.07 | -50.48 | -50.89 | -51.30 | -1.20 |
| -1.10 | -43.13 | -43.53 | -43.94 | -44.35 | -44.75 | -45.16 | -45.57 | -45.97 | -46.38 | -46.79 | -47.20 | -1.10 |
| -1.00 | -39.09 | -39.49 | -39.90 | -40.30 | -40.70 | -41.11 | -41.51 | -41.91 | -42.32 | -42.72 | -43.13 | -1.00 |
| -0.90 | -35.08 | -35.48 | -35.88 | -36.28 | -36.68 | -37.08 | -37.48 | -37.89 | -38.29 | -38.69 | -39.09 | -0.90 |
| -0.80 | -31.10 | -31.50 | -31.90 | -32.29 | -32.69 | -33.09 | -33.49 | -33.89 | -34.28 | -34.68 | -35.08 | -0.80 |
| -0.70 | -27.14 | -27.54 | -27.93 | -28.33 | -28.72 | -29.12 | -29.52 | -29.91 | -30.31 | -30.70 | -31.10 | -0.70 |
| -0.60 | -23.21 | -23.60 | -24.00 | -24.39 | -24.78 | -25.18 | -25.57 | -25.96 | -26.36 | -26.75 | -27.14 | -0.60 |
| -0.50 | -19.30 | -19.69 | -20.08 | -20.47 | -20.86 | -21.25 | -21.64 | -22.04 | -22.43 | -22.82 | -23.21 | -0.50 |
| -0.40 | -15.41 | -15.80 | -16.18 | -16.57 | -16.96 | -17.35 | -17.74 | -18.13 | -18.52 | -18.91 | -19.30 | -0.40 |
| -0.30 | -11.53 | -11.92 | -12.31 | -12.69 | -13.08 | -13.47 | -13.85 | -14.24 | -14.63 | -15.02 | -15.41 | -0.30 |
| -0.20 | -7.67 | -8.06 | -8.44 | -8.83 | -9.21 | -9.60 | -9.99 | -10.37 | -10.76 | -11.15 | -11.53 | -0.20 |
| -0.10 | -3.83 | -4.21 | -4.60 | -4.98 | -5.37 | -5.75 | -6.13 | -6.52 | -6.90 | -7.29 | -7.67 | -0.10 |
| 0.00 | 0.00 | -0.38 | -0.76 | -1.15 | -1.53 | -1.91 | -2.30 | -2.68 | -3.06 | -3.45 | -3.83 | 0.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B1.** AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.38 | 0.76 | 1.15 | 1.53 | 1.91 | 2.29 | 2.67 | 3.06 | 3.44 | 3.82 | 0.00 |
| 0.10 | 3.82 | 4.20 | 4.58 | 4.96 | 5.34 | 5.72 | 6.10 | 6.48 | 6.86 | 7.24 | 7.62 | 0.10 |
| 0.20 | 7.62 | 8.00 | 8.38 | 8.76 | 9.14 | 9.52 | 9.90 | 10.28 | 10.66 | 11.04 | 11.42 | 0.20 |
| 0.30 | 11.42 | 11.80 | 12.17 | 12.55 | 12.93 | 13.31 | 13.69 | 14.06 | 14.44 | 14.82 | 15.20 | 0.30 |
| 0.40 | 15.20 | 15.57 | 15.95 | 16.33 | 16.70 | 17.08 | 17.46 | 17.83 | 18.21 | 18.58 | 18.96 | 0.40 |
| 0.50 | 18.96 | 19.33 | 19.71 | 20.08 | 20.46 | 20.83 | 21.21 | 21.58 | 21.96 | 22.33 | 22.71 | 0.50 |
| 0.60 | 22.71 | 23.08 | 23.45 | 23.83 | 24.20 | 24.57 | 24.95 | 25.32 | 25.69 | 26.06 | 26.44 | 0.60 |
| 0.70 | 26.44 | 26.81 | 27.18 | 27.55 | 27.92 | 28.29 | 28.66 | 29.04 | 29.41 | 29.78 | 30.15 | 0.70 |
| 0.80 | 30.15 | 30.52 | 30.89 | 31.26 | 31.63 | 32.00 | 32.37 | 32.74 | 33.11 | 33.47 | 33.84 | 0.80 |
| 0.90 | 33.84 | 34.21 | 34.58 | 34.95 | 35.32 | 35.68 | 36.05 | 36.42 | 36.79 | 37.15 | 37.52 | 0.90 |
| 1.00 | 37.52 | 37.89 | 38.25 | 38.62 | 38.98 | 39.35 | 39.72 | 40.08 | 40.45 | 40.81 | 41.18 | 1.00 |
| 1.10 | 41.18 | 41.54 | 41.91 | 42.27 | 42.64 | 43.00 | 43.36 | 43.73 | 44.09 | 44.45 | 44.82 | 1.10 |
| 1.20 | 44.82 | 45.18 | 45.54 | 45.91 | 46.27 | 46.63 | 46.99 | 47.35 | 47.72 | 48.08 | 48.44 | 1.20 |
| 1.30 | 48.44 | 48.80 | 49.16 | 49.52 | 49.88 | 50.24 | 50.60 | 50.96 | 51.32 | 51.68 | 52.04 | 1.30 |
| 1.40 | 52.04 | 52.40 | 52.76 | 53.12 | 53.48 | 53.84 | 54.19 | 54.55 | 54.91 | 55.27 | 55.63 | 1.40 |
| 1.50 | 55.63 | 55.98 | 56.34 | 56.70 | 57.05 | 57.41 | 57.77 | 58.12 | 58.48 | 58.84 | 59.19 | 1.50 |
| 1.60 | 59.19 | 59.55 | 59.90 | 60.26 | 60.61 | 60.97 | 61.32 | 61.68 | 62.03 | 62.39 | 62.74 | 1.60 |
| 1.70 | 62.74 | 63.09 | 63.45 | 63.80 | 64.15 | 64.51 | 64.86 | 65.21 | 65.57 | 65.92 | 66.27 | 1.70 |
| 1.80 | 66.27 | 66.62 | 66.97 | 67.33 | 67.68 | 68.03 | 68.38 | 68.73 | 69.08 | 69.43 | 69.78 | 1.80 |
| 1.90 | 69.78 | 70.13 | 70.48 | 70.83 | 71.18 | 71.53 | 71.88 | 72.23 | 72.58 | 72.93 | 73.28 | 1.90 |
| 2.00 | 73.28 | 73.63 | 73.98 | 74.32 | 74.67 | 75.02 | 75.37 | 75.72 | 76.06 | 76.41 | 76.76 | 2.00 |
| 2.10 | 76.76 | 77.10 | 77.45 | 77.80 | 78.14 | 78.49 | 78.84 | 79.18 | 79.53 | 79.87 | 80.22 | 2.10 |
| 2.20 | 80.22 | 80.56 | 80.91 | 81.25 | 81.60 | 81.94 | 82.29 | 82.63 | 82.98 | 83.32 | 83.66 | 2.20 |
| 2.30 | 83.66 | 84.01 | 84.35 | 84.69 | 85.04 | 85.38 | 85.72 | 86.07 | 86.41 | 86.75 | 87.09 | 2.30 |
| 2.40 | 87.09 | 87.43 | 87.78 | 88.12 | 88.46 | 88.80 | 89.14 | 89.48 | 89.82 | 90.16 | 90.51 | 2.40 |
| 2.50 | 90.51 | 90.85 | 91.19 | 91.53 | 91.87 | 92.21 | 92.55 | 92.89 | 93.22 | 93.56 | 93.90 | 2.50 |
| 2.60 | 93.90 | 94.24 | 94.58 | 94.92 | 95.26 | 95.60 | 95.93 | 96.27 | 96.61 | 96.95 | 97.29 | 2.60 |
| 2.70 | 97.29 | 97.62 | 97.96 | 98.30 | 98.63 | 98.97 | 99.31 | 99.64 | 99.98 | 100.32 | 100.65 | 2.70 |
| 2.80 | 100.65 | 100.99 | 101.32 | 101.66 | 102.00 | 102.33 | 102.67 | 103.00 | 103.34 | 103.67 | 104.01 | 2.80 |
| 2.90 | 104.01 | 104.34 | 104.67 | 105.01 | 105.34 | 105.68 | 106.01 | 106.34 | 106.68 | 107.01 | 107.34 | 2.90 |
| 3.00 | 107.34 | 107.68 | 108.01 | 108.34 | 108.68 | 109.01 | 109.34 | 109.67 | 110.01 | 110.34 | 110.67 | 3.00 |
| 3.10 | 110.67 | 111.00 | 111.33 | 111.66 | 112.00 | 112.33 | 112.66 | 112.99 | 113.32 | 113.65 | 113.98 | 3.10 |
| 3.20 | 113.98 | 114.31 | 114.64 | 114.97 | 115.30 | 115.63 | 115.96 | 116.29 | 116.62 | 116.95 | 117.28 | 3.20 |
| 3.30 | 117.28 | 117.61 | 117.94 | 118.27 | 118.60 | 118.92 | 119.25 | 119.58 | 119.91 | 120.24 | 120.56 | 3.30 |
| 3.40 | 120.56 | 120.89 | 121.22 | 121.55 | 121.88 | 122.20 | 122.53 | 122.86 | 123.18 | 123.51 | 123.84 | 3.40 |
| 3.50 | 123.84 | 124.16 | 124.49 | 124.82 | 125.14 | 125.47 | 125.80 | 126.12 | 126.45 | 126.77 | 127.10 | 3.50 |
| 3.60 | 127.10 | 127.42 | 127.75 | 128.07 | 128.40 | 128.72 | 129.05 | 129.37 | 129.70 | 130.02 | 130.35 | 3.60 |
| 3.70 | 130.35 | 130.67 | 130.99 | 131.32 | 131.64 | 131.97 | 132.29 | 132.61 | 132.94 | 133.26 | 133.58 | 3.70 |
| 3.80 | 133.58 | 133.91 | 134.23 | 134.55 | 134.87 | 135.20 | 135.52 | 135.84 | 136.16 | 136.49 | 136.81 | 3.80 |
| 3.90 | 136.81 | 137.13 | 137.45 | 137.77 | 138.09 | 138.42 | 138.74 | 139.06 | 139.38 | 139.70 | 140.02 | 3.90 |
| 4.00 | 140.02 | 140.34 | 140.66 | 140.98 | 141.30 | 141.62 | 141.94 | 142.26 | 142.58 | 142.90 | 143.22 | 4.00 |
| 4.10 | 143.22 | 143.54 | 143.86 | 144.18 | 144.50 | 144.82 | 145.14 | 145.46 | 145.78 | 146.10 | 146.42 | 4.10 |
| 4.20 | 146.42 | 146.73 | 147.05 | 147.37 | 147.69 | 148.01 | 148.33 | 148.64 | 148.96 | 149.28 | 149.60 | 4.20 |
| 4.30 | 149.60 | 149.92 | 150.23 | 150.55 | 150.87 | 151.18 | 151.50 | 151.82 | 152.14 | 152.45 | 152.77 | 4.30 |
| 4.40 | 152.77 | 153.09 | 153.40 | 153.72 | 154.03 | 154.35 | 154.67 | 154.98 | 155.30 | 155.61 | 155.93 | 4.40 |
| 4.50 | 155.93 | 156.25 | 156.56 | 156.88 | 157.19 | 157.51 | 157.82 | 158.14 | 158.45 | 158.77 | 159.08 | 4.50 |
| 4.60 | 159.08 | 159.40 | 159.71 | 160.02 | 160.34 | 160.65 | 160.97 | 161.28 | 161.59 | 161.91 | 162.22 | 4.60 |
| 4.70 | 162.22 | 162.54 | 162.85 | 163.16 | 163.48 | 163.79 | 164.10 | 164.42 | 164.73 | 165.04 | 165.35 | 4.70 |
| 4.80 | 165.35 | 165.67 | 165.98 | 166.29 | 166.60 | 166.92 | 167.23 | 167.54 | 167.85 | 168.16 | 168.48 | 4.80 |
| 4.90 | 168.48 | 168.79 | 169.10 | 169.41 | 169.72 | 170.03 | 170.35 | 170.66 | 170.97 | 171.28 | 171.59 | 4.90 |
| 5.00 | 171.59 | 171.90 | 172.21 | 172.52 | 172.83 | 173.14 | 173.45 | 173.76 | 174.07 | 174.38 | 174.69 | 5.00 |
| 5.10 | 174.69 | 175.00 | 175.31 | 175.62 | 175.93 | 176.24 | 176.55 | 176.86 | 177.17 | 177.48 | 177.79 | 5.10 |
| 5.20 | 177.79 | 178.10 | 178.41 | 178.72 | 179.03 | 179.34 | 179.64 | 179.95 | 180.26 | 180.57 | 180.88 | 5.20 |
| 5.30 | 180.88 | 181.19 | 181.49 | 181.80 | 182.11 | 182.42 | 182.73 | 183.03 | 183.34 | 183.65 | 183.96 | 5.30 |
| 5.40 | 183.96 | 184.26 | 184.57 | 184.88 | 185.19 | 185.49 | 185.80 | 186.11 | 186.41 | 186.72 | 187.03 | 5.40 |
| 5.50 | 187.03 | 187.33 | 187.64 | 187.95 | 188.25 | 188.56 | 188.86 | 189.17 | 189.48 | 189.78 | 190.09 | 5.50 |
| 5.60 | 190.09 | 190.39 | 190.70 | 191.01 | 191.31 | 191.62 | 191.92 | 192.23 | 192.53 | 192.84 | 193.14 | 5.60 |
| 5.70 | 193.14 | 193.45 | 193.75 | 194.06 | 194.36 | 194.67 | 194.97 | 195.28 | 195.58 | 195.88 | 196.19 | 5.70 |
| 5.80 | 196.19 | 196.49 | 196.80 | 197.10 | 197.41 | 197.71 | 198.01 | 198.32 | 198.62 | 198.92 | 199.23 | 5.80 |
| 5.90 | 199.23 | 199.53 | 199.83 | 200.14 | 200.44 | 200.74 | 201.05 | 201.35 | 201.65 | 201.96 | 202.26 | 5.90 |
| 6.00 | 202.26 | 202.56 | 202.86 | 203.17 | 203.47 | 203.77 | 204.07 | 204.38 | 204.68 | 204.98 | 205.28 | 6.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B1.** AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.00 | 202.26 | 202.56 | 202.86 | 203.17 | 203.47 | 203.77 | 204.07 | 204.38 | 204.68 | 204.98 | 205.28 | 6.00 |
| 6.10 | 205.28 | 205.58 | 205.88 | 206.19 | 206.49 | 206.79 | 207.09 | 207.39 | 207.69 | 208.00 | 208.30 | 6.10 |
| 6.20 | 208.30 | 208.60 | 208.90 | 209.20 | 209.50 | 209.80 | 210.10 | 210.40 | 210.70 | 211.00 | 211.31 | 6.20 |
| 6.30 | 211.31 | 211.61 | 211.91 | 212.21 | 212.51 | 212.81 | 213.11 | 213.41 | 213.71 | 214.01 | 214.31 | 6.30 |
| 6.40 | 214.31 | 214.61 | 214.91 | 215.21 | 215.50 | 215.80 | 216.10 | 216.40 | 216.70 | 217.00 | 217.30 | 6.40 |
| 6.50 | 217.30 | 217.60 | 217.90 | 218.20 | 218.50 | 218.79 | 219.09 | 219.39 | 219.69 | 219.99 | 220.29 | 6.50 |
| 6.60 | 220.29 | 220.59 | 220.88 | 221.18 | 221.48 | 221.78 | 222.08 | 222.37 | 222.67 | 222.97 | 223.27 | 6.60 |
| 6.70 | 223.27 | 223.57 | 223.86 | 224.16 | 224.46 | 224.75 | 225.05 | 225.35 | 225.65 | 225.94 | 226.24 | 6.70 |
| 6.80 | 226.24 | 226.54 | 226.83 | 227.13 | 227.43 | 227.72 | 228.02 | 228.32 | 228.61 | 228.91 | 229.21 | 6.80 |
| 6.90 | 229.21 | 229.50 | 229.80 | 230.10 | 230.39 | 230.69 | 230.98 | 231.28 | 231.58 | 231.87 | 232.17 | 6.90 |
| 7.00 | 232.17 | 232.46 | 232.76 | 233.05 | 233.35 | 233.64 | 233.94 | 234.24 | 234.53 | 234.83 | 235.12 | 7.00 |
| 7.10 | 235.12 | 235.42 | 235.71 | 236.01 | 236.30 | 236.59 | 236.89 | 237.18 | 237.48 | 237.77 | 238.07 | 7.10 |
| 7.20 | 238.07 | 238.36 | 238.66 | 238.95 | 239.24 | 239.54 | 239.83 | 240.13 | 240.42 | 240.71 | 241.01 | 7.20 |
| 7.30 | 241.01 | 241.30 | 241.60 | 241.89 | 242.18 | 242.48 | 242.77 | 243.06 | 243.36 | 243.65 | 243.94 | 7.30 |
| 7.40 | 243.94 | 244.23 | 244.53 | 244.82 | 245.11 | 245.41 | 245.70 | 245.99 | 246.28 | 246.58 | 246.87 | 7.40 |
| 7.50 | 246.87 | 247.16 | 247.45 | 247.75 | 248.04 | 248.33 | 248.62 | 248.92 | 249.21 | 249.50 | 249.79 | 7.50 |
| 7.60 | 249.79 | 250.08 | 250.38 | 250.67 | 250.96 | 251.25 | 251.54 | 251.83 | 252.12 | 252.42 | 252.71 | 7.60 |
| 7.70 | 252.71 | 253.00 | 253.29 | 253.58 | 253.87 | 254.16 | 254.45 | 254.75 | 255.04 | 255.33 | 255.62 | 7.70 |
| 7.80 | 255.62 | 255.91 | 256.20 | 256.49 | 256.78 | 257.07 | 257.36 | 257.65 | 257.94 | 258.23 | 258.52 | 7.80 |
| 7.90 | 258.52 | 258.81 | 259.10 | 259.39 | 259.68 | 259.97 | 260.26 | 260.55 | 260.84 | 261.13 | 261.42 | 7.90 |
| 8.00 | 261.42 | 261.71 | 262.00 | 262.29 | 262.58 | 262.87 | 263.16 | 263.44 | 263.73 | 264.02 | 264.31 | 8.00 |
| 8.10 | 264.31 | 264.60 | 264.89 | 265.18 | 265.47 | 265.76 | 266.04 | 266.33 | 266.62 | 266.91 | 267.20 | 8.10 |
| 8.20 | 267.20 | 267.49 | 267.78 | 268.06 | 268.35 | 268.64 | 268.93 | 269.22 | 269.50 | 269.79 | 270.08 | 8.20 |
| 8.30 | 270.08 | 270.37 | 270.66 | 270.94 | 271.23 | 271.52 | 271.81 | 272.09 | 272.38 | 272.67 | 272.96 | 8.30 |
| 8.40 | 272.96 | 273.24 | 273.53 | 273.82 | 274.10 | 274.39 | 274.68 | 274.97 | 275.25 | 275.54 | 275.83 | 8.40 |
| 8.50 | 275.83 | 276.11 | 276.40 | 276.69 | 276.97 | 277.26 | 277.55 | 277.83 | 278.12 | 278.40 | 278.69 | 8.50 |
| 8.60 | 278.69 | 278.98 | 279.26 | 279.55 | 279.84 | 280.12 | 280.41 | 280.69 | 280.98 | 281.27 | 281.55 | 8.60 |
| 8.70 | 281.55 | 281.84 | 282.12 | 282.41 | 282.69 | 282.98 | 283.26 | 283.55 | 283.84 | 284.12 | 284.41 | 8.70 |
| 8.80 | 284.41 | 284.69 | 284.98 | 285.26 | 285.55 | 285.83 | 286.12 | 286.40 | 286.69 | 286.97 | 287.26 | 8.80 |
| 8.90 | 287.26 | 287.54 | 287.82 | 288.11 | 288.39 | 288.68 | 288.96 | 289.25 | 289.53 | 289.82 | 290.10 | 8.90 |
| 9.00 | 290.10 | 290.38 | 290.67 | 290.95 | 291.24 | 291.52 | 291.80 | 292.09 | 292.37 | 292.66 | 292.94 | 9.00 |
| 9.10 | 292.94 | 293.22 | 293.51 | 293.79 | 294.07 | 294.36 | 294.64 | 294.92 | 295.21 | 295.49 | 295.77 | 9.10 |
| 9.20 | 295.77 | 296.06 | 296.34 | 296.62 | 296.91 | 297.19 | 297.47 | 297.76 | 298.04 | 298.32 | 298.60 | 9.20 |
| 9.30 | 298.60 | 298.89 | 299.17 | 299.45 | 299.73 | 300.02 | 300.30 | 300.58 | 300.86 | 301.15 | 301.43 | 9.30 |
| 9.40 | 301.43 | 301.71 | 301.99 | 302.28 | 302.56 | 302.84 | 303.12 | 303.40 | 303.69 | 303.97 | 304.25 | 9.40 |
| 9.50 | 304.25 | 304.53 | 304.81 | 305.10 | 305.38 | 305.66 | 305.94 | 306.22 | 306.50 | 306.78 | 307.07 | 9.50 |
| 9.60 | 307.07 | 307.35 | 307.63 | 307.91 | 308.19 | 308.47 | 308.75 | 309.03 | 309.32 | 309.60 | 309.88 | 9.60 |
| 9.70 | 309.88 | 310.16 | 310.44 | 310.72 | 311.00 | 311.28 | 311.56 | 311.84 | 312.12 | 312.40 | 312.69 | 9.70 |
| 9.80 | 312.69 | 312.97 | 313.25 | 313.53 | 313.81 | 314.09 | 314.37 | 314.65 | 314.93 | 315.21 | 315.49 | 9.80 |
| 9.90 | 315.49 | 315.77 | 316.05 | 316.33 | 316.61 | 316.89 | 317.17 | 317.45 | 317.73 | 318.01 | 318.29 | 9.90 |
| 10.00 | 318.29 | 318.57 | 318.85 | 319.13 | 319.41 | 319.69 | 319.96 | 320.24 | 320.52 | 320.80 | 321.08 | 10.00 |
| 10.10 | 321.08 | 321.36 | 321.64 | 321.92 | 322.20 | 322.48 | 322.76 | 323.04 | 323.32 | 323.59 | 323.87 | 10.10 |
| 10.20 | 323.87 | 324.15 | 324.43 | 324.71 | 324.99 | 325.27 | 325.55 | 325.82 | 326.10 | 326.38 | 326.66 | 10.20 |
| 10.30 | 326.66 | 326.94 | 327.22 | 327.50 | 327.77 | 328.05 | 328.33 | 328.61 | 328.89 | 329.16 | 329.44 | 10.30 |
| 10.40 | 329.44 | 329.72 | 330.00 | 330.28 | 330.55 | 330.83 | 331.11 | 331.39 | 331.67 | 331.94 | 332.22 | 10.40 |
| 10.50 | 332.22 | 332.50 | 332.78 | 333.05 | 333.33 | 333.61 | 333.89 | 334.17 | 334.44 | 334.72 | 335.00 | 10.50 |
| 10.60 | 335.00 | 335.27 | 335.55 | 335.83 | 336.11 | 336.38 | 336.66 | 336.94 | 337.22 | 337.49 | 337.77 | 10.60 |
| 10.70 | 337.77 | 338.05 | 338.32 | 338.60 | 338.88 | 339.15 | 339.43 | 339.71 | 339.98 | 340.26 | 340.54 | 10.70 |
| 10.80 | 340.54 | 340.81 | 341.09 | 341.37 | 341.64 | 341.92 | 342.20 | 342.47 | 342.75 | 343.03 | 343.30 | 10.80 |
| 10.90 | 343.30 | 343.58 | 343.85 | 344.13 | 344.41 | 344.68 | 344.96 | 345.24 | 345.51 | 345.79 | 346.06 | 10.90 |
| 11.00 | 346.06 | 346.34 | 346.62 | 346.89 | 347.17 | 347.44 | 347.72 | 347.99 | 348.27 | 348.55 | 348.82 | 11.00 |
| 11.10 | 348.82 | 349.10 | 349.37 | 349.65 | 349.92 | 350.20 | 350.47 | 350.75 | 351.03 | 351.30 | 351.58 | 11.10 |
| 11.20 | 351.58 | 351.85 | 352.13 | 352.40 | 352.68 | 352.95 | 353.23 | 353.50 | 353.78 | 354.05 | 354.33 | 11.20 |
| 11.30 | 354.33 | 354.60 | 354.88 | 355.15 | 355.43 | 355.70 | 355.98 | 356.25 | 356.53 | 356.80 | 357.08 | 11.30 |
| 11.40 | 357.08 | 357.35 | 357.63 | 357.90 | 358.17 | 358.45 | 358.72 | 359.00 | 359.27 | 359.55 | 359.82 | 11.40 |
| 11.50 | 359.82 | 360.10 | 360.37 | 360.64 | 360.92 | 361.19 | 361.47 | 361.74 | 362.02 | 362.29 | 362.56 | 11.50 |
| 11.60 | 362.56 | 362.84 | 363.11 | 363.39 | 363.66 | 363.93 | 364.21 | 364.48 | 364.76 | 365.03 | 365.30 | 11.60 |
| 11.70 | 365.30 | 365.58 | 365.85 | 366.12 | 366.40 | 366.67 | 366.95 | 367.22 | 367.49 | 367.77 | 368.04 | 11.70 |
| 11.80 | 368.04 | 368.31 | 368.59 | 368.86 | 369.13 | 369.41 | 369.68 | 369.95 | 370.23 | 370.50 | 370.77 | 11.80 |
| 11.90 | 370.77 | 371.05 | 371.32 | 371.59 | 371.87 | 372.14 | 372.41 | 372.68 | 372.96 | 373.23 | 373.50 | 11.90 |
| 12.00 | 373.50 | 373.78 | 374.05 | 374.32 | 374.60 | 374.87 | 375.14 | 375.41 | 375.69 | 375.96 | 376.23 | 12.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

Table B1. AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, referenc junctions at 0 °C*—Continued

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TEMPERATURES IN DEGREES C (IPTS 1968) | | | | | | | |
| 12.00 | 373.50 | 373.78 | 374.05 | 374.32 | 374.60 | 374.87 | 375.14 | 375.41 | 375.69 | 375.96 | 376.23 | 12.00 |
| 12.10 | 376.23 | 376.50 | 376.78 | 377.05 | 377.32 | 377.59 | 377.87 | 378.14 | 378.41 | 378.68 | 378.96 | 12.10 |
| 12.20 | 378.96 | 379.23 | 379.50 | 379.77 | 380.05 | 380.32 | 380.59 | 380.86 | 381.14 | 381.41 | 381.68 | 12.20 |
| 12.30 | 381.68 | 381.95 | 382.22 | 382.50 | 382.77 | 383.04 | 383.31 | 383.58 | 383.86 | 384.13 | 384.40 | 12.30 |
| 12.40 | 384.40 | 384.67 | 384.94 | 385.21 | 385.49 | 385.76 | 386.03 | 386.30 | 386.57 | 386.84 | 387.12 | 12.40 |
| 12.50 | 387.12 | 387.39 | 387.66 | 387.93 | 388.20 | 388.47 | 388.75 | 389.02 | 389.29 | 389.56 | 389.83 | 12.50 |
| 12.60 | 389.83 | 390.10 | 390.37 | 390.64 | 390.92 | 391.19 | 391.46 | 391.73 | 392.00 | 392.27 | 392.54 | 12.60 |
| 12.70 | 392.54 | 392.81 | 393.08 | 393.36 | 393.63 | 393.90 | 394.17 | 394.44 | 394.71 | 394.98 | 395.25 | 12.70 |
| 12.80 | 395.25 | 395.52 | 395.79 | 396.06 | 396.33 | 396.61 | 396.88 | 397.15 | 397.42 | 397.69 | 397.96 | 12.80 |
| 12.90 | 397.96 | 398.23 | 398.50 | 398.77 | 399.04 | 399.31 | 399.58 | 399.85 | | | | 12.90 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B2.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C.*

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TEMPERATURES IN DEGREES C (IPTS 1968) | | | | | | | |
| 0.00 | 0.00 | 0.39 | 0.77 | 1.16 | 1.54 | 1.93 | 2.31 | 2.70 | 3.08 | 3.47 | 3.85 | 0.00 |
| 0.10 | 3.85 | 4.24 | 4.62 | 5.00 | 5.39 | 5.77 | 6.15 | 6.54 | 6.92 | 7.30 | 7.68 | 0.10 |
| 0.20 | 7.68 | 8.07 | 8.45 | 8.83 | 9.21 | 9.59 | 9.97 | 10.36 | 10.74 | 11.12 | 11.50 | 0.20 |
| 0.30 | 11.50 | 11.88 | 12.26 | 12.64 | 13.02 | 13.40 | 13.78 | 14.15 | 14.53 | 14.91 | 15.29 | 0.30 |
| 0.40 | 15.29 | 15.67 | 16.05 | 16.43 | 16.80 | 17.18 | 17.56 | 17.94 | 18.31 | 18.69 | 19.07 | 0.40 |
| 0.50 | 19.07 | 19.44 | 19.82 | 20.19 | 20.57 | 20.95 | 21.32 | 21.70 | 22.07 | 22.45 | 22.82 | 0.50 |
| 0.60 | 22.82 | 23.19 | 23.57 | 23.94 | 24.32 | 24.69 | 25.06 | 25.44 | 25.81 | 26.18 | 26.56 | 0.60 |
| 0.70 | 26.56 | 26.93 | 27.30 | 27.67 | 28.05 | 28.42 | 28.79 | 29.16 | 29.53 | 29.90 | 30.27 | 0.70 |
| 0.80 | 30.27 | 30.64 | 31.01 | 31.38 | 31.75 | 32.12 | 32.49 | 32.86 | 33.23 | 33.60 | 33.97 | 0.80 |
| 0.90 | 33.97 | 34.34 | 34.71 | 35.08 | 35.44 | 35.81 | 36.18 | 36.55 | 36.92 | 37.28 | 37.65 | 0.90 |
| 1.00 | 37.65 | 38.02 | 38.38 | 38.75 | 39.12 | 39.48 | 39.85 | 40.21 | 40.58 | 40.94 | 41.31 | 1.00 |
| 1.10 | 41.31 | 41.67 | 42.04 | 42.40 | 42.77 | 43.13 | 43.50 | 43.86 | 44.22 | 44.59 | 44.95 | 1.10 |
| 1.20 | 44.95 | 45.31 | 45.68 | 46.04 | 46.40 | 46.77 | 47.13 | 47.49 | 47.85 | 48.21 | 48.58 | 1.20 |
| 1.30 | 48.58 | 48.94 | 49.30 | 49.66 | 50.02 | 50.38 | 50.74 | 51.10 | 51.46 | 51.82 | 52.18 | 1.30 |
| 1.40 | 52.18 | 52.54 | 52.90 | 53.26 | 53.62 | 53.98 | 54.34 | 54.69 | 55.05 | 55.41 | 55.77 | 1.40 |
| 1.50 | 55.77 | 56.13 | 56.48 | 56.84 | 57.20 | 57.55 | 57.91 | 58.27 | 58.63 | 58.98 | 59.34 | 1.50 |
| 1.60 | 59.34 | 59.69 | 60.05 | 60.41 | 60.76 | 61.12 | 61.47 | 61.83 | 62.18 | 62.54 | 62.89 | 1.60 |
| 1.70 | 62.89 | 63.24 | 63.60 | 63.95 | 64.31 | 64.66 | 65.01 | 65.37 | 65.72 | 66.07 | 66.43 | 1.70 |
| 1.80 | 66.43 | 66.78 | 67.13 | 67.48 | 67.83 | 68.19 | 68.54 | 68.89 | 69.24 | 69.59 | 69.94 | 1.80 |
| 1.90 | 69.94 | 70.29 | 70.65 | 71.00 | 71.35 | 71.70 | 72.05 | 72.40 | 72.75 | 73.10 | 73.45 | 1.90 |
| 2.00 | 73.45 | 73.79 | 74.14 | 74.49 | 74.84 | 75.19 | 75.54 | 75.89 | 76.24 | 76.58 | 76.93 | 2.00 |
| 2.10 | 76.93 | 77.28 | 77.63 | 77.97 | 78.32 | 78.67 | 79.01 | 79.36 | 79.71 | 80.05 | 80.40 | 2.10 |
| 2.20 | 80.40 | 80.75 | 81.09 | 81.44 | 81.78 | 82.13 | 82.47 | 82.82 | 83.16 | 83.51 | 83.85 | 2.20 |
| 2.30 | 83.85 | 84.20 | 84.54 | 84.89 | 85.23 | 85.57 | 85.92 | 86.26 | 86.61 | 86.95 | 87.29 | 2.30 |
| 2.40 | 87.29 | 87.63 | 87.98 | 88.32 | 88.66 | 89.00 | 89.35 | 89.69 | 90.03 | 90.37 | 90.71 | 2.40 |
| 2.50 | 90.71 | 91.06 | 91.40 | 91.74 | 92.08 | 92.42 | 92.76 | 93.10 | 93.44 | 93.78 | 94.12 | 2.50 |
| 2.60 | 94.12 | 94.46 | 94.80 | 95.14 | 95.48 | 95.82 | 96.16 | 96.50 | 96.84 | 97.18 | 97.51 | 2.60 |
| 2.70 | 97.51 | 97.85 | 98.19 | 98.53 | 98.87 | 99.20 | 99.54 | 99.88 | 100.22 | 100.55 | 100.89 | 2.70 |
| 2.80 | 100.89 | 101.23 | 101.57 | 101.90 | 102.24 | 102.58 | 102.91 | 103.25 | 103.58 | 103.92 | 104.26 | 2.80 |
| 2.90 | 104.26 | 104.59 | 104.93 | 105.26 | 105.60 | 105.93 | 106.27 | 106.60 | 106.94 | 107.27 | 107.60 | 2.90 |
| 3.00 | 107.60 | 107.94 | 108.27 | 108.61 | 108.94 | 109.27 | 109.61 | 109.94 | 110.27 | 110.61 | 110.94 | 3.00 |
| 3.10 | 110.94 | 111.27 | 111.61 | 111.94 | 112.27 | 112.60 | 112.94 | 113.27 | 113.60 | 113.93 | 114.26 | 3.10 |
| 3.20 | 114.26 | 114.59 | 114.93 | 115.26 | 115.59 | 115.92 | 116.25 | 116.58 | 116.91 | 117.24 | 117.57 | 3.20 |
| 3.30 | 117.57 | 117.90 | 118.23 | 118.56 | 118.89 | 119.22 | 119.55 | 119.88 | 120.21 | 120.54 | 120.87 | 3.30 |
| 3.40 | 120.87 | 121.20 | 121.52 | 121.85 | 122.18 | 122.51 | 122.84 | 123.17 | 123.49 | 123.82 | 124.15 | 3.40 |
| 3.50 | 124.15 | 124.48 | 124.80 | 125.13 | 125.46 | 125.79 | 126.11 | 126.44 | 126.77 | 127.09 | 127.42 | 3.50 |
| 3.60 | 127.42 | 127.75 | 128.07 | 128.40 | 128.72 | 129.05 | 129.38 | 129.70 | 130.03 | 130.35 | 130.68 | 3.60 |
| 3.70 | 130.68 | 131.00 | 131.33 | 131.65 | 131.98 | 132.30 | 132.63 | 132.95 | 133.28 | 133.60 | 133.92 | 3.70 |
| 3.80 | 133.92 | 134.25 | 134.57 | 134.89 | 135.22 | 135.54 | 135.86 | 136.19 | 136.51 | 136.83 | 137.16 | 3.80 |
| 3.90 | 137.16 | 137.48 | 137.80 | 138.12 | 138.45 | 138.77 | 139.09 | 139.41 | 139.74 | 140.06 | 140.38 | 3.90 |
| 4.00 | 140.38 | 140.70 | 141.02 | 141.34 | 141.66 | 141.99 | 142.31 | 142.63 | 142.95 | 143.27 | 143.59 | 4.00 |
| 4.10 | 143.59 | 143.91 | 144.23 | 144.55 | 144.87 | 145.19 | 145.51 | 145.83 | 146.15 | 146.47 | 146.79 | 4.10 |
| 4.20 | 146.79 | 147.11 | 147.43 | 147.75 | 148.07 | 148.38 | 148.70 | 149.02 | 149.34 | 149.66 | 149.98 | 4.20 |
| 4.30 | 149.98 | 150.30 | 150.61 | 150.93 | 151.25 | 151.57 | 151.88 | 152.20 | 152.52 | 152.84 | 153.15 | 4.30 |
| 4.40 | 153.15 | 153.47 | 153.79 | 154.11 | 154.42 | 154.74 | 155.06 | 155.37 | 155.69 | 156.00 | 156.32 | 4.40 |
| 4.50 | 156.32 | 156.64 | 156.95 | 157.27 | 157.58 | 157.90 | 158.22 | 158.53 | 158.85 | 159.16 | 159.48 | 4.50 |
| 4.60 | 159.48 | 159.79 | 160.11 | 160.42 | 160.74 | 161.05 | 161.37 | 161.68 | 161.99 | 162.31 | 162.62 | 4.60 |
| 4.70 | 162.62 | 162.94 | 163.25 | 163.56 | 163.88 | 164.19 | 164.51 | 164.82 | 165.13 | 165.45 | 165.76 | 4.70 |
| 4.80 | 165.76 | 166.07 | 166.38 | 166.70 | 167.01 | 167.32 | 167.64 | 167.95 | 168.26 | 168.57 | 168.88 | 4.80 |
| 4.90 | 168.88 | 169.20 | 169.51 | 169.82 | 170.13 | 170.44 | 170.76 | 171.07 | 171.38 | 171.69 | 172.00 | 4.90 |
| 5.00 | 172.00 | 172.31 | 172.62 | 172.93 | 173.24 | 173.56 | 173.87 | 174.18 | 174.49 | 174.80 | 175.11 | 5.00 |
| 5.10 | 175.11 | 175.42 | 175.73 | 176.04 | 176.35 | 176.66 | 176.97 | 177.28 | 177.59 | 177.90 | 178.21 | 5.10 |
| 5.20 | 178.21 | 178.51 | 178.82 | 179.13 | 179.44 | 179.75 | 180.06 | 180.37 | 180.68 | 180.98 | 181.29 | 5.20 |
| 5.30 | 181.29 | 181.60 | 181.91 | 182.22 | 182.53 | 182.83 | 183.14 | 183.45 | 183.76 | 184.06 | 184.37 | 5.30 |
| 5.40 | 184.37 | 184.68 | 184.99 | 185.29 | 185.60 | 185.91 | 186.22 | 186.52 | 186.83 | 187.14 | 187.44 | 5.40 |
| 5.50 | 187.44 | 187.75 | 188.06 | 188.36 | 188.67 | 188.97 | 189.28 | 189.59 | 189.89 | 190.20 | 190.50 | 5.50 |
| 5.60 | 190.50 | 190.81 | 191.12 | 191.42 | 191.73 | 192.03 | 192.34 | 192.64 | 192.95 | 193.25 | 193.56 | 5.60 |
| 5.70 | 193.56 | 193.86 | 194.17 | 194.47 | 194.78 | 195.08 | 195.39 | 195.69 | 195.99 | 196.30 | 196.60 | 5.70 |
| 5.80 | 196.60 | 196.91 | 197.21 | 197.51 | 197.82 | 198.12 | 198.42 | 198.73 | 199.03 | 199.34 | 199.64 | 5.80 |
| 5.90 | 199.64 | 199.94 | 200.24 | 200.55 | 200.85 | 201.15 | 201.46 | 201.76 | 202.06 | 202.36 | 202.67 | 5.90 |
| 6.00 | 202.67 | 202.97 | 203.27 | 203.57 | 203.88 | 204.18 | 204.48 | 204.78 | 205.08 | 205.39 | 205.69 | 6.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

Table B2. AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.00 | 202.67 | 202.97 | 203.27 | 203.57 | 203.88 | 204.18 | 204.48 | 204.78 | 205.08 | 205.39 | 205.69 | 6.00 |
| 6.10 | 205.69 | 205.99 | 206.29 | 206.59 | 206.89 | 207.19 | 207.50 | 207.80 | 208.10 | 208.40 | 208.70 | 6.10 |
| 6.20 | 208.70 | 209.00 | 209.30 | 209.60 | 209.90 | 210.20 | 210.50 | 210.80 | 211.10 | 211.40 | 211.70 | 6.20 |
| 6.30 | 211.70 | 212.00 | 212.30 | 212.60 | 212.90 | 213.20 | 213.50 | 213.80 | 214.10 | 214.40 | 214.70 | 6.30 |
| 6.40 | 214.70 | 215.00 | 215.30 | 215.60 | 215.90 | 216.20 | 216.50 | 216.80 | 217.09 | 217.39 | 217.69 | 6.40 |
| 6.50 | 217.69 | 217.99 | 218.29 | 218.59 | 218.89 | 219.18 | 219.48 | 219.78 | 220.08 | 220.38 | 220.67 | 6.50 |
| 6.60 | 220.67 | 220.97 | 221.27 | 221.57 | 221.87 | 222.16 | 222.46 | 222.76 | 223.06 | 223.35 | 223.65 | 6.60 |
| 6.70 | 223.65 | 223.95 | 224.24 | 224.54 | 224.84 | 225.14 | 225.43 | 225.73 | 226.03 | 226.32 | 226.62 | 6.70 |
| 6.80 | 226.62 | 226.92 | 227.21 | 227.51 | 227.80 | 228.10 | 228.40 | 228.69 | 228.99 | 229.28 | 229.58 | 6.80 |
| 6.90 | 229.58 | 229.88 | 230.17 | 230.47 | 230.76 | 231.06 | 231.35 | 231.65 | 231.95 | 232.24 | 232.54 | 6.90 |
| 7.00 | 232.54 | 232.83 | 233.13 | 233.42 | 233.72 | 234.01 | 234.31 | 234.60 | 234.89 | 235.19 | 235.48 | 7.00 |
| 7.10 | 235.48 | 235.78 | 236.07 | 236.37 | 236.66 | 236.96 | 237.25 | 237.54 | 237.84 | 238.13 | 238.43 | 7.10 |
| 7.20 | 238.43 | 238.72 | 239.01 | 239.31 | 239.60 | 239.89 | 240.19 | 240.48 | 240.77 | 241.07 | 241.36 | 7.20 |
| 7.30 | 241.36 | 241.65 | 241.95 | 242.24 | 242.53 | 242.83 | 243.12 | 243.41 | 243.70 | 244.00 | 244.29 | 7.30 |
| 7.40 | 244.29 | 244.58 | 244.88 | 245.17 | 245.46 | 245.75 | 246.04 | 246.34 | 246.63 | 246.92 | 247.21 | 7.40 |
| 7.50 | 247.21 | 247.50 | 247.80 | 248.09 | 248.38 | 248.67 | 248.96 | 249.26 | 249.55 | 249.84 | 250.13 | 7.50 |
| 7.60 | 250.13 | 250.42 | 250.71 | 251.00 | 251.29 | 251.59 | 251.88 | 252.17 | 252.46 | 252.75 | 253.04 | 7.60 |
| 7.70 | 253.04 | 253.33 | 253.62 | 253.91 | 254.20 | 254.49 | 254.78 | 255.07 | 255.36 | 255.65 | 255.94 | 7.70 |
| 7.80 | 255.94 | 256.24 | 256.53 | 256.82 | 257.11 | 257.40 | 257.68 | 257.97 | 258.26 | 258.55 | 258.84 | 7.80 |
| 7.90 | 258.84 | 259.13 | 259.42 | 259.71 | 260.00 | 260.29 | 260.58 | 260.87 | 261.16 | 261.45 | 261.74 | 7.90 |
| 8.00 | 261.74 | 262.03 | 262.32 | 262.60 | 262.89 | 263.18 | 263.47 | 263.76 | 264.05 | 264.34 | 264.62 | 8.00 |
| 8.10 | 264.62 | 264.91 | 265.20 | 265.49 | 265.78 | 266.07 | 266.35 | 266.64 | 266.93 | 267.22 | 267.51 | 8.10 |
| 8.20 | 267.51 | 267.79 | 268.08 | 268.37 | 268.66 | 268.95 | 269.23 | 269.52 | 269.81 | 270.10 | 270.38 | 8.20 |
| 8.30 | 270.38 | 270.67 | 270.96 | 271.25 | 271.53 | 271.82 | 272.11 | 272.39 | 272.68 | 272.97 | 273.25 | 8.30 |
| 8.40 | 273.25 | 273.54 | 273.83 | 274.12 | 274.40 | 274.69 | 274.97 | 275.26 | 275.55 | 275.83 | 276.12 | 8.40 |
| 8.50 | 276.12 | 276.41 | 276.69 | 276.98 | 277.27 | 277.55 | 277.84 | 278.12 | 278.41 | 278.70 | 278.98 | 8.50 |
| 8.60 | 278.98 | 279.27 | 279.55 | 279.84 | 280.12 | 280.41 | 280.70 | 280.98 | 281.27 | 281.55 | 281.84 | 8.60 |
| 8.70 | 281.84 | 282.12 | 282.41 | 282.69 | 282.98 | 283.26 | 283.55 | 283.83 | 284.12 | 284.40 | 284.69 | 8.70 |
| 8.80 | 284.69 | 284.97 | 285.26 | 285.54 | 285.83 | 286.11 | 286.40 | 286.68 | 286.97 | 287.25 | 287.53 | 8.80 |
| 8.90 | 287.53 | 287.82 | 288.10 | 288.39 | 288.67 | 288.95 | 289.24 | 289.52 | 289.81 | 290.09 | 290.37 | 8.90 |
| 9.00 | 290.37 | 290.66 | 290.94 | 291.23 | 291.51 | 291.79 | 292.08 | 292.36 | 292.64 | 292.93 | 293.21 | 9.00 |
| 9.10 | 293.21 | 293.49 | 293.78 | 294.06 | 294.34 | 294.63 | 294.91 | 295.19 | 295.48 | 295.76 | 296.04 | 9.10 |
| 9.20 | 296.04 | 296.33 | 296.61 | 296.89 | 297.17 | 297.46 | 297.74 | 298.02 | 298.30 | 298.59 | 298.87 | 9.20 |
| 9.30 | 298.87 | 299.15 | 299.43 | 299.72 | 300.00 | 300.28 | 300.56 | 300.85 | 301.13 | 301.41 | 301.69 | 9.30 |
| 9.40 | 301.69 | 301.97 | 302.26 | 302.54 | 302.82 | 303.10 | 303.38 | 303.66 | 303.95 | 304.23 | 304.51 | 9.40 |
| 9.50 | 304.51 | 304.79 | 305.07 | 305.35 | 305.64 | 305.92 | 306.20 | 306.48 | 306.76 | 307.04 | 307.32 | 9.50 |
| 9.60 | 307.32 | 307.60 | 307.88 | 308.17 | 308.45 | 308.73 | 309.01 | 309.29 | 309.57 | 309.85 | 310.13 | 9.60 |
| 9.70 | 310.13 | 310.41 | 310.69 | 310.97 | 311.25 | 311.53 | 311.81 | 312.10 | 312.38 | 312.66 | 312.94 | 9.70 |
| 9.80 | 312.94 | 313.22 | 313.50 | 313.78 | 314.06 | 314.34 | 314.62 | 314.90 | 315.18 | 315.46 | 315.74 | 9.80 |
| 9.90 | 315.74 | 316.02 | 316.30 | 316.58 | 316.86 | 317.14 | 317.41 | 317.69 | 317.97 | 318.25 | 318.53 | 9.90 |
| 10.00 | 318.53 | 318.81 | 319.09 | 319.37 | 319.65 | 319.93 | 320.21 | 320.49 | 320.77 | 321.05 | 321.33 | 10.00 |
| 10.10 | 321.33 | 321.60 | 321.88 | 322.16 | 322.44 | 322.72 | 323.00 | 323.28 | 323.56 | 323.83 | 324.11 | 10.10 |
| 10.20 | 324.11 | 324.39 | 324.67 | 324.95 | 325.23 | 325.51 | 325.78 | 326.06 | 326.34 | 326.62 | 326.90 | 10.20 |
| 10.30 | 326.90 | 327.18 | 327.45 | 327.73 | 328.01 | 328.29 | 328.57 | 328.84 | 329.12 | 329.40 | 329.68 | 10.30 |
| 10.40 | 329.68 | 329.96 | 330.23 | 330.51 | 330.79 | 331.07 | 331.34 | 331.62 | 331.90 | 332.18 | 332.45 | 10.40 |
| 10.50 | 332.45 | 332.73 | 333.01 | 333.29 | 333.56 | 333.84 | 334.12 | 334.39 | 334.67 | 334.95 | 335.23 | 10.50 |
| 10.60 | 335.23 | 335.50 | 335.78 | 336.06 | 336.33 | 336.61 | 336.89 | 337.16 | 337.44 | 337.72 | 338.00 | 10.60 |
| 10.70 | 338.00 | 338.27 | 338.55 | 338.82 | 339.10 | 339.38 | 339.65 | 339.93 | 340.21 | 340.48 | 340.76 | 10.70 |
| 10.80 | 340.76 | 341.04 | 341.31 | 341.59 | 341.87 | 342.14 | 342.42 | 342.69 | 342.97 | 343.25 | 343.52 | 10.80 |
| 10.90 | 343.52 | 343.80 | 344.07 | 344.35 | 344.62 | 344.90 | 345.18 | 345.45 | 345.73 | 346.00 | 346.28 | 10.90 |
| 11.00 | 346.28 | 346.55 | 346.83 | 347.11 | 347.38 | 347.66 | 347.93 | 348.21 | 348.48 | 348.76 | 349.03 | 11.00 |
| 11.10 | 349.03 | 349.31 | 349.58 | 349.86 | 350.13 | 350.41 | 350.68 | 350.96 | 351.23 | 351.51 | 351.78 | 11.10 |
| 11.20 | 351.78 | 352.06 | 352.33 | 352.61 | 352.88 | 353.16 | 353.43 | 353.71 | 353.98 | 354.26 | 354.53 | 11.20 |
| 11.30 | 354.53 | 354.81 | 355.08 | 355.35 | 355.63 | 355.90 | 356.18 | 356.45 | 356.73 | 357.00 | 357.28 | 11.30 |
| 11.40 | 357.28 | 357.55 | 357.82 | 358.10 | 358.37 | 358.65 | 358.92 | 359.19 | 359.47 | 359.74 | 360.02 | 11.40 |
| 11.50 | 360.02 | 360.29 | 360.56 | 360.84 | 361.11 | 361.38 | 361.66 | 361.93 | 362.21 | 362.48 | 362.75 | 11.50 |
| 11.60 | 362.75 | 363.03 | 363.30 | 363.57 | 363.85 | 364.12 | 364.39 | 364.67 | 364.94 | 365.21 | 365.49 | 11.60 |
| 11.70 | 365.49 | 365.76 | 366.03 | 366.31 | 366.58 | 366.85 | 367.13 | 367.40 | 367.67 | 367.94 | 368.22 | 11.70 |
| 11.80 | 368.22 | 368.49 | 368.76 | 369.04 | 369.31 | 369.58 | 369.85 | 370.13 | 370.40 | 370.67 | 370.95 | 11.80 |
| 11.90 | 370.95 | 371.22 | 371.49 | 371.76 | 372.04 | 372.31 | 372.58 | 372.85 | 373.12 | 373.40 | 373.67 | 11.90 |
| 12.00 | 373.67 | 373.94 | 374.21 | 374.49 | 374.76 | 375.03 | 375.30 | 375.57 | 375.85 | 376.12 | 376.39 | 12.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B2.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.00 | 373.67 | 373.94 | 374.21 | 374.49 | 374.76 | 375.03 | 375.30 | 375.57 | 375.85 | 376.12 | 376.39 | 12.00 |
| 12.10 | 376.39 | 376.66 | 376.93 | 377.21 | 377.48 | 377.75 | 378.02 | 378.29 | 378.57 | 378.84 | 379.11 | 12.10 |
| 12.20 | 379.11 | 379.38 | 379.65 | 379.92 | 380.20 | 380.47 | 380.74 | 381.01 | 381.28 | 381.55 | 381.82 | 12.20 |
| 12.30 | 381.82 | 382.10 | 382.37 | 382.64 | 382.91 | 383.18 | 383.45 | 383.72 | 383.99 | 384.27 | 384.54 | 12.30 |
| 12.40 | 384.54 | 384.81 | 385.08 | 385.35 | 385.62 | 385.89 | 386.16 | 386.43 | 386.70 | 386.98 | 387.25 | 12.40 |
| 12.50 | 387.25 | 387.52 | 387.79 | 388.06 | 388.33 | 388.60 | 388.87 | 389.14 | 389.41 | 389.68 | 389.95 | 12.50 |
| 12.60 | 389.95 | 390.22 | 390.49 | 390.76 | 391.03 | 391.30 | 391.57 | 391.85 | 392.12 | 392.39 | 392.66 | 12.60 |
| 12.70 | 392.66 | 392.93 | 393.20 | 393.47 | 393.74 | 394.01 | 394.28 | 394.55 | 394.82 | 395.09 | 395.36 | 12.70 |
| 12.80 | 395.36 | 395.63 | 395.90 | 396.17 | 396.44 | 396.71 | 396.98 | 397.25 | 397.52 | 397.79 | 398.05 | 12.80 |
| 12.90 | 398.05 | 398.32 | 398.59 | 398.86 | 399.13 | 399.40 | 399.67 | 399.94 | 400.21 | 400.48 | 400.75 | 12.90 |
| 13.00 | 400.75 | 401.02 | 401.29 | 401.56 | 401.83 | 402.10 | 402.37 | 402.64 | 402.90 | 403.17 | 403.44 | 13.00 |
| 13.10 | 403.44 | 403.71 | 403.98 | 404.25 | 404.52 | 404.79 | 405.06 | 405.33 | 405.59 | 405.86 | 406.13 | 13.10 |
| 13.20 | 406.13 | 406.40 | 406.67 | 406.94 | 407.21 | 407.48 | 407.75 | 408.01 | 408.28 | 408.55 | 408.82 | 13.20 |
| 13.30 | 408.82 | 409.09 | 409.36 | 409.63 | 409.89 | 410.16 | 410.43 | 410.70 | 410.97 | 411.24 | 411.50 | 13.30 |
| 13.40 | 411.50 | 411.77 | 412.04 | 412.31 | 412.58 | 412.85 | 413.11 | 413.38 | 413.65 | 413.92 | 414.19 | 13.40 |
| 13.50 | 414.19 | 414.45 | 414.72 | 414.99 | 415.26 | 415.53 | 415.79 | 416.06 | 416.33 | 416.60 | 416.87 | 13.50 |
| 13.60 | 416.87 | 417.13 | 417.40 | 417.67 | 417.94 | 418.20 | 418.47 | 418.74 | 419.01 | 419.28 | 419.54 | 13.60 |
| 13.70 | 419.54 | 419.81 | 420.08 | 420.35 | 420.61 | 420.88 | 421.15 | 421.42 | 421.68 | 421.95 | 422.22 | 13.70 |
| 13.80 | 422.22 | 422.49 | 422.75 | 423.02 | 423.29 | 423.55 | 423.82 | 424.09 | 424.36 | 424.62 | 424.89 | 13.80 |
| 13.90 | 424.89 | 425.16 | 425.42 | 425.69 | 425.96 | 426.23 | 426.49 | 426.76 | 427.03 | 427.29 | 427.56 | 13.90 |
| 14.00 | 427.56 | 427.83 | 428.09 | 428.36 | 428.63 | 428.89 | 429.16 | 429.43 | 429.69 | 429.96 | 430.23 | 14.00 |
| 14.10 | 430.23 | 430.49 | 430.76 | 431.03 | 431.29 | 431.50 | 431.83 | 432.09 | 432.36 | 432.63 | 432.89 | 14.10 |
| 14.20 | 432.89 | 433.16 | 433.42 | 433.69 | 433.96 | 434.22 | 434.49 | 434.76 | 435.02 | 435.29 | 435.55 | 14.20 |
| 14.30 | 435.55 | 435.82 | 436.09 | 436.35 | 436.62 | 436.89 | 437.15 | 437.42 | 437.68 | 437.95 | 438.22 | 14.30 |
| 14.40 | 438.22 | 438.48 | 438.75 | 439.01 | 439.28 | 439.54 | 439.81 | 440.08 | 440.34 | 440.61 | 440.87 | 14.40 |
| 14.50 | 440.87 | 441.14 | 441.40 | 441.67 | 441.94 | 442.20 | 442.47 | 442.73 | 443.00 | 443.26 | 443.53 | 14.50 |
| 14.60 | 443.53 | 443.79 | 444.06 | 444.33 | 444.59 | 444.86 | 445.12 | 445.39 | 445.65 | 445.92 | 446.18 | 14.60 |
| 14.70 | 446.18 | 446.45 | 446.71 | 446.98 | 447.24 | 447.51 | 447.77 | 448.04 | 448.30 | 448.57 | 448.83 | 14.70 |
| 14.80 | 448.83 | 449.10 | 449.36 | 449.63 | 449.89 | 450.16 | 450.42 | 450.69 | 450.95 | 451.22 | 451.48 | 14.80 |
| 14.90 | 451.48 | 451.75 | 452.01 | 452.28 | 452.54 | 452.81 | 453.07 | 453.34 | 453.60 | 453.87 | 454.13 | 14.90 |
| 15.00 | 454.13 | 454.40 | 454.66 | 454.93 | 455.19 | 455.45 | 455.72 | 455.98 | 456.25 | 456.51 | 456.78 | 15.00 |
| 15.10 | 456.78 | 457.04 | 457.31 | 457.57 | 457.83 | 458.10 | 458.36 | 458.63 | 458.89 | 459.16 | 459.42 | 15.10 |
| 15.20 | 459.42 | 459.68 | 459.95 | 460.21 | 460.48 | 460.74 | 461.01 | 461.27 | 461.53 | 461.80 | 462.06 | 15.20 |
| 15.30 | 462.06 | 462.33 | 462.59 | 462.85 | 463.12 | 463.38 | 463.65 | 463.91 | 464.17 | 464.44 | 464.70 | 15.30 |
| 15.40 | 464.70 | 464.96 | 465.23 | 465.49 | 465.76 | 466.02 | 466.28 | 466.55 | 466.81 | 467.07 | 467.34 | 15.40 |
| 15.50 | 467.34 | 467.60 | 467.86 | 468.13 | 468.39 | 468.66 | 468.92 | 469.18 | 469.45 | 469.71 | 469.97 | 15.50 |
| 15.60 | 469.97 | 470.24 | 470.50 | 470.76 | 471.03 | 471.29 | 471.55 | 471.82 | 472.08 | 472.34 | 472.61 | 15.60 |
| 15.70 | 472.61 | 472.87 | 473.13 | 473.40 | 473.66 | 473.92 | 474.19 | 474.45 | 474.71 | 474.97 | 475.24 | 15.70 |
| 15.80 | 475.24 | 475.50 | 475.76 | 476.03 | 476.29 | 476.55 | 476.82 | 477.08 | 477.34 | 477.60 | 477.87 | 15.80 |
| 15.90 | 477.87 | 478.13 | 478.39 | 478.66 | 478.92 | 479.18 | 479.44 | 479.71 | 479.97 | 480.23 | 480.50 | 15.90 |
| 16.00 | 480.50 | 480.76 | 481.02 | 481.28 | 481.55 | 481.81 | 482.07 | 482.33 | 482.60 | 482.86 | 483.12 | 16.00 |
| 16.10 | 483.12 | 483.38 | 483.65 | 483.91 | 484.17 | 484.43 | 484.70 | 484.96 | 485.22 | 485.48 | 485.75 | 16.10 |
| 16.20 | 485.75 | 486.01 | 486.27 | 486.53 | 486.79 | 487.06 | 487.32 | 487.58 | 487.84 | 488.11 | 488.37 | 16.20 |
| 16.30 | 488.37 | 488.63 | 488.89 | 489.15 | 489.42 | 489.68 | 489.94 | 490.20 | 490.46 | 490.73 | 490.99 | 16.30 |
| 16.40 | 490.99 | 491.25 | 491.51 | 491.77 | 492.04 | 492.30 | 492.56 | 492.82 | 493.08 | 493.34 | 493.61 | 16.40 |
| 16.50 | 493.61 | 493.87 | 494.13 | 494.39 | 494.65 | 494.92 | 495.18 | 495.44 | 495.70 | 495.96 | 496.22 | 16.50 |
| 16.60 | 496.22 | 496.49 | 496.75 | 497.01 | 497.27 | 497.53 | 497.79 | 498.05 | 498.32 | 498.58 | 498.84 | 16.60 |
| 16.70 | 498.84 | 499.10 | 499.36 | 499.62 | 499.89 | 500.15 | 500.41 | 500.67 | 500.93 | 501.19 | 501.45 | 16.70 |
| 16.80 | 501.45 | 501.71 | 501.98 | 502.24 | 502.50 | 502.76 | 503.02 | 503.28 | 503.54 | 503.80 | 504.07 | 16.80 |
| 16.90 | 504.07 | 504.33 | 504.59 | 504.85 | 505.11 | 505.37 | 505.63 | 505.89 | 506.15 | 506.41 | 506.68 | 16.90 |
| 17.00 | 506.68 | 506.94 | 507.20 | 507.46 | 507.72 | 507.98 | 508.24 | 508.50 | 508.76 | 509.02 | 509.28 | 17.00 |
| 17.10 | 509.28 | 509.55 | 509.81 | 510.07 | 510.33 | 510.59 | 510.85 | 511.11 | 511.37 | 511.63 | 511.89 | 17.10 |
| 17.20 | 511.89 | 512.15 | 512.41 | 512.67 | 512.93 | 513.20 | 513.46 | 513.72 | 513.98 | 514.24 | 514.50 | 17.20 |
| 17.30 | 514.50 | 514.76 | 515.02 | 515.28 | 515.54 | 515.80 | 516.06 | 516.32 | 516.58 | 516.84 | 517.10 | 17.30 |
| 17.40 | 517.10 | 517.36 | 517.62 | 517.88 | 518.14 | 518.40 | 518.66 | 518.92 | 519.18 | 519.44 | 519.71 | 17.40 |
| 17.50 | 519.71 | 519.97 | 520.23 | 520.49 | 520.75 | 521.01 | 521.27 | 521.53 | 521.79 | 522.05 | 522.31 | 17.50 |
| 17.60 | 522.31 | 522.57 | 522.83 | 523.09 | 523.35 | 523.61 | 523.87 | 524.13 | 524.39 | 524.65 | 524.91 | 17.60 |
| 17.70 | 524.91 | 525.17 | 525.43 | 525.69 | 525.95 | 526.21 | 526.47 | 526.73 | 526.99 | 527.24 | 527.50 | 17.70 |
| 17.80 | 527.50 | 527.76 | 528.02 | 528.28 | 528.54 | 528.80 | 529.06 | 529.32 | 529.58 | 529.84 | 530.10 | 17.80 |
| 17.90 | 530.10 | 530.36 | 530.62 | 530.88 | 531.14 | 531.40 | 531.66 | 531.92 | 532.18 | 532.44 | 532.70 | 17.90 |
| 18.00 | 532.70 | 532.96 | 533.22 | 533.48 | 533.74 | 533.99 | 534.25 | 534.51 | 534.77 | 535.03 | 535.29 | 18.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

Table B2. AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.00 | 532.70 | 532.96 | 533.22 | 533.48 | 533.74 | 533.99 | 534.25 | 534.51 | 534.77 | 535.03 | 535.29 | 18.00 |
| 18.10 | 535.29 | 535.55 | 535.81 | 536.07 | 536.33 | 536.59 | 536.85 | 537.11 | 537.37 | 537.63 | 537.88 | 18.10 |
| 18.20 | 537.88 | 538.14 | 538.40 | 538.66 | 538.92 | 539.18 | 539.44 | 539.70 | 539.96 | 540.22 | 540.48 | 18.20 |
| 18.30 | 540.48 | 540.74 | 540.99 | 541.25 | 541.51 | 541.77 | 542.03 | 542.29 | 542.55 | 542.81 | 543.07 | 18.30 |
| 18.40 | 543.07 | 543.33 | 543.58 | 543.84 | 544.10 | 544.36 | 544.62 | 544.88 | 545.14 | 545.40 | 545.66 | 18.40 |
| 18.50 | 545.66 | 545.91 | 546.17 | 546.43 | 546.69 | 546.95 | 547.21 | 547.47 | 547.73 | 547.98 | 548.24 | 18.50 |
| 18.60 | 548.24 | 548.50 | 548.76 | 549.02 | 549.28 | 549.54 | 549.80 | 550.05 | 550.31 | 550.57 | 550.83 | 18.60 |
| 18.70 | 550.83 | 551.09 | 551.35 | 551.61 | 551.86 | 552.12 | 552.38 | 552.64 | 552.90 | 553.16 | 553.41 | 18.70 |
| 18.80 | 553.41 | 553.67 | 553.93 | 554.19 | 554.45 | 554.71 | 554.97 | 555.22 | 555.48 | 555.74 | 556.00 | 18.80 |
| 18.90 | 556.00 | 556.26 | 556.52 | 556.77 | 557.03 | 557.29 | 557.55 | 557.81 | 558.06 | 558.32 | 558.58 | 18.90 |
| 19.00 | 558.58 | 558.84 | 559.10 | 559.36 | 559.61 | 559.87 | 560.13 | 560.39 | 560.65 | 560.90 | 561.16 | 19.00 |
| 19.10 | 561.16 | 561.42 | 561.68 | 561.94 | 562.20 | 562.45 | 562.71 | 562.97 | 563.23 | 563.49 | 563.74 | 19.10 |
| 19.20 | 563.74 | 564.00 | 564.26 | 564.52 | 564.78 | 565.03 | 565.29 | 565.55 | 565.81 | 566.07 | 566.32 | 19.20 |
| 19.30 | 566.32 | 566.58 | 566.84 | 567.10 | 567.35 | 567.61 | 567.87 | 568.13 | 568.39 | 568.64 | 568.90 | 19.30 |
| 19.40 | 568.90 | 569.16 | 569.42 | 569.67 | 569.93 | 570.19 | 570.45 | 570.71 | 570.96 | 571.22 | 571.48 | 19.40 |
| 19.50 | 571.48 | 571.74 | 571.99 | 572.25 | 572.51 | 572.77 | 573.02 | 573.28 | 573.54 | 573.80 | 574.05 | 19.50 |
| 19.60 | 574.05 | 574.31 | 574.57 | 574.83 | 575.08 | 575.34 | 575.60 | 575.86 | 576.11 | 576.37 | 576.63 | 19.60 |
| 19.70 | 576.63 | 576.89 | 577.14 | 577.40 | 577.66 | 577.92 | 578.17 | 578.43 | 578.69 | 578.95 | 579.20 | 19.70 |
| 19.80 | 579.20 | 579.46 | 579.72 | 579.98 | 580.23 | 580.49 | 580.75 | 581.00 | 581.26 | 581.52 | 581.78 | 19.80 |
| 19.90 | 581.78 | 582.03 | 582.29 | 582.55 | 582.81 | 583.06 | 583.32 | 583.58 | 583.83 | 584.09 | 584.35 | 19.90 |
| 20.00 | 584.35 | 584.61 | 584.86 | 585.12 | 585.38 | 585.63 | 585.89 | 586.15 | 586.41 | 586.66 | 586.92 | 20.00 |
| 20.10 | 586.92 | 587.18 | 587.43 | 587.69 | 587.95 | 588.20 | 588.46 | 588.72 | 588.98 | 589.23 | 589.49 | 20.10 |
| 20.20 | 589.49 | 589.75 | 590.00 | 590.26 | 590.52 | 590.77 | 591.03 | 591.29 | 591.54 | 591.80 | 592.06 | 20.20 |
| 20.30 | 592.06 | 592.32 | 592.57 | 592.83 | 593.09 | 593.34 | 593.60 | 593.86 | 594.11 | 594.37 | 594.63 | 20.30 |
| 20.40 | 594.63 | 594.88 | 595.14 | 595.40 | 595.65 | 595.91 | 596.17 | 596.42 | 596.68 | 596.94 | 597.19 | 20.40 |
| 20.50 | 597.19 | 597.45 | 597.71 | 597.96 | 598.22 | 598.48 | 598.73 | 598.99 | 599.25 | 599.50 | 599.76 | 20.50 |
| 20.60 | 599.76 | 600.02 | 600.27 | 600.53 | 600.79 | 601.04 | 601.30 | 601.56 | 601.81 | 602.07 | 602.33 | 20.60 |
| 20.70 | 602.33 | 602.58 | 602.84 | 603.10 | 603.35 | 603.61 | 603.86 | 604.12 | 604.38 | 604.63 | 604.89 | 20.70 |
| 20.80 | 604.89 | 605.15 | 605.40 | 605.66 | 605.92 | 606.17 | 606.43 | 606.69 | 606.94 | 607.20 | 607.45 | 20.80 |
| 20.90 | 607.45 | 607.71 | 607.97 | 608.22 | 608.48 | 608.74 | 608.99 | 609.25 | 609.50 | 609.76 | 610.02 | 20.90 |
| 21.00 | 610.02 | 610.27 | 610.53 | 610.79 | 611.04 | 611.30 | 611.55 | 611.81 | 612.07 | 612.32 | 612.58 | 21.00 |
| 21.10 | 612.58 | 612.84 | 613.09 | 613.35 | 613.60 | 613.86 | 614.12 | 614.37 | 614.63 | 614.88 | 615.14 | 21.10 |
| 21.20 | 615.14 | 615.40 | 615.65 | 615.91 | 616.17 | 616.42 | 616.68 | 616.93 | 617.19 | 617.45 | 617.70 | 21.20 |
| 21.30 | 617.70 | 617.96 | 618.21 | 618.47 | 618.73 | 618.98 | 619.24 | 619.49 | 619.75 | 620.01 | 620.26 | 21.30 |
| 21.40 | 620.26 | 620.52 | 620.77 | 621.03 | 621.29 | 621.54 | 621.80 | 622.05 | 622.31 | 622.56 | 622.82 | 21.40 |
| 21.50 | 622.82 | 623.08 | 623.33 | 623.59 | 623.84 | 624.10 | 624.36 | 624.61 | 624.87 | 625.12 | 625.38 | 21.50 |
| 21.60 | 625.38 | 625.63 | 625.89 | 626.15 | 626.40 | 626.66 | 626.91 | 627.17 | 627.43 | 627.68 | 627.94 | 21.60 |
| 21.70 | 627.94 | 628.19 | 628.45 | 628.70 | 628.96 | 629.22 | 629.47 | 629.73 | 629.98 | 630.24 | 630.49 | 21.70 |
| 21.80 | 630.49 | 630.75 | 631.01 | 631.26 | 631.52 | 631.77 | 632.03 | 632.28 | 632.54 | 632.79 | 633.05 | 21.80 |
| 21.90 | 633.05 | 633.31 | 633.56 | 633.82 | 634.07 | 634.33 | 634.58 | 634.84 | 635.10 | 635.35 | 635.61 | 21.90 |
| 22.00 | 635.61 | 635.86 | 636.12 | 636.37 | 636.63 | 636.88 | 637.14 | 637.40 | 637.65 | 637.91 | 638.16 | 22.00 |
| 22.10 | 638.16 | 638.42 | 638.67 | 638.93 | 639.18 | 639.44 | 639.69 | 639.95 | 640.21 | 640.46 | 640.72 | 22.10 |
| 22.20 | 640.72 | 640.97 | 641.23 | 641.48 | 641.74 | 641.99 | 642.25 | 642.50 | 642.76 | 643.01 | 643.27 | 22.20 |
| 22.30 | 643.27 | 643.53 | 643.78 | 644.04 | 644.29 | 644.55 | 644.80 | 645.06 | 645.31 | 645.57 | 645.82 | 22.30 |
| 22.40 | 645.82 | 646.08 | 646.33 | 646.59 | 646.84 | 647.10 | 647.36 | 647.61 | 647.87 | 648.12 | 648.38 | 22.40 |
| 22.50 | 648.38 | 648.63 | 648.89 | 649.14 | 649.40 | 649.65 | 649.91 | 650.16 | 650.42 | 650.67 | 650.93 | 22.50 |
| 22.60 | 650.93 | 651.18 | 651.44 | 651.69 | 651.95 | 652.20 | 652.46 | 652.72 | 652.97 | 653.23 | 653.48 | 22.60 |
| 22.70 | 653.48 | 653.74 | 653.99 | 654.25 | 654.50 | 654.76 | 655.01 | 655.27 | 655.52 | 655.78 | 656.03 | 22.70 |
| 22.80 | 656.03 | 656.29 | 656.54 | 656.80 | 657.05 | 657.31 | 657.56 | 657.82 | 658.07 | 658.33 | 658.58 | 22.80 |
| 22.90 | 658.58 | 658.84 | 659.09 | 659.35 | 659.60 | 659.86 | 660.11 | 660.37 | 660.62 | 660.88 | 661.13 | 22.90 |
| 23.00 | 661.13 | 661.39 | 661.64 | 661.90 | 662.15 | 662.41 | 662.66 | 662.92 | 663.17 | 663.43 | 663.68 | 23.00 |
| 23.10 | 663.68 | 663.94 | 664.19 | 664.45 | 664.70 | 664.96 | 665.21 | 665.47 | 665.72 | 665.98 | 666.23 | 23.10 |
| 23.20 | 666.23 | 666.49 | 666.74 | 667.00 | 667.25 | 667.51 | 667.76 | 668.02 | 668.27 | 668.53 | 668.78 | 23.20 |
| 23.30 | 668.78 | 669.04 | 669.29 | 669.55 | 669.80 | 670.06 | 670.31 | 670.57 | 670.82 | 671.08 | 671.33 | 23.30 |
| 23.40 | 671.33 | 671.59 | 671.84 | 672.09 | 672.35 | 672.60 | 672.86 | 673.11 | 673.37 | 673.62 | 673.88 | 23.40 |
| 23.50 | 673.88 | 674.13 | 674.39 | 674.64 | 674.90 | 675.15 | 675.41 | 675.66 | 675.92 | 676.17 | 676.43 | 23.50 |
| 23.60 | 676.43 | 676.68 | 676.94 | 677.19 | 677.45 | 677.70 | 677.95 | 678.21 | 678.46 | 678.72 | 678.97 | 23.60 |
| 23.70 | 678.97 | 679.23 | 679.48 | 679.74 | 679.99 | 680.25 | 680.50 | 680.76 | 681.01 | 681.27 | 681.52 | 23.70 |
| 23.80 | 681.52 | 681.78 | 682.03 | 682.29 | 682.54 | 682.79 | 683.05 | 683.30 | 683.56 | 683.81 | 684.07 | 23.80 |
| 23.90 | 684.07 | 684.32 | 684.58 | 684.83 | 685.09 | 685.34 | 685.60 | 685.85 | 686.11 | 686.36 | 686.61 | 23.90 |
| 24.00 | 686.61 | 686.87 | 687.12 | 687.38 | 687.63 | 687.89 | 688.14 | 688.40 | 688.65 | 688.91 | 689.16 | 24.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B2.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.00 | 686.61 | 686.87 | 687.12 | 687.38 | 687.63 | 687.89 | 688.14 | 688.40 | 688.65 | 688.91 | 689.16 | 24.00 |
| 24.10 | 689.16 | 689.42 | 689.67 | 689.92 | 690.18 | 690.43 | 690.69 | 690.94 | 691.20 | 691.45 | 691.71 | 24.10 |
| 24.20 | 691.71 | 691.96 | 692.22 | 692.47 | 692.72 | 692.98 | 693.23 | 693.49 | 693.74 | 694.00 | 694.25 | 24.20 |
| 24.30 | 694.25 | 694.51 | 694.76 | 695.02 | 695.27 | 695.53 | 695.78 | 696.03 | 696.29 | 696.54 | 696.80 | 24.30 |
| 24.40 | 696.80 | 697.05 | 697.31 | 697.56 | 697.82 | 698.07 | 698.32 | 698.58 | 698.83 | 699.09 | 699.34 | 24.40 |
| 24.50 | 699.34 | 699.60 | 699.85 | 700.11 | 700.36 | 700.62 | 700.87 | 701.12 | 701.38 | 701.63 | 701.89 | 24.50 |
| 24.60 | 701.89 | 702.14 | 702.40 | 702.65 | 702.91 | 703.16 | 703.41 | 703.67 | 703.92 | 704.18 | 704.43 | 24.60 |
| 24.70 | 704.43 | 704.69 | 704.94 | 705.20 | 705.45 | 705.70 | 705.96 | 706.21 | 706.47 | 706.72 | 706.98 | 24.70 |
| 24.80 | 706.98 | 707.23 | 707.49 | 707.74 | 707.99 | 708.25 | 708.50 | 708.76 | 709.01 | 709.27 | 709.52 | 24.80 |
| 24.90 | 709.52 | 709.78 | 710.03 | 710.28 | 710.54 | 710.79 | 711.05 | 711.30 | 711.56 | 711.81 | 712.07 | 24.90 |
| 25.00 | 712.07 | 712.32 | 712.57 | 712.83 | 713.08 | 713.34 | 713.59 | 713.85 | 714.10 | 714.36 | 714.61 | 25.00 |
| 25.10 | 714.61 | 714.86 | 715.12 | 715.37 | 715.63 | 715.88 | 716.14 | 716.39 | 716.65 | 716.90 | 717.15 | 25.10 |
| 25.20 | 717.15 | 717.41 | 717.66 | 717.92 | 718.17 | 718.43 | 718.68 | 718.93 | 719.19 | 719.44 | 719.70 | 25.20 |
| 25.30 | 719.70 | 719.95 | 720.21 | 720.46 | 720.72 | 720.97 | 721.22 | 721.48 | 721.73 | 721.99 | 722.24 | 25.30 |
| 25.40 | 722.24 | 722.50 | 722.75 | 723.00 | 723.26 | 723.51 | 723.77 | 724.02 | 724.28 | 724.53 | 724.79 | 25.40 |
| 25.50 | 724.79 | 725.04 | 725.29 | 725.55 | 725.80 | 726.06 | 726.31 | 726.57 | 726.82 | 727.07 | 727.33 | 25.50 |
| 25.60 | 727.33 | 727.58 | 727.84 | 728.09 | 728.35 | 728.60 | 728.85 | 729.11 | 729.36 | 729.62 | 729.87 | 25.60 |
| 25.70 | 729.87 | 730.13 | 730.38 | 730.64 | 730.89 | 731.14 | 731.40 | 731.65 | 731.91 | 732.16 | 732.42 | 25.70 |
| 25.80 | 732.42 | 732.67 | 732.92 | 733.18 | 733.43 | 733.69 | 733.94 | 734.20 | 734.45 | 734.70 | 734.96 | 25.80 |
| 25.90 | 734.96 | 735.21 | 735.47 | 735.72 | 735.98 | 736.23 | 736.48 | 736.74 | 736.99 | 737.25 | 737.50 | 25.90 |
| 26.00 | 737.50 | 737.76 | 738.01 | 738.27 | 738.52 | 738.77 | 739.03 | 739.28 | 739.54 | 739.79 | 740.05 | 26.00 |
| 26.10 | 740.05 | 740.30 | 740.55 | 740.81 | 741.06 | 741.32 | 741.57 | 741.83 | 742.08 | 742.33 | 742.59 | 26.10 |
| 26.20 | 742.59 | 742.84 | 743.10 | 743.35 | 743.61 | 743.86 | 744.12 | 744.37 | 744.62 | 744.88 | 745.13 | 26.20 |
| 26.30 | 745.13 | 745.39 | 745.64 | 745.90 | 746.15 | 746.40 | 746.66 | 746.91 | 747.17 | 747.42 | 747.68 | 26.30 |
| 26.40 | 747.68 | 747.93 | 748.18 | 748.44 | 748.69 | 748.95 | 749.20 | 749.46 | 749.71 | 749.96 | 750.22 | 26.40 |
| 26.50 | 750.22 | 750.47 | 750.73 | 750.98 | 751.24 | 751.49 | 751.75 | 752.00 | 752.25 | 752.51 | 752.76 | 26.50 |
| 26.60 | 752.76 | 753.02 | 753.27 | 753.53 | 753.78 | 754.03 | 754.29 | 754.54 | 754.80 | 755.05 | 755.31 | 26.60 |
| 26.70 | 755.31 | 755.56 | 755.82 | 756.07 | 756.32 | 756.58 | 756.83 | 757.09 | 757.34 | 757.60 | 757.85 | 26.70 |
| 26.80 | 757.85 | 758.10 | 758.36 | 758.61 | 758.87 | 759.12 | 759.38 | 759.63 | 759.89 | 760.14 | 760.39 | 26.80 |
| 26.90 | 760.39 | 760.65 | 760.90 | 761.16 | 761.41 | 761.67 | 761.92 | 762.17 | 762.43 | 762.68 | 762.94 | 26.90 |
| 27.00 | 762.94 | 763.19 | 763.45 | 763.70 | 763.96 | 764.21 | 764.46 | 764.72 | 764.97 | 765.23 | 765.48 | 27.00 |
| 27.10 | 765.48 | 765.74 | 765.99 | 766.24 | 766.50 | 766.75 | 767.01 | 767.26 | 767.52 | 767.77 | 768.03 | 27.10 |
| 27.20 | 768.03 | 768.28 | 768.53 | 768.79 | 769.04 | 769.30 | 769.55 | 769.81 | 770.06 | 770.32 | 770.57 | 27.20 |
| 27.30 | 770.57 | 770.82 | 771.08 | 771.33 | 771.59 | 771.84 | 772.10 | 772.35 | 772.61 | 772.86 | 773.11 | 27.30 |
| 27.40 | 773.11 | 773.37 | 773.62 | 773.88 | 774.13 | 774.39 | 774.64 | 774.90 | 775.15 | 775.40 | 775.66 | 27.40 |
| 27.50 | 775.66 | 775.91 | 776.17 | 776.42 | 776.68 | 776.93 | 777.19 | 777.44 | 777.69 | 777.95 | 778.20 | 27.50 |
| 27.60 | 778.20 | 778.46 | 778.71 | 778.97 | 779.22 | 779.48 | 779.73 | 779.99 | 780.24 | 780.49 | 780.75 | 27.60 |
| 27.70 | 780.75 | 781.00 | 781.26 | 781.51 | 781.77 | 782.02 | 782.28 | 782.53 | 782.78 | 783.04 | 783.29 | 27.70 |
| 27.80 | 783.29 | 783.55 | 783.80 | 784.06 | 784.31 | 784.57 | 784.82 | 785.08 | 785.33 | 785.58 | 785.84 | 27.80 |
| 27.90 | 785.84 | 786.09 | 786.35 | 786.60 | 786.86 | 787.11 | 787.37 | 787.62 | 787.88 | 788.13 | 788.38 | 27.90 |
| 28.00 | 788.38 | 788.64 | 788.89 | 789.15 | 789.40 | 789.66 | 789.91 | 790.17 | 790.42 | 790.68 | 790.93 | 28.00 |
| 28.10 | 790.93 | 791.19 | 791.44 | 791.69 | 791.95 | 792.20 | 792.46 | 792.71 | 792.97 | 793.22 | 793.48 | 28.10 |
| 28.20 | 793.48 | 793.73 | 793.99 | 794.24 | 794.50 | 794.75 | 795.00 | 795.26 | 795.51 | 795.77 | 796.02 | 28.20 |
| 28.30 | 796.02 | 796.28 | 796.53 | 796.79 | 797.04 | 797.30 | 797.55 | 797.81 | 798.06 | 798.32 | 798.57 | 28.30 |
| 28.40 | 798.57 | 798.82 | 799.08 | 799.33 | 799.59 | 799.84 | 800.10 | 800.35 | 800.61 | 800.86 | 801.12 | 28.40 |
| 28.50 | 801.12 | 801.37 | 801.63 | 801.88 | 802.14 | 802.39 | 802.64 | 802.90 | 803.15 | 803.41 | 803.66 | 28.50 |
| 28.60 | 803.66 | 803.92 | 804.17 | 804.43 | 804.68 | 804.94 | 805.19 | 805.45 | 805.70 | 805.96 | 806.21 | 28.60 |
| 28.70 | 806.21 | 806.47 | 806.72 | 806.98 | 807.23 | 807.49 | 807.74 | 807.99 | 808.25 | 808.50 | 808.76 | 28.70 |
| 28.80 | 808.76 | 809.01 | 809.27 | 809.52 | 809.78 | 810.03 | 810.29 | 810.54 | 810.80 | 811.05 | 811.31 | 28.80 |
| 28.90 | 811.31 | 811.56 | 811.82 | 812.07 | 812.33 | 812.58 | 812.84 | 813.09 | 813.35 | 813.60 | 813.86 | 28.90 |
| 29.00 | 813.86 | 814.11 | 814.37 | 814.62 | 814.88 | 815.13 | 815.38 | 815.64 | 815.89 | 816.15 | 816.40 | 29.00 |
| 29.10 | 816.40 | 816.66 | 816.91 | 817.17 | 817.42 | 817.68 | 817.93 | 818.19 | 818.44 | 818.70 | 818.95 | 29.10 |
| 29.20 | 818.95 | 819.21 | 819.46 | 819.72 | 819.97 | 820.23 | 820.48 | 820.74 | 820.99 | 821.25 | 821.50 | 29.20 |
| 29.30 | 821.50 | 821.76 | 822.01 | 822.27 | 822.52 | 822.78 | 823.03 | 823.29 | 823.54 | 823.80 | 824.05 | 29.30 |
| 29.40 | 824.05 | 824.31 | 824.56 | 824.82 | 825.07 | 825.33 | 825.58 | 825.84 | 826.09 | 826.35 | 826.60 | 29.40 |
| 29.50 | 826.60 | 826.86 | 827.11 | 827.37 | 827.62 | 827.88 | 828.13 | 828.39 | 828.64 | 828.90 | 829.15 | 29.50 |
| 29.60 | 829.15 | 829.41 | 829.66 | 829.92 | 830.17 | 830.43 | 830.68 | 830.94 | 831.19 | 831.45 | 831.70 | 29.60 |
| 29.70 | 831.70 | 831.96 | 832.22 | 832.47 | 832.73 | 832.98 | 833.24 | 833.49 | 833.75 | 834.00 | 834.26 | 29.70 |
| 29.80 | 834.26 | 834.51 | 834.77 | 835.02 | 835.28 | 835.53 | 835.79 | 836.04 | 836.30 | 836.55 | 836.81 | 29.80 |
| 29.90 | 836.81 | 837.06 | 837.32 | 837.57 | 837.83 | 838.08 | 838.34 | 838.59 | 838.85 | 839.11 | 839.36 | 29.90 |
| 30.00 | 839.36 | 839.62 | 839.87 | 840.13 | 840.38 | 840.64 | 840.89 | 841.15 | 841.40 | 841.66 | 841.91 | 30.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**TABLE B2.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30.00 | 839.36 | 839.62 | 839.87 | 840.13 | 840.38 | 840.64 | 840.89 | 841.15 | 841.40 | 841.66 | 841.91 | 30.00 |
| 30.10 | 841.91 | 842.17 | 842.42 | 842.68 | 842.93 | 843.19 | 843.45 | 843.70 | 843.96 | 844.21 | 844.47 | 30.10 |
| 30.20 | 844.47 | 844.72 | 844.98 | 845.23 | 845.49 | 845.74 | 846.00 | 846.25 | 846.51 | 846.76 | 847.02 | 30.20 |
| 30.30 | 847.02 | 847.28 | 847.53 | 847.79 | 848.04 | 848.30 | 848.55 | 848.81 | 849.06 | 849.32 | 849.57 | 30.30 |
| 30.40 | 849.57 | 849.83 | 850.08 | 850.34 | 850.60 | 850.85 | 851.11 | 851.36 | 851.62 | 851.87 | 852.13 | 30.40 |
| 30.50 | 852.13 | 852.38 | 852.64 | 852.90 | 853.15 | 853.41 | 853.66 | 853.92 | 854.17 | 854.43 | 854.68 | 30.50 |
| 30.60 | 854.68 | 854.94 | 855.19 | 855.45 | 855.71 | 855.96 | 856.22 | 856.47 | 856.73 | 856.98 | 857.24 | 30.60 |
| 30.70 | 857.24 | 857.49 | 857.75 | 858.01 | 858.26 | 858.52 | 858.77 | 859.03 | 859.28 | 859.54 | 859.80 | 30.70 |
| 30.80 | 859.80 | 860.05 | 860.31 | 860.56 | 860.82 | 861.07 | 861.33 | 861.58 | 861.84 | 862.10 | 862.35 | 30.80 |
| 30.90 | 862.35 | 862.61 | 862.86 | 863.12 | 863.37 | 863.63 | 863.89 | 864.14 | 864.40 | 864.65 | 864.91 | 30.90 |
| 31.00 | 864.91 | 865.16 | 865.42 | 865.68 | 865.93 | 866.19 | 866.44 | 866.70 | 866.95 | 867.21 | 867.47 | 31.00 |
| 31.10 | 867.47 | 867.72 | 867.98 | 868.23 | 868.49 | 868.75 | 869.00 | 869.26 | 869.51 | 869.77 | 870.02 | 31.10 |
| 31.20 | 870.02 | 870.28 | 870.54 | 870.79 | 871.05 | 871.30 | 871.56 | 871.82 | 872.07 | 872.33 | 872.58 | 31.20 |
| 31.30 | 872.58 | 872.84 | 873.09 | 873.35 | 873.61 | 873.86 | 874.12 | 874.37 | 874.63 | 874.89 | 875.14 | 31.30 |
| 31.40 | 875.14 | 875.40 | 875.65 | 875.91 | 876.17 | 876.42 | 876.68 | 876.93 | 877.19 | 877.45 | 877.70 | 31.40 |
| 31.50 | 877.70 | 877.96 | 878.21 | 878.47 | 878.73 | 878.98 | 879.24 | 879.49 | 879.75 | 880.01 | 880.26 | 31.50 |
| 31.60 | 880.26 | 880.52 | 880.77 | 881.03 | 881.29 | 881.54 | 881.80 | 882.05 | 882.31 | 882.57 | 882.82 | 31.60 |
| 31.70 | 882.82 | 883.08 | 883.34 | 883.59 | 883.85 | 884.10 | 884.36 | 884.62 | 884.87 | 885.13 | 885.38 | 31.70 |
| 31.80 | 885.38 | 885.64 | 885.90 | 886.15 | 886.41 | 886.67 | 886.92 | 887.18 | 887.43 | 887.69 | 887.95 | 31.80 |
| 31.90 | 887.95 | 888.20 | 888.46 | 888.72 | 888.97 | 889.23 | 889.48 | 889.74 | 890.00 | 890.25 | 890.51 | 31.90 |
| 32.00 | 890.51 | 890.77 | 891.02 | 891.28 | 891.53 | 891.79 | 892.05 | 892.30 | 892.56 | 892.82 | 893.07 | 32.00 |
| 32.10 | 893.07 | 893.33 | 893.58 | 893.84 | 894.10 | 894.35 | 894.61 | 894.87 | 895.12 | 895.38 | 895.64 | 32.10 |
| 32.20 | 895.64 | 895.89 | 896.15 | 896.41 | 896.66 | 896.92 | 897.17 | 897.43 | 897.69 | 897.94 | 898.20 | 32.20 |
| 32.30 | 898.20 | 898.46 | 898.71 | 898.97 | 899.23 | 899.48 | 899.74 | 900.00 | 900.25 | 900.51 | 900.77 | 32.30 |
| 32.40 | 900.77 | 901.02 | 901.28 | 901.54 | 901.79 | 902.05 | 902.30 | 902.56 | 902.82 | 903.07 | 903.33 | 32.40 |
| 32.50 | 903.33 | 903.59 | 903.84 | 904.10 | 904.36 | 904.61 | 904.87 | 905.13 | 905.38 | 905.64 | 905.90 | 32.50 |
| 32.60 | 905.90 | 906.15 | 906.41 | 906.67 | 906.92 | 907.18 | 907.44 | 907.69 | 907.95 | 908.21 | 908.46 | 32.60 |
| 32.70 | 908.46 | 908.72 | 908.98 | 909.23 | 909.49 | 909.75 | 910.00 | 910.26 | 910.52 | 910.77 | 911.03 | 32.70 |
| 32.80 | 911.03 | 911.29 | 911.55 | 911.80 | 912.06 | 912.32 | 912.57 | 912.83 | 913.09 | 913.34 | 913.60 | 32.80 |
| 32.90 | 913.60 | 913.86 | 914.11 | 914.37 | 914.63 | 914.88 | 915.14 | 915.40 | 915.65 | 915.91 | 916.17 | 32.90 |
| 33.00 | 916.17 | 916.43 | 916.68 | 916.94 | 917.20 | 917.45 | 917.71 | 917.97 | 918.22 | 918.48 | 918.74 | 33.00 |
| 33.10 | 918.74 | 919.00 | 919.25 | 919.51 | 919.77 | 920.02 | 920.28 | 920.54 | 920.79 | 921.05 | 921.31 | 33.10 |
| 33.20 | 921.31 | 921.57 | 921.82 | 922.08 | 922.34 | 922.59 | 922.85 | 923.11 | 923.36 | 923.62 | 923.88 | 33.20 |
| 33.30 | 923.88 | 924.14 | 924.39 | 924.65 | 924.91 | 925.16 | 925.42 | 925.68 | 925.94 | 926.19 | 926.45 | 33.30 |
| 33.40 | 926.45 | 926.71 | 926.96 | 927.22 | 927.48 | 927.74 | 927.99 | 928.25 | 928.51 | 928.77 | 929.02 | 33.40 |
| 33.50 | 929.02 | 929.28 | 929.54 | 929.79 | 930.05 | 930.31 | 930.57 | 930.82 | 931.08 | 931.34 | 931.60 | 33.50 |
| 33.60 | 931.60 | 931.85 | 932.11 | 932.37 | 932.62 | 932.88 | 933.14 | 933.40 | 933.65 | 933.91 | 934.17 | 33.60 |
| 33.70 | 934.17 | 934.43 | 934.68 | 934.94 | 935.20 | 935.46 | 935.71 | 935.97 | 936.23 | 936.49 | 936.74 | 33.70 |
| 33.80 | 936.74 | 937.00 | 937.26 | 937.52 | 937.77 | 938.03 | 938.29 | 938.55 | 938.80 | 939.06 | 939.32 | 33.80 |
| 33.90 | 939.32 | 939.58 | 939.83 | 940.09 | 940.35 | 940.61 | 940.86 | 941.12 | 941.38 | 941.64 | 941.89 | 33.90 |
| 34.00 | 941.89 | 942.15 | 942.41 | 942.67 | 942.92 | 943.18 | 943.44 | 943.70 | 943.96 | 944.21 | 944.47 | 34.00 |
| 34.10 | 944.47 | 944.73 | 944.99 | 945.24 | 945.50 | 945.76 | 946.02 | 946.27 | 946.53 | 946.79 | 947.05 | 34.10 |
| 34.20 | 947.05 | 947.31 | 947.56 | 947.82 | 948.08 | 948.34 | 948.59 | 948.85 | 949.11 | 949.37 | 949.63 | 34.20 |
| 34.30 | 949.63 | 949.88 | 950.14 | 950.40 | 950.66 | 950.91 | 951.17 | 951.43 | 951.69 | 951.95 | 952.20 | 34.30 |
| 34.40 | 952.20 | 952.46 | 952.72 | 952.98 | 953.24 | 953.49 | 953.75 | 954.01 | 954.27 | 954.53 | 954.78 | 34.40 |
| 34.50 | 954.78 | 955.04 | 955.30 | 955.56 | 955.82 | 956.07 | 956.33 | 956.59 | 956.85 | 957.11 | 957.36 | 34.50 |
| 34.60 | 957.36 | 957.62 | 957.88 | 958.14 | 958.40 | 958.65 | 958.91 | 959.17 | 959.43 | 959.69 | 959.94 | 34.60 |
| 34.70 | 959.94 | 960.20 | 960.46 | 960.72 | 960.98 | 961.23 | 961.49 | 961.75 | 962.01 | 962.27 | 962.53 | 34.70 |
| 34.80 | 962.53 | 962.78 | 963.04 | 963.30 | 963.56 | 963.82 | 964.08 | 964.33 | 964.59 | 964.85 | 965.11 | 34.80 |
| 34.90 | 965.11 | 965.37 | 965.62 | 965.88 | 966.14 | 966.40 | 966.66 | 966.92 | 967.17 | 967.43 | 967.69 | 34.90 |
| 35.00 | 967.69 | 967.95 | 968.21 | 968.47 | 968.72 | 968.98 | 969.24 | 969.50 | 969.76 | 970.02 | 970.28 | 35.00 |
| 35.10 | 970.28 | 970.53 | 970.79 | 971.05 | 971.31 | 971.57 | 971.83 | 972.08 | 972.34 | 972.60 | 972.86 | 35.10 |
| 35.20 | 972.86 | 973.12 | 973.38 | 973.64 | 973.89 | 974.15 | 974.41 | 974.67 | 974.93 | 975.19 | 975.45 | 35.20 |
| 35.30 | 975.45 | 975.70 | 975.96 | 976.22 | 976.48 | 976.74 | 977.00 | 977.26 | 977.51 | 977.77 | 978.03 | 35.30 |
| 35.40 | 978.03 | 978.29 | 978.55 | 978.81 | 979.07 | 979.33 | 979.58 | 979.84 | 980.10 | 980.36 | 980.62 | 35.40 |
| 35.50 | 980.62 | 980.88 | 981.14 | 981.40 | 981.65 | 981.91 | 982.17 | 982.43 | 982.69 | 982.95 | 983.21 | 35.50 |
| 35.60 | 983.21 | 983.47 | 983.72 | 983.98 | 984.24 | 984.50 | 984.76 | 985.02 | 985.28 | 985.54 | 985.80 | 35.60 |
| 35.70 | 985.80 | 986.05 | 986.31 | 986.57 | 986.83 | 987.09 | 987.35 | 987.61 | 987.87 | 988.13 | 988.39 | 35.70 |
| 35.80 | 988.39 | 988.64 | 988.90 | 989.16 | 989.42 | 989.68 | 989.94 | 990.20 | 990.46 | 990.72 | 990.98 | 35.80 |
| 35.90 | 990.98 | 991.23 | 991.49 | 991.75 | 992.01 | 992.27 | 992.53 | 992.79 | 993.05 | 993.31 | 993.57 | 35.90 |
| 36.00 | 993.57 | 993.83 | 994.08 | 994.34 | 994.60 | 994.86 | 995.12 | 995.38 | 995.64 | 995.90 | 996.16 | 36.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B2.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.00 | 993.57 | 993.83 | 994.08 | 994.34 | 994.60 | 994.86 | 995.12 | 995.38 | 995.64 | 995.90 | 996.16 | 36.00 |
| 36.10 | 996.16 | 996.42 | 996.68 | 996.94 | 997.20 | 997.46 | 997.71 | 997.97 | 998.23 | 998.49 | 998.75 | 36.10 |
| 36.20 | 998.75 | 999.01 | 999.27 | 999.53 | 999.79 | 1000.05 | 1000.31 | 1000.57 | 1000.83 | 1001.09 | 1001.35 | 36.20 |
| 36.30 | 1001.35 | 1001.60 | 1001.86 | 1002.12 | 1002.38 | 1002.64 | 1002.90 | 1003.16 | 1003.42 | 1003.68 | 1003.94 | 36.30 |
| 36.40 | 1003.94 | 1004.20 | 1004.46 | 1004.72 | 1004.98 | 1005.24 | 1005.50 | 1005.76 | 1006.02 | 1006.28 | 1006.54 | 36.40 |
| 36.50 | 1006.54 | 1006.80 | 1007.05 | 1007.31 | 1007.57 | 1007.83 | 1008.09 | 1008.35 | 1008.61 | 1008.87 | 1009.13 | 36.50 |
| 36.60 | 1009.13 | 1009.39 | 1009.65 | 1009.91 | 1010.17 | 1010.43 | 1010.69 | 1010.95 | 1011.21 | 1011.47 | 1011.73 | 36.60 |
| 36.70 | 1011.73 | 1011.99 | 1012.25 | 1012.51 | 1012.77 | 1013.03 | 1013.29 | 1013.55 | 1013.81 | 1014.07 | 1014.33 | 36.70 |
| 36.80 | 1014.33 | 1014.59 | 1014.85 | 1015.11 | 1015.37 | 1015.63 | 1015.89 | 1016.15 | 1016.41 | 1016.67 | 1016.93 | 36.80 |
| 36.90 | 1016.93 | 1017.19 | 1017.45 | 1017.71 | 1017.97 | 1018.23 | 1018.49 | 1018.75 | 1019.01 | 1019.27 | 1019.53 | 36.90 |
| 37.00 | 1019.53 | 1019.79 | 1020.05 | 1020.31 | 1020.57 | 1020.83 | 1021.09 | 1021.35 | 1021.61 | 1021.87 | 1022.13 | 37.00 |
| 37.10 | 1022.13 | 1022.39 | 1022.65 | 1022.91 | 1023.17 | 1023.43 | 1023.69 | 1023.95 | 1024.21 | 1024.47 | 1024.73 | 37.10 |
| 37.20 | 1024.73 | 1024.99 | 1025.25 | 1025.51 | 1025.77 | 1026.03 | 1026.29 | 1026.55 | 1026.81 | 1027.07 | 1027.33 | 37.20 |
| 37.30 | 1027.33 | 1027.59 | 1027.85 | 1028.11 | 1028.37 | 1028.63 | 1028.89 | 1029.15 | 1029.41 | 1029.67 | 1029.94 | 37.30 |
| 37.40 | 1029.94 | 1030.20 | 1030.46 | 1030.72 | 1030.98 | 1031.24 | 1031.50 | 1031.76 | 1032.02 | 1032.28 | 1032.54 | 37.40 |
| 37.50 | 1032.54 | 1032.80 | 1033.06 | 1033.32 | 1033.58 | 1033.84 | 1034.10 | 1034.36 | 1034.62 | 1034.88 | 1035.15 | 37.50 |
| 37.60 | 1035.15 | 1035.41 | 1035.67 | 1035.93 | 1036.19 | 1036.45 | 1036.71 | 1036.97 | 1037.23 | 1037.49 | 1037.75 | 37.60 |
| 37.70 | 1037.75 | 1038.01 | 1038.27 | 1038.53 | 1038.79 | 1039.06 | 1039.32 | 1039.58 | 1039.84 | 1040.10 | 1040.36 | 37.70 |
| 37.80 | 1040.36 | 1040.62 | 1040.88 | 1041.14 | 1041.40 | 1041.66 | 1041.92 | 1042.19 | 1042.45 | 1042.71 | 1042.97 | 37.80 |
| 37.90 | 1042.97 | 1043.23 | 1043.49 | 1043.75 | 1044.01 | 1044.27 | 1044.53 | 1044.79 | 1045.06 | 1045.32 | 1045.58 | 37.90 |
| 38.00 | 1045.58 | 1045.84 | 1046.10 | 1046.36 | 1046.62 | 1046.88 | 1047.14 | 1047.40 | 1047.67 | 1047.93 | 1048.19 | 38.00 |
| 38.10 | 1048.19 | 1048.45 | 1048.71 | 1048.97 | 1049.23 | 1049.49 | 1049.75 | 1050.02 | 1050.28 | 1050.54 | 1050.80 | 38.10 |
| 38.20 | 1050.80 | 1051.06 | 1051.32 | 1051.58 | 1051.84 | 1052.11 | 1052.37 | 1052.63 | 1052.89 | 1053.15 | 1053.41 | 38.20 |
| 38.30 | 1053.41 | 1053.67 | 1053.93 | 1054.20 | 1054.46 | 1054.72 | 1054.98 | 1055.24 | 1055.50 | 1055.76 | 1056.03 | 38.30 |
| 38.40 | 1056.03 | 1056.29 | 1056.55 | 1056.81 | 1057.07 | 1057.33 | 1057.59 | 1057.86 | 1058.12 | 1058.38 | 1058.64 | 38.40 |
| 38.50 | 1058.64 | 1058.90 | 1059.16 | 1059.42 | 1059.69 | 1059.95 | 1060.21 | 1060.47 | 1060.73 | 1060.99 | 1061.26 | 38.50 |
| 38.60 | 1061.26 | 1061.52 | 1061.78 | 1062.04 | 1062.30 | 1062.56 | 1062.83 | 1063.09 | 1063.35 | 1063.61 | 1063.87 | 38.60 |
| 38.70 | 1063.87 | 1064.13 | 1064.40 | 1064.66 | 1064.92 | 1065.18 | 1065.44 | 1065.70 | 1065.97 | 1066.23 | 1066.49 | 38.70 |
| 38.80 | 1066.49 | 1066.75 | 1067.01 | 1067.28 | 1067.54 | 1067.80 | 1068.06 | 1068.32 | 1068.58 | 1068.85 | 1069.11 | 38.80 |
| 38.90 | 1069.11 | 1069.37 | 1069.63 | 1069.89 | 1070.16 | 1070.42 | 1070.68 | 1070.94 | 1071.20 | 1071.47 | 1071.73 | 38.90 |
| 39.00 | 1071.73 | 1071.99 | 1072.25 | 1072.51 | 1072.78 | 1073.04 | 1073.30 | 1073.56 | 1073.83 | 1074.09 | 1074.35 | 39.00 |
| 39.10 | 1074.35 | 1074.61 | 1074.87 | 1075.14 | 1075.40 | 1075.66 | 1075.92 | 1076.18 | 1076.45 | 1076.71 | 1076.97 | 39.10 |
| 39.20 | 1076.97 | 1077.23 | 1077.50 | 1077.76 | 1078.02 | 1078.28 | 1078.55 | 1078.81 | 1079.07 | 1079.33 | 1079.59 | 39.20 |
| 39.30 | 1079.59 | 1079.86 | 1080.12 | 1080.38 | 1080.64 | 1080.91 | 1081.17 | 1081.43 | 1081.69 | 1081.96 | 1082.22 | 39.30 |
| 39.40 | 1082.22 | 1082.48 | 1082.74 | 1083.01 | 1083.27 | 1083.53 | 1083.79 | 1084.06 | 1084.32 | 1084.58 | 1084.84 | 39.40 |
| 39.50 | 1084.84 | 1085.11 | 1085.37 | 1085.63 | 1085.89 | 1086.16 | 1086.42 | 1086.68 | 1086.95 | 1087.21 | 1087.47 | 39.50 |
| 39.60 | 1087.47 | 1087.73 | 1088.00 | 1088.26 | 1088.52 | 1088.78 | 1089.05 | 1089.31 | 1089.57 | 1089.84 | 1090.10 | 39.60 |
| 39.70 | 1090.10 | 1090.36 | 1090.62 | 1090.89 | 1091.15 | 1091.41 | 1091.68 | 1091.94 | 1092.20 | 1092.46 | 1092.73 | 39.70 |
| 39.80 | 1092.73 | 1092.99 | 1093.25 | 1093.52 | 1093.78 | 1094.04 | 1094.31 | 1094.57 | 1094.83 | 1095.09 | 1095.36 | 39.80 |
| 39.90 | 1095.36 | 1095.62 | 1095.88 | 1096.15 | 1096.41 | 1096.67 | 1096.94 | 1097.20 | 1097.46 | 1097.73 | 1097.99 | 39.90 |
| 40.00 | 1097.99 | 1098.25 | 1098.52 | 1098.78 | 1099.04 | 1099.31 | 1099.57 | 1099.83 | 1100.10 | 1100.36 | 1100.62 | 40.00 |
| 40.10 | 1100.62 | 1100.89 | 1101.15 | 1101.41 | 1101.68 | 1101.94 | 1102.20 | 1102.47 | 1102.73 | 1102.99 | 1103.26 | 40.10 |
| 40.20 | 1103.26 | 1103.52 | 1103.78 | 1104.05 | 1104.31 | 1104.57 | 1104.84 | 1105.10 | 1105.36 | 1105.63 | 1105.89 | 40.20 |
| 40.30 | 1105.89 | 1106.15 | 1106.42 | 1106.68 | 1106.95 | 1107.21 | 1107.47 | 1107.74 | 1108.00 | 1108.26 | 1108.53 | 40.30 |
| 40.40 | 1108.53 | 1108.79 | 1109.05 | 1109.32 | 1109.58 | 1109.85 | 1110.11 | 1110.37 | 1110.64 | 1110.90 | 1111.16 | 40.40 |
| 40.50 | 1111.16 | 1111.43 | 1111.69 | 1111.96 | 1112.22 | 1112.48 | 1112.75 | 1113.01 | 1113.28 | 1113.54 | 1113.80 | 40.50 |
| 40.60 | 1113.80 | 1114.07 | 1114.33 | 1114.60 | 1114.86 | 1115.12 | 1115.39 | 1115.65 | 1115.92 | 1116.18 | 1116.44 | 40.60 |
| 40.70 | 1116.44 | 1116.71 | 1116.97 | 1117.24 | 1117.50 | 1117.76 | 1118.03 | 1118.29 | 1118.56 | 1118.82 | 1119.09 | 40.70 |
| 40.80 | 1119.09 | 1119.35 | 1119.61 | 1119.88 | 1120.14 | 1120.41 | 1120.67 | 1120.94 | 1121.20 | 1121.46 | 1121.73 | 40.80 |
| 40.90 | 1121.73 | 1121.99 | 1122.26 | 1122.52 | 1122.79 | 1123.05 | 1123.31 | 1123.58 | 1123.84 | 1124.11 | 1124.37 | 40.90 |
| 41.00 | 1124.37 | 1124.64 | 1124.90 | 1125.17 | 1125.43 | 1125.70 | 1125.96 | 1126.22 | 1126.49 | 1126.75 | 1127.02 | 41.00 |
| 41.10 | 1127.02 | 1127.28 | 1127.55 | 1127.81 | 1128.08 | 1128.34 | 1128.61 | 1128.87 | 1129.14 | 1129.40 | 1129.67 | 41.10 |
| 41.20 | 1129.67 | 1129.93 | 1130.19 | 1130.46 | 1130.72 | 1130.99 | 1131.25 | 1131.52 | 1131.78 | 1132.05 | 1132.31 | 41.20 |
| 41.30 | 1132.31 | 1132.58 | 1132.84 | 1133.11 | 1133.37 | 1133.64 | 1133.90 | 1134.17 | 1134.43 | 1134.70 | 1134.96 | 41.30 |
| 41.40 | 1134.96 | 1135.23 | 1135.49 | 1135.76 | 1136.02 | 1136.29 | 1136.55 | 1136.82 | 1137.08 | 1137.35 | 1137.61 | 41.40 |
| 41.50 | 1137.61 | 1137.88 | 1138.15 | 1138.41 | 1138.68 | 1138.94 | 1139.21 | 1139.47 | 1139.74 | 1140.00 | 1140.27 | 41.50 |
| 41.60 | 1140.27 | 1140.53 | 1140.80 | 1141.06 | 1141.33 | 1141.59 | 1141.86 | 1142.13 | 1142.39 | 1142.66 | 1142.92 | 41.60 |
| 41.70 | 1142.92 | 1143.19 | 1143.45 | 1143.72 | 1143.98 | 1144.25 | 1144.51 | 1144.78 | 1145.05 | 1145.31 | 1145.58 | 41.70 |
| 41.80 | 1145.58 | 1145.84 | 1146.11 | 1146.37 | 1146.64 | 1146.91 | 1147.17 | 1147.44 | 1147.70 | 1147.97 | 1148.23 | 41.80 |
| 41.90 | 1148.23 | 1148.50 | 1148.77 | 1149.03 | 1149.30 | 1149.56 | 1149.83 | 1150.10 | 1150.36 | 1150.63 | 1150.89 | 41.90 |
| 42.00 | 1150.89 | 1151.16 | 1151.42 | 1151.69 | 1151.96 | 1152.22 | 1152.49 | 1152.75 | 1153.02 | 1153.29 | 1153.55 | 42.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B2.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°C) as a function of thermoelectric voltage, reference junctions at 0 °C*—Continued

TEMPERATURES IN DEGREES C (IPTS 1968)

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42.00 | 1150.89 | 1151.16 | 1151.42 | 1151.69 | 1151.96 | 1152.22 | 1152.49 | 1152.75 | 1153.02 | 1153.29 | 1153.55 | 42.00 |
| 42.10 | 1153.55 | 1153.82 | 1154.09 | 1154.35 | 1154.62 | 1154.88 | 1155.15 | 1155.42 | 1155.68 | 1155.95 | 1156.21 | 42.10 |
| 42.20 | 1156.21 | 1156.48 | 1156.75 | 1157.01 | 1157.28 | 1157.55 | 1157.81 | 1158.08 | 1158.35 | 1158.61 | 1158.88 | 42.20 |
| 42.30 | 1158.88 | 1159.14 | 1159.41 | 1159.68 | 1159.94 | 1160.21 | 1160.48 | 1160.74 | 1161.01 | 1161.28 | 1161.54 | 42.30 |
| 42.40 | 1161.54 | 1161.81 | 1162.08 | 1162.34 | 1162.61 | 1162.88 | 1163.14 | 1163.41 | 1163.68 | 1163.94 | 1164.21 | 42.40 |
| 42.50 | 1164.21 | 1164.48 | 1164.74 | 1165.01 | 1165.28 | 1165.54 | 1165.81 | 1166.08 | 1166.34 | 1166.61 | 1166.88 | 42.50 |
| 42.60 | 1166.88 | 1167.14 | 1167.41 | 1167.68 | 1167.95 | 1168.21 | 1168.48 | 1168.75 | 1169.01 | 1169.28 | 1169.55 | 42.60 |
| 42.70 | 1169.55 | 1169.81 | 1170.08 | 1170.35 | 1170.62 | 1170.88 | 1171.15 | 1171.42 | 1171.68 | 1171.95 | 1172.22 | 42.70 |
| 42.80 | 1172.22 | 1172.49 | 1172.75 | 1173.02 | 1173.29 | 1173.55 | 1173.82 | 1174.09 | 1174.36 | 1174.62 | 1174.89 | 42.80 |
| 42.90 | 1174.89 | 1175.16 | 1175.43 | 1175.69 | 1175.96 | 1176.23 | 1176.50 | 1176.76 | 1177.03 | 1177.30 | 1177.57 | 42.90 |
| 43.00 | 1177.57 | 1177.83 | 1178.10 | 1178.37 | 1178.64 | 1178.90 | 1179.17 | 1179.44 | 1179.71 | 1179.98 | 1180.24 | 43.00 |
| 43.10 | 1180.24 | 1180.51 | 1180.78 | 1181.05 | 1181.31 | 1181.58 | 1181.85 | 1182.12 | 1182.39 | 1182.65 | 1182.92 | 43.10 |
| 43.20 | 1182.92 | 1183.19 | 1183.46 | 1183.73 | 1183.99 | 1184.26 | 1184.53 | 1184.80 | 1185.07 | 1185.33 | 1185.60 | 43.20 |
| 43.30 | 1185.60 | 1185.87 | 1186.14 | 1186.41 | 1186.67 | 1186.94 | 1187.21 | 1187.48 | 1187.75 | 1188.01 | 1188.28 | 43.30 |
| 43.40 | 1188.28 | 1188.55 | 1188.82 | 1189.09 | 1189.36 | 1189.62 | 1189.89 | 1190.16 | 1190.43 | 1190.70 | 1190.97 | 43.40 |
| 43.50 | 1190.97 | 1191.23 | 1191.50 | 1191.77 | 1192.04 | 1192.31 | 1192.58 | 1192.85 | 1193.11 | 1193.38 | 1193.65 | 43.50 |
| 43.60 | 1193.65 | 1193.92 | 1194.19 | 1194.46 | 1194.73 | 1195.00 | 1195.26 | 1195.53 | 1195.80 | 1196.07 | 1196.34 | 43.60 |
| 43.70 | 1196.34 | 1196.61 | 1196.88 | 1197.15 | 1197.41 | 1197.68 | 1197.95 | 1198.22 | 1198.49 | 1198.76 | 1199.03 | 43.70 |
| 43.80 | 1199.03 | 1199.30 | 1199.57 | 1199.84 | 1200.10 | 1200.37 | 1200.64 | 1200.91 | 1201.18 | 1201.45 | 1201.72 | 43.80 |
| 43.90 | 1201.72 | 1201.99 | 1202.26 | 1202.53 | 1202.80 | 1203.07 | 1203.33 | 1203.60 | 1203.87 | 1204.14 | 1204.41 | 43.90 |
| 44.00 | 1204.41 | 1204.68 | 1204.95 | 1205.22 | 1205.49 | 1205.76 | 1206.03 | 1206.30 | 1206.57 | 1206.84 | 1207.11 | 44.00 |
| 44.10 | 1207.11 | 1207.38 | 1207.65 | 1207.92 | 1208.18 | 1208.45 | 1208.72 | 1208.99 | 1209.26 | 1209.53 | 1209.80 | 44.10 |
| 44.20 | 1209.80 | 1210.07 | 1210.34 | 1210.61 | 1210.88 | 1211.15 | 1211.42 | 1211.69 | 1211.96 | 1212.23 | 1212.50 | 44.20 |
| 44.30 | 1212.50 | 1212.77 | 1213.04 | 1213.31 | 1213.58 | 1213.85 | 1214.12 | 1214.39 | 1214.66 | 1214.93 | 1215.20 | 44.30 |
| 44.40 | 1215.20 | 1215.47 | 1215.74 | 1216.01 | 1216.28 | 1216.55 | 1216.82 | 1217.09 | 1217.36 | 1217.63 | 1217.90 | 44.40 |
| 44.50 | 1217.90 | 1218.18 | 1218.45 | 1218.72 | 1218.99 | 1219.26 | 1219.53 | 1219.80 | 1220.07 | 1220.34 | 1220.61 | 44.50 |
| 44.60 | 1220.61 | 1220.88 | 1221.15 | 1221.42 | 1221.69 | 1221.96 | 1222.23 | 1222.50 | 1222.77 | 1223.04 | 1223.32 | 44.60 |
| 44.70 | 1223.32 | 1223.59 | 1223.86 | 1224.13 | 1224.40 | 1224.67 | 1224.94 | 1225.21 | 1225.48 | 1225.75 | 1226.02 | 44.70 |
| 44.80 | 1226.02 | 1226.30 | 1226.57 | 1226.84 | 1227.11 | 1227.38 | 1227.65 | 1227.92 | 1228.19 | 1228.46 | 1228.73 | 44.80 |
| 44.90 | 1228.73 | 1229.01 | 1229.28 | 1229.55 | 1229.82 | 1230.09 | 1230.36 | 1230.63 | 1230.90 | 1231.18 | 1231.45 | 44.90 |
| 45.00 | 1231.45 | 1231.72 | 1231.99 | 1232.26 | 1232.53 | 1232.80 | 1233.08 | 1233.35 | 1233.62 | 1233.89 | 1234.16 | 45.00 |
| 45.10 | 1234.16 | 1234.43 | 1234.70 | 1234.98 | 1235.25 | 1235.52 | 1235.79 | 1236.06 | 1236.33 | 1236.61 | 1236.88 | 45.10 |
| 45.20 | 1236.88 | 1237.15 | 1237.42 | 1237.69 | 1237.97 | 1238.24 | 1238.51 | 1238.78 | 1239.05 | 1239.33 | 1239.60 | 45.20 |
| 45.30 | 1239.60 | 1239.87 | 1240.14 | 1240.41 | 1240.69 | 1240.96 | 1241.23 | 1241.50 | 1241.77 | 1242.05 | 1242.32 | 45.30 |
| 45.40 | 1242.32 | 1242.59 | 1242.86 | 1243.13 | 1243.41 | 1243.68 | 1243.95 | 1244.22 | 1244.50 | 1244.77 | 1245.04 | 45.40 |
| 45.50 | 1245.04 | 1245.31 | 1245.59 | 1245.86 | 1246.13 | 1246.40 | 1246.68 | 1246.95 | 1247.22 | 1247.49 | 1247.77 | 45.50 |
| 45.60 | 1247.77 | 1248.04 | 1248.31 | 1248.58 | 1248.86 | 1249.13 | 1249.40 | 1249.67 | 1249.95 | 1250.22 | 1250.49 | 45.60 |
| 45.70 | 1250.49 | 1250.77 | 1251.04 | 1251.31 | 1251.58 | 1251.86 | 1252.13 | 1252.40 | 1252.68 | 1252.95 | 1253.22 | 45.70 |
| 45.80 | 1253.22 | 1253.50 | 1253.77 | 1254.04 | 1254.32 | 1254.59 | 1254.86 | 1255.13 | 1255.41 | 1255.68 | 1255.95 | 45.80 |
| 45.90 | 1255.95 | 1256.23 | 1256.50 | 1256.77 | 1257.05 | 1257.32 | 1257.59 | 1257.87 | 1258.14 | 1258.41 | 1258.69 | 45.90 |
| 46.00 | 1258.69 | 1258.96 | 1259.23 | 1259.51 | 1259.78 | 1260.06 | 1260.33 | 1260.60 | 1260.88 | 1261.15 | 1261.42 | 46.00 |
| 46.10 | 1261.42 | 1261.70 | 1261.97 | 1262.24 | 1262.52 | 1262.79 | 1263.07 | 1263.34 | 1263.61 | 1263.89 | 1264.16 | 46.10 |
| 46.20 | 1264.16 | 1264.44 | 1264.71 | 1264.98 | 1265.26 | 1265.53 | 1265.81 | 1266.08 | 1266.35 | 1266.63 | 1266.90 | 46.20 |
| 46.30 | 1266.90 | 1267.18 | 1267.45 | 1267.72 | 1268.00 | 1268.27 | 1268.55 | 1268.82 | 1269.10 | 1269.37 | 1269.64 | 46.30 |
| 46.40 | 1269.64 | 1269.92 | 1270.19 | 1270.47 | 1270.74 | 1271.02 | 1271.29 | 1271.56 | 1271.84 | 1272.11 | 1272.39 | 46.40 |
| 46.50 | 1272.39 | 1272.66 | 1272.94 | 1273.21 | 1273.49 | 1273.76 | 1274.04 | 1274.31 | 1274.59 | 1274.86 | 1275.13 | 46.50 |
| 46.60 | 1275.13 | 1275.41 | 1275.68 | 1275.96 | 1276.23 | 1276.51 | 1276.78 | 1277.06 | 1277.33 | 1277.61 | 1277.88 | 46.60 |
| 46.70 | 1277.88 | 1278.16 | 1278.43 | 1278.71 | 1278.98 | 1279.26 | 1279.53 | 1279.81 | 1280.08 | 1280.36 | 1280.63 | 46.70 |
| 46.80 | 1280.63 | 1280.91 | 1281.18 | 1281.46 | 1281.74 | 1282.01 | 1282.29 | 1282.56 | 1282.84 | 1283.11 | 1283.39 | 46.80 |
| 46.90 | 1283.39 | 1283.66 | 1283.94 | 1284.21 | 1284.49 | 1284.76 | 1285.04 | 1285.32 | 1285.59 | 1285.87 | 1286.14 | 46.90 |
| 47.00 | 1286.14 | 1286.42 | 1286.69 | 1286.97 | 1287.25 | 1287.52 | 1287.80 | 1288.07 | 1288.35 | 1288.62 | 1288.90 | 47.00 |
| 47.10 | 1288.90 | 1289.18 | 1289.45 | 1289.73 | 1290.00 | 1290.28 | 1290.56 | 1290.83 | 1291.11 | 1291.38 | 1291.66 | 47.10 |
| 47.20 | 1291.66 | 1291.94 | 1292.21 | 1292.49 | 1292.76 | 1293.04 | 1293.32 | 1293.59 | 1293.87 | 1294.14 | 1294.42 | 47.20 |
| 47.30 | 1294.42 | 1294.70 | 1294.97 | 1295.25 | 1295.53 | 1295.80 | 1296.08 | 1296.35 | 1296.63 | 1296.91 | 1297.18 | 47.30 |
| 47.40 | 1297.18 | 1297.46 | 1297.74 | 1298.01 | 1298.29 | 1298.57 | 1298.84 | 1299.12 | 1299.40 | 1299.67 | 1299.95 | 47.40 |
| 47.50 | 1299.95 |  |  |  |  |  |  |  |  |  |  | 47.50 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B3.** AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F.*

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -4.30 | -410.55 | -416.02 | -422.37 | -430.22 | -441.59 | | | | | | | -4.30 |
| -4.20 | -374.14 | -377.01 | -379.99 | -383.09 | -386.34 | -389.74 | -393.34 | -397.16 | -401.25 | -405.68 | -410.55 | -4.20 |
| -4.10 | -349.64 | -351.83 | -354.07 | -356.35 | -358.70 | -361.09 | -363.56 | -366.08 | -368.69 | -371.37 | -374.14 | -4.10 |
| -4.00 | -329.76 | -331.61 | -333.48 | -335.39 | -337.32 | -339.29 | -341.28 | -343.31 | -345.38 | -347.49 | -349.64 | -4.00 |
| -3.90 | -312.51 | -314.15 | -315.80 | -317.47 | -319.16 | -320.88 | -322.61 | -324.36 | -326.14 | -327.93 | -329.76 | -3.90 |
| -3.80 | -297.02 | -298.51 | -300.01 | -301.52 | -303.05 | -304.59 | -306.14 | -307.71 | -309.30 | -310.90 | -312.51 | -3.80 |
| -3.70 | -282.80 | -284.18 | -285.56 | -286.96 | -288.36 | -289.78 | -291.20 | -292.64 | -294.09 | -295.55 | -297.02 | -3.70 |
| -3.60 | -269.56 | -270.85 | -272.14 | -273.44 | -274.75 | -276.07 | -277.40 | -278.74 | -280.08 | -281.44 | -282.80 | -3.60 |
| -3.50 | -257.09 | -258.31 | -259.53 | -260.76 | -262.00 | -263.24 | -264.49 | -265.75 | -267.01 | -268.28 | -269.56 | -3.50 |
| -3.40 | -245.27 | -246.42 | -247.59 | -248.75 | -249.93 | -251.11 | -252.29 | -253.48 | -254.68 | -255.88 | -257.09 | -3.40 |
| -3.30 | -233.97 | -235.08 | -236.19 | -237.31 | -238.43 | -239.56 | -240.69 | -241.83 | -242.97 | -244.11 | -245.27 | -3.30 |
| -3.20 | -223.14 | -224.20 | -225.27 | -226.34 | -227.42 | -228.50 | -229.59 | -230.68 | -231.77 | -232.87 | -233.97 | -3.20 |
| -3.10 | -212.70 | -213.72 | -214.76 | -215.79 | -216.83 | -217.87 | -218.92 | -219.97 | -221.02 | -222.08 | -223.14 | -3.10 |
| -3.00 | -202.60 | -203.60 | -204.60 | -205.60 | -206.60 | -207.61 | -208.62 | -209.63 | -210.65 | -211.67 | -212.70 | -3.00 |
| -2.90 | -192.81 | -193.78 | -194.75 | -195.72 | -196.69 | -197.67 | -198.65 | -199.64 | -200.62 | -201.61 | -202.60 | -2.90 |
| -2.80 | -183.30 | -184.24 | -185.18 | -186.12 | -187.07 | -188.02 | -188.98 | -189.93 | -190.89 | -191.85 | -192.81 | -2.80 |
| -2.70 | -174.02 | -174.94 | -175.86 | -176.78 | -177.70 | -178.63 | -179.56 | -180.49 | -181.42 | -182.36 | -183.30 | -2.70 |
| -2.60 | -164.97 | -165.86 | -166.76 | -167.66 | -168.57 | -169.47 | -170.38 | -171.28 | -172.19 | -173.11 | -174.02 | -2.60 |
| -2.50 | -156.11 | -156.99 | -157.87 | -158.75 | -159.63 | -160.52 | -161.40 | -162.29 | -163.18 | -164.07 | -164.97 | -2.50 |
| -2.40 | -147.44 | -148.30 | -149.16 | -150.02 | -150.89 | -151.75 | -152.62 | -153.49 | -154.36 | -155.24 | -156.11 | -2.40 |
| -2.30 | -138.92 | -139.77 | -140.61 | -141.46 | -142.31 | -143.16 | -144.01 | -144.87 | -145.72 | -146.58 | -147.44 | -2.30 |
| -2.20 | -130.56 | -131.39 | -132.22 | -133.06 | -133.89 | -134.73 | -135.56 | -136.40 | -137.24 | -138.08 | -138.92 | -2.20 |
| -2.10 | -122.34 | -123.15 | -123.97 | -124.79 | -125.61 | -126.43 | -127.26 | -128.08 | -128.91 | -129.73 | -130.56 | -2.10 |
| -2.00 | -114.24 | -115.04 | -115.85 | -116.66 | -117.46 | -118.27 | -119.08 | -119.90 | -120.71 | -121.52 | -122.34 | -2.00 |
| -1.90 | -106.26 | -107.05 | -107.84 | -108.64 | -109.44 | -110.23 | -111.03 | -111.83 | -112.63 | -113.44 | -114.24 | -1.90 |
| -1.80 | -98.38 | -99.16 | -99.95 | -100.73 | -101.52 | -102.31 | -103.09 | -103.88 | -104.67 | -105.47 | -106.26 | -1.80 |
| -1.70 | -90.61 | -91.38 | -92.15 | -92.93 | -93.70 | -94.48 | -95.26 | -96.04 | -96.82 | -97.60 | -98.38 | -1.70 |
| -1.60 | -82.92 | -83.68 | -84.45 | -85.22 | -85.98 | -86.75 | -87.52 | -88.29 | -89.06 | -89.83 | -90.61 | -1.60 |
| -1.50 | -75.32 | -76.07 | -76.83 | -77.59 | -78.35 | -79.11 | -79.87 | -80.63 | -81.39 | -82.16 | -82.92 | -1.50 |
| -1.40 | -67.79 | -68.54 | -69.29 | -70.04 | -70.79 | -71.55 | -72.30 | -73.05 | -73.81 | -74.56 | -75.32 | -1.40 |
| -1.30 | -60.34 | -61.08 | -61.83 | -62.57 | -63.31 | -64.06 | -64.80 | -65.55 | -66.30 | -67.05 | -67.79 | -1.30 |
| -1.20 | -52.96 | -53.69 | -54.43 | -55.16 | -55.90 | -56.64 | -57.38 | -58.12 | -58.86 | -59.60 | -60.34 | -1.20 |
| -1.10 | -45.63 | -46.36 | -47.09 | -47.82 | -48.55 | -49.29 | -50.02 | -50.75 | -51.49 | -52.22 | -52.96 | -1.10 |
| -1.00 | -38.36 | -39.09 | -39.81 | -40.54 | -41.26 | -41.99 | -42.72 | -43.45 | -44.17 | -44.90 | -45.63 | -1.00 |
| -0.90 | -31.15 | -31.87 | -32.59 | -33.31 | -34.03 | -34.75 | -35.47 | -36.19 | -36.92 | -37.64 | -38.36 | -0.90 |
| -0.80 | -23.98 | -24.70 | -25.41 | -26.13 | -26.84 | -27.56 | -28.28 | -28.99 | -29.71 | -30.43 | -31.15 | -0.80 |
| -0.70 | -16.86 | -17.57 | -18.28 | -18.99 | -19.70 | -20.42 | -21.13 | -21.84 | -22.55 | -23.27 | -23.98 | -0.70 |
| -0.60 | -9.78 | -10.49 | -11.19 | -11.90 | -12.61 | -13.32 | -14.02 | -14.73 | -15.44 | -16.15 | -16.86 | -0.60 |
| -0.50 | -2.74 | -3.44 | -4.14 | -4.85 | -5.55 | -6.26 | -6.96 | -7.66 | -8.37 | -9.07 | -9.78 | -0.50 |
| -0.40 | 4.27 | 3.57 | 2.87 | 2.17 | 1.47 | 0.77 | 0.07 | -0.63 | -1.33 | -2.04 | -2.74 | -0.40 |
| -0.30 | 11.24 | 10.55 | 9.85 | 9.15 | 8.46 | 7.76 | 7.06 | 6.36 | 5.67 | 4.97 | 4.27 | -0.30 |
| -0.20 | 18.19 | 17.49 | 16.80 | 16.11 | 15.41 | 14.72 | 14.02 | 13.33 | 12.63 | 11.94 | 11.24 | -0.20 |
| -0.10 | 25.11 | 24.42 | 23.72 | 23.03 | 22.34 | 21.65 | 20.96 | 20.27 | 19.57 | 18.88 | 18.19 | -0.10 |
| 0.00 | 32.00 | 31.31 | 30.62 | 29.93 | 29.25 | 28.56 | 27.87 | 27.18 | 26.49 | 25.80 | 25.11 | 0.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

Table B3. AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 32.00 | 32.69 | 33.38 | 34.06 | 34.75 | 35.44 | 36.13 | 36.81 | 37.50 | 38.19 | 38.87 | 0.00 |
| 0.10 | 38.87 | 39.56 | 40.24 | 40.93 | 41.62 | 42.30 | 42.99 | 43.67 | 44.36 | 45.04 | 45.72 | 0.10 |
| 0.20 | 45.72 | 46.41 | 47.09 | 47.77 | 48.46 | 49.14 | 49.82 | 50.51 | 51.19 | 51.87 | 52.55 | 0.20 |
| 0.30 | 52.55 | 53.23 | 53.91 | 54.59 | 55.27 | 55.95 | 56.63 | 57.31 | 57.99 | 58.67 | 59.35 | 0.30 |
| 0.40 | 59.35 | 60.03 | 60.71 | 61.39 | 62.06 | 62.74 | 63.42 | 64.10 | 64.77 | 65.45 | 66.13 | 0.40 |
| 0.50 | 66.13 | 66.80 | 67.48 | 68.15 | 68.83 | 69.50 | 70.18 | 70.85 | 71.52 | 72.20 | 72.87 | 0.50 |
| 0.60 | 72.87 | 73.54 | 74.21 | 74.89 | 75.56 | 76.23 | 76.90 | 77.57 | 78.24 | 78.91 | 79.58 | 0.60 |
| 0.70 | 79.58 | 80.25 | 80.92 | 81.59 | 82.26 | 82.93 | 83.60 | 84.26 | 84.93 | 85.60 | 86.27 | 0.70 |
| 0.80 | 86.27 | 86.93 | 87.60 | 88.26 | 88.93 | 89.60 | 90.26 | 90.92 | 91.59 | 92.25 | 92.92 | 0.80 |
| 0.90 | 92.92 | 93.58 | 94.24 | 94.91 | 95.57 | 96.23 | 96.89 | 97.55 | 98.21 | 98.87 | 99.53 | 0.90 |
| 1.00 | 99.53 | 100.19 | 100.85 | 101.51 | 102.17 | 102.83 | 103.49 | 104.15 | 104.80 | 105.46 | 106.12 | 1.00 |
| 1.10 | 106.12 | 106.78 | 107.43 | 108.09 | 108.74 | 109.40 | 110.05 | 110.71 | 111.36 | 112.02 | 112.67 | 1.10 |
| 1.20 | 112.67 | 113.32 | 113.98 | 114.63 | 115.28 | 115.93 | 116.59 | 117.24 | 117.89 | 118.54 | 119.19 | 1.20 |
| 1.30 | 119.19 | 119.84 | 120.49 | 121.14 | 121.79 | 122.44 | 123.08 | 123.73 | 124.38 | 125.03 | 125.67 | 1.30 |
| 1.40 | 125.67 | 126.32 | 126.97 | 127.61 | 128.26 | 128.90 | 129.55 | 130.19 | 130.84 | 131.48 | 132.13 | 1.40 |
| 1.50 | 132.13 | 132.77 | 133.41 | 134.06 | 134.70 | 135.34 | 135.98 | 136.62 | 137.26 | 137.91 | 138.55 | 1.50 |
| 1.60 | 138.55 | 139.19 | 139.83 | 140.46 | 141.10 | 141.74 | 142.38 | 143.02 | 143.66 | 144.30 | 144.93 | 1.60 |
| 1.70 | 144.93 | 145.57 | 146.21 | 146.84 | 147.48 | 148.11 | 148.75 | 149.38 | 150.02 | 150.65 | 151.29 | 1.70 |
| 1.80 | 151.29 | 151.92 | 152.55 | 153.19 | 153.82 | 154.45 | 155.08 | 155.72 | 156.35 | 156.98 | 157.61 | 1.80 |
| 1.90 | 157.61 | 158.24 | 158.87 | 159.50 | 160.13 | 160.76 | 161.39 | 162.02 | 162.65 | 163.27 | 163.90 | 1.90 |
| 2.00 | 163.90 | 164.53 | 165.16 | 165.78 | 166.41 | 167.04 | 167.66 | 168.29 | 168.91 | 169.54 | 170.16 | 2.00 |
| 2.10 | 170.16 | 170.79 | 171.41 | 172.03 | 172.66 | 173.28 | 173.90 | 174.53 | 175.15 | 175.77 | 176.39 | 2.10 |
| 2.20 | 176.39 | 177.01 | 177.64 | 178.26 | 178.88 | 179.50 | 180.12 | 180.74 | 181.36 | 181.98 | 182.59 | 2.20 |
| 2.30 | 182.59 | 183.21 | 183.83 | 184.45 | 185.07 | 185.68 | 186.30 | 186.92 | 187.53 | 188.15 | 188.77 | 2.30 |
| 2.40 | 188.77 | 189.38 | 190.00 | 190.61 | 191.23 | 191.84 | 192.46 | 193.07 | 193.68 | 194.30 | 194.91 | 2.40 |
| 2.50 | 194.91 | 195.52 | 196.13 | 196.75 | 197.36 | 197.97 | 198.58 | 199.19 | 199.80 | 200.41 | 201.03 | 2.50 |
| 2.60 | 201.03 | 201.64 | 202.24 | 202.85 | 203.46 | 204.07 | 204.68 | 205.29 | 205.90 | 206.51 | 207.11 | 2.60 |
| 2.70 | 207.11 | 207.72 | 208.33 | 208.93 | 209.54 | 210.15 | 210.75 | 211.36 | 211.96 | 212.57 | 213.18 | 2.70 |
| 2.80 | 213.18 | 213.78 | 214.38 | 214.99 | 215.59 | 216.20 | 216.80 | 217.40 | 218.01 | 218.61 | 219.21 | 2.80 |
| 2.90 | 219.21 | 219.81 | 220.41 | 221.02 | 221.62 | 222.22 | 222.82 | 223.42 | 224.02 | 224.62 | 225.22 | 2.90 |
| 3.00 | 225.22 | 225.82 | 226.42 | 227.02 | 227.62 | 228.22 | 228.81 | 229.41 | 230.01 | 230.61 | 231.21 | 3.00 |
| 3.10 | 231.21 | 231.80 | 232.40 | 233.00 | 233.59 | 234.19 | 234.78 | 235.38 | 235.98 | 236.57 | 237.17 | 3.10 |
| 3.20 | 237.17 | 237.76 | 238.36 | 238.95 | 239.54 | 240.14 | 240.73 | 241.32 | 241.92 | 242.51 | 243.10 | 3.20 |
| 3.30 | 243.10 | 243.70 | 244.29 | 244.88 | 245.47 | 246.06 | 246.65 | 247.25 | 247.84 | 248.43 | 249.02 | 3.30 |
| 3.40 | 249.02 | 249.61 | 250.20 | 250.79 | 251.38 | 251.96 | 252.55 | 253.14 | 253.73 | 254.32 | 254.91 | 3.40 |
| 3.50 | 254.91 | 255.50 | 256.08 | 256.67 | 257.26 | 257.84 | 258.43 | 259.02 | 259.60 | 260.19 | 260.78 | 3.50 |
| 3.60 | 260.78 | 261.36 | 261.95 | 262.53 | 263.12 | 263.70 | 264.29 | 264.87 | 265.46 | 266.04 | 266.62 | 3.60 |
| 3.70 | 266.62 | 267.21 | 267.79 | 268.37 | 268.96 | 269.54 | 270.12 | 270.70 | 271.29 | 271.87 | 272.45 | 3.70 |
| 3.80 | 272.45 | 273.03 | 273.61 | 274.19 | 274.77 | 275.35 | 275.93 | 276.51 | 277.09 | 277.67 | 278.25 | 3.80 |
| 3.90 | 278.25 | 278.83 | 279.41 | 279.99 | 280.57 | 281.15 | 281.73 | 282.31 | 282.88 | 283.46 | 284.04 | 3.90 |
| 4.00 | 284.04 | 284.62 | 285.19 | 285.77 | 286.35 | 286.92 | 287.50 | 288.08 | 288.65 | 289.23 | 289.80 | 4.00 |
| 4.10 | 289.80 | 290.38 | 290.95 | 291.53 | 292.10 | 292.68 | 293.25 | 293.83 | 294.40 | 294.98 | 295.55 | 4.10 |
| 4.20 | 295.55 | 296.12 | 296.70 | 297.27 | 297.84 | 298.41 | 298.99 | 299.56 | 300.13 | 300.70 | 301.28 | 4.20 |
| 4.30 | 301.28 | 301.85 | 302.42 | 302.99 | 303.56 | 304.13 | 304.70 | 305.27 | 305.84 | 306.41 | 306.98 | 4.30 |
| 4.40 | 306.98 | 307.55 | 308.12 | 308.69 | 309.26 | 309.83 | 310.40 | 310.97 | 311.54 | 312.11 | 312.67 | 4.40 |
| 4.50 | 312.67 | 313.24 | 313.81 | 314.38 | 314.94 | 315.51 | 316.08 | 316.65 | 317.21 | 317.78 | 318.35 | 4.50 |
| 4.60 | 318.35 | 318.91 | 319.48 | 320.04 | 320.61 | 321.17 | 321.74 | 322.31 | 322.87 | 323.44 | 324.00 | 4.60 |
| 4.70 | 324.00 | 324.56 | 325.13 | 325.69 | 326.26 | 326.82 | 327.38 | 327.95 | 328.51 | 329.07 | 329.64 | 4.70 |
| 4.80 | 329.64 | 330.20 | 330.76 | 331.33 | 331.89 | 332.45 | 333.01 | 333.57 | 334.14 | 334.70 | 335.26 | 4.80 |
| 4.90 | 335.26 | 335.82 | 336.38 | 336.94 | 337.50 | 338.06 | 338.62 | 339.18 | 339.74 | 340.30 | 340.86 | 4.90 |
| 5.00 | 340.86 | 341.42 | 341.98 | 342.54 | 343.10 | 343.66 | 344.22 | 344.78 | 345.33 | 345.89 | 346.45 | 5.00 |
| 5.10 | 346.45 | 347.01 | 347.57 | 348.12 | 348.68 | 349.24 | 349.80 | 350.35 | 350.91 | 351.47 | 352.02 | 5.10 |
| 5.20 | 352.02 | 352.58 | 353.14 | 353.69 | 354.25 | 354.80 | 355.36 | 355.91 | 356.47 | 357.02 | 357.58 | 5.20 |
| 5.30 | 357.58 | 358.13 | 358.69 | 359.24 | 359.80 | 360.35 | 360.91 | 361.46 | 362.01 | 362.57 | 363.12 | 5.30 |
| 5.40 | 363.12 | 363.67 | 364.23 | 364.78 | 365.33 | 365.89 | 366.44 | 366.99 | 367.54 | 368.10 | 368.65 | 5.40 |
| 5.50 | 368.65 | 369.20 | 369.75 | 370.30 | 370.85 | 371.41 | 371.96 | 372.51 | 373.06 | 373.61 | 374.16 | 5.50 |
| 5.60 | 374.16 | 374.71 | 375.26 | 375.81 | 376.36 | 376.91 | 377.46 | 378.01 | 378.56 | 379.11 | 379.66 | 5.60 |
| 5.70 | 379.66 | 380.21 | 380.75 | 381.30 | 381.85 | 382.40 | 382.95 | 383.50 | 384.04 | 384.59 | 385.14 | 5.70 |
| 5.80 | 385.14 | 385.69 | 386.24 | 386.78 | 387.33 | 387.88 | 388.42 | 388.97 | 389.52 | 390.06 | 390.61 | 5.80 |
| 5.90 | 390.61 | 391.16 | 391.70 | 392.25 | 392.79 | 393.34 | 393.88 | 394.43 | 394.97 | 395.52 | 396.06 | 5.90 |
| 6.00 | 396.06 | 396.61 | 397.15 | 397.70 | 398.24 | 398.79 | 399.33 | 399.88 | 400.42 | 400.96 | 401.51 | 6.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

TABLE B3. AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.00 | 396.06 | 396.61 | 397.15 | 397.70 | 398.24 | 398.79 | 399.33 | 399.88 | 400.42 | 400.96 | 401.51 | 6.00 |
| 6.10 | 401.51 | 402.05 | 402.59 | 403.14 | 403.68 | 404.22 | 404.76 | 405.31 | 405.85 | 406.39 | 406.93 | 6.10 |
| 6.20 | 406.93 | 407.48 | 408.02 | 408.56 | 409.10 | 409.64 | 410.18 | 410.73 | 411.27 | 411.81 | 412.35 | 6.20 |
| 6.30 | 412.35 | 412.89 | 413.43 | 413.97 | 414.51 | 415.05 | 415.59 | 416.13 | 416.67 | 417.21 | 417.75 | 6.30 |
| 6.40 | 417.75 | 418.29 | 418.83 | 419.37 | 419.91 | 420.45 | 420.99 | 421.53 | 422.06 | 422.60 | 423.14 | 6.40 |
| 6.50 | 423.14 | 423.68 | 424.22 | 424.75 | 425.29 | 425.83 | 426.37 | 426.91 | 427.44 | 427.98 | 428.52 | 6.50 |
| 6.60 | 428.52 | 429.05 | 429.59 | 430.13 | 430.66 | 431.20 | 431.74 | 432.27 | 432.81 | 433.35 | 433.88 | 6.60 |
| 6.70 | 433.88 | 434.42 | 434.95 | 435.49 | 436.02 | 436.56 | 437.09 | 437.63 | 438.16 | 438.70 | 439.23 | 6.70 |
| 6.80 | 439.23 | 439.77 | 440.30 | 440.84 | 441.37 | 441.90 | 442.44 | 442.97 | 443.51 | 444.04 | 444.57 | 6.80 |
| 6.90 | 444.57 | 445.11 | 445.64 | 446.17 | 446.71 | 447.24 | 447.77 | 448.30 | 448.84 | 449.37 | 449.90 | 6.90 |
| 7.00 | 449.90 | 450.43 | 450.96 | 451.50 | 452.03 | 452.56 | 453.09 | 453.62 | 454.15 | 454.69 | 455.22 | 7.00 |
| 7.10 | 455.22 | 455.75 | 456.28 | 456.81 | 457.34 | 457.87 | 458.40 | 458.93 | 459.46 | 459.99 | 460.52 | 7.10 |
| 7.20 | 460.52 | 461.05 | 461.58 | 462.11 | 462.64 | 463.17 | 463.70 | 464.23 | 464.76 | 465.29 | 465.81 | 7.20 |
| 7.30 | 465.81 | 466.34 | 466.87 | 467.40 | 467.93 | 468.46 | 468.98 | 469.51 | 470.04 | 470.57 | 471.10 | 7.30 |
| 7.40 | 471.10 | 471.62 | 472.15 | 472.68 | 473.20 | 473.73 | 474.26 | 474.79 | 475.31 | 475.84 | 476.37 | 7.40 |
| 7.50 | 476.37 | 476.89 | 477.42 | 477.94 | 478.47 | 479.00 | 479.52 | 480.05 | 480.57 | 481.10 | 481.63 | 7.50 |
| 7.60 | 481.63 | 482.15 | 482.68 | 483.20 | 483.73 | 484.25 | 484.78 | 485.30 | 485.82 | 486.35 | 486.87 | 7.60 |
| 7.70 | 486.87 | 487.40 | 487.92 | 488.45 | 488.97 | 489.49 | 490.02 | 490.54 | 491.06 | 491.59 | 492.11 | 7.70 |
| 7.80 | 492.11 | 492.63 | 493.16 | 493.63 | 494.20 | 494.73 | 495.25 | 495.77 | 496.29 | 496.82 | 497.34 | 7.80 |
| 7.90 | 497.34 | 497.86 | 498.38 | 498.90 | 499.43 | 499.95 | 500.47 | 500.99 | 501.51 | 502.03 | 502.56 | 7.90 |
| 8.00 | 502.56 | 503.08 | 503.60 | 504.12 | 504.64 | 505.16 | 505.68 | 506.20 | 506.72 | 507.24 | 507.76 | 8.00 |
| 8.10 | 507.76 | 508.28 | 508.80 | 509.32 | 509.84 | 510.36 | 510.88 | 511.40 | 511.92 | 512.44 | 512.96 | 8.10 |
| 8.20 | 512.96 | 513.48 | 514.00 | 514.51 | 515.03 | 515.55 | 516.07 | 516.59 | 517.11 | 517.63 | 518.14 | 8.20 |
| 8.30 | 518.14 | 518.66 | 519.18 | 519.70 | 520.22 | 520.73 | 521.25 | 521.77 | 522.29 | 522.80 | 523.32 | 8.30 |
| 8.40 | 523.32 | 523.84 | 524.35 | 524.87 | 525.39 | 525.91 | 526.42 | 526.94 | 527.45 | 527.97 | 528.49 | 8.40 |
| 8.50 | 528.49 | 529.00 | 529.52 | 530.04 | 530.55 | 531.07 | 531.58 | 532.10 | 532.61 | 533.13 | 533.64 | 8.50 |
| 8.60 | 533.64 | 534.16 | 534.67 | 535.19 | 535.70 | 536.22 | 536.73 | 537.25 | 537.76 | 538.28 | 538.79 | 8.60 |
| 8.70 | 538.79 | 539.31 | 539.82 | 540.33 | 540.85 | 541.36 | 541.88 | 542.39 | 542.90 | 543.42 | 543.93 | 8.70 |
| 8.80 | 543.93 | 544.44 | 544.96 | 545.47 | 545.98 | 546.50 | 547.01 | 547.52 | 548.03 | 548.55 | 549.06 | 8.80 |
| 8.90 | 549.06 | 549.57 | 550.08 | 550.60 | 551.11 | 551.62 | 552.13 | 552.64 | 553.16 | 553.67 | 554.18 | 8.90 |
| 9.00 | 554.18 | 554.69 | 555.20 | 555.71 | 556.23 | 556.74 | 557.25 | 557.76 | 558.27 | 558.78 | 559.29 | 9.00 |
| 9.10 | 559.29 | 559.80 | 560.31 | 560.82 | 561.33 | 561.84 | 562.35 | 562.86 | 563.37 | 563.88 | 564.39 | 9.10 |
| 9.20 | 564.39 | 564.90 | 565.41 | 565.92 | 566.43 | 566.94 | 567.45 | 567.96 | 568.47 | 568.98 | 569.49 | 9.20 |
| 9.30 | 569.49 | 570.00 | 570.51 | 571.01 | 571.52 | 572.03 | 572.54 | 573.05 | 573.56 | 574.06 | 574.57 | 9.30 |
| 9.40 | 574.57 | 575.08 | 575.59 | 576.10 | 576.60 | 577.11 | 577.62 | 578.13 | 578.64 | 579.14 | 579.65 | 9.40 |
| 9.50 | 579.65 | 580.16 | 580.66 | 581.17 | 581.68 | 582.19 | 582.69 | 583.20 | 583.71 | 584.21 | 584.72 | 9.50 |
| 9.60 | 584.72 | 585.23 | 585.73 | 586.24 | 586.74 | 587.25 | 587.76 | 588.26 | 588.77 | 589.27 | 589.78 | 9.60 |
| 9.70 | 589.78 | 590.29 | 590.79 | 591.30 | 591.80 | 592.31 | 592.81 | 593.32 | 593.82 | 594.33 | 594.83 | 9.70 |
| 9.80 | 594.83 | 595.34 | 595.84 | 596.35 | 596.85 | 597.36 | 597.86 | 598.37 | 598.87 | 599.38 | 599.88 | 9.80 |
| 9.90 | 599.88 | 600.38 | 600.89 | 601.39 | 601.90 | 602.40 | 602.90 | 603.41 | 603.91 | 604.41 | 604.92 | 9.90 |
| 10.00 | 604.92 | 605.42 | 605.92 | 606.43 | 606.93 | 607.43 | 607.94 | 608.44 | 608.94 | 609.45 | 609.95 | 10.00 |
| 10.10 | 609.95 | 610.45 | 610.95 | 611.46 | 611.96 | 612.46 | 612.96 | 613.47 | 613.97 | 614.47 | 614.97 | 10.10 |
| 10.20 | 614.97 | 615.47 | 615.98 | 616.48 | 616.98 | 617.48 | 617.98 | 618.48 | 618.98 | 619.49 | 619.99 | 10.20 |
| 10.30 | 619.99 | 620.49 | 620.99 | 621.49 | 621.99 | 622.49 | 622.99 | 623.49 | 624.00 | 624.50 | 625.00 | 10.30 |
| 10.40 | 625.00 | 625.50 | 626.00 | 626.50 | 627.00 | 627.50 | 628.00 | 628.50 | 629.00 | 629.50 | 630.00 | 10.40 |
| 10.50 | 630.00 | 630.50 | 631.00 | 631.50 | 632.00 | 632.50 | 633.00 | 633.50 | 634.00 | 634.50 | 635.00 | 10.50 |
| 10.60 | 635.00 | 635.49 | 635.99 | 636.49 | 636.99 | 637.49 | 637.99 | 638.49 | 638.99 | 639.49 | 639.98 | 10.60 |
| 10.70 | 639.98 | 640.48 | 640.98 | 641.48 | 641.98 | 642.48 | 642.97 | 643.47 | 643.97 | 644.47 | 644.97 | 10.70 |
| 10.80 | 644.97 | 645.47 | 645.96 | 646.46 | 646.96 | 647.46 | 647.95 | 648.45 | 648.95 | 649.45 | 649.94 | 10.80 |
| 10.90 | 649.94 | 650.44 | 650.94 | 651.44 | 651.93 | 652.43 | 652.93 | 653.42 | 653.92 | 654.42 | 654.91 | 10.90 |
| 11.00 | 654.91 | 655.41 | 655.91 | 656.40 | 656.90 | 657.40 | 657.89 | 658.39 | 658.89 | 659.38 | 659.88 | 11.00 |
| 11.10 | 659.88 | 660.37 | 660.87 | 661.37 | 661.86 | 662.36 | 662.85 | 663.35 | 663.85 | 664.34 | 664.84 | 11.10 |
| 11.20 | 664.84 | 665.33 | 665.83 | 666.32 | 666.82 | 667.31 | 667.81 | 668.30 | 668.80 | 669.29 | 669.79 | 11.20 |
| 11.30 | 669.79 | 670.28 | 670.78 | 671.27 | 671.77 | 672.26 | 672.76 | 673.25 | 673.75 | 674.24 | 674.74 | 11.30 |
| 11.40 | 674.74 | 675.23 | 675.73 | 676.22 | 676.71 | 677.21 | 677.70 | 678.20 | 678.69 | 679.18 | 679.68 | 11.40 |
| 11.50 | 679.68 | 680.17 | 680.67 | 681.16 | 681.65 | 682.15 | 682.64 | 683.13 | 683.63 | 684.12 | 684.61 | 11.50 |
| 11.60 | 684.61 | 685.11 | 685.60 | 686.09 | 686.59 | 687.08 | 687.57 | 688.07 | 688.56 | 689.05 | 689.55 | 11.60 |
| 11.70 | 689.55 | 690.04 | 690.53 | 691.02 | 691.52 | 692.01 | 692.50 | 692.99 | 693.49 | 693.98 | 694.47 | 11.70 |
| 11.80 | 694.47 | 694.96 | 695.46 | 695.95 | 696.44 | 696.93 | 697.42 | 697.92 | 698.41 | 698.90 | 699.39 | 11.80 |
| 11.90 | 699.39 | 699.88 | 700.37 | 700.87 | 701.36 | 701.85 | 702.34 | 702.83 | 703.32 | 703.82 | 704.31 | 11.90 |
| 12.00 | 704.31 | 704.80 | 705.29 | 705.78 | 706.27 | 706.76 | 707.25 | 707.74 | 708.24 | 708.73 | 709.22 | 12.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

Table B3. AWG 28 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12.00 | 704.31 | 704.80 | 705.29 | 705.78 | 706.27 | 706.76 | 707.25 | 707.74 | 708.24 | 708.73 | 709.22 | 12.00 |
| 12.10 | 709.22 | 709.71 | 710.20 | 710.69 | 711.18 | 711.67 | 712.16 | 712.65 | 713.14 | 713.63 | 714.12 | 12.10 |
| 12.20 | 714.12 | 714.61 | 715.10 | 715.59 | 716.08 | 716.57 | 717.06 | 717.55 | 718.04 | 718.53 | 719.02 | 12.20 |
| 12.30 | 719.02 | 719.51 | 720.00 | 720.49 | 720.98 | 721.47 | 721.96 | 722.45 | 722.94 | 723.43 | 723.92 | 12.30 |
| 12.40 | 723.92 | 724.41 | 724.90 | 725.39 | 725.88 | 726.36 | 726.85 | 727.34 | 727.83 | 728.32 | 728.81 | 12.40 |
| 12.50 | 728.81 | 729.30 | 729.79 | 730.28 | 730.76 | 731.25 | 731.74 | 732.23 | 732.72 | 733.21 | 733.70 | 12.50 |
| 12.60 | 733.70 | 734.18 | 734.67 | 735.16 | 735.65 | 736.14 | 736.62 | 737.11 | 737.60 | 738.09 | 738.58 | 12.60 |
| 12.70 | 738.58 | 739.06 | 739.55 | 740.04 | 740.53 | 741.02 | 741.50 | 741.99 | 742.48 | 742.97 | 743.45 | 12.70 |
| 12.80 | 743.45 | 743.94 | 744.43 | 744.92 | 745.40 | 745.89 | 746.38 | 746.86 | 747.35 | 747.84 | 748.33 | 12.80 |
| 12.90 | 748.33 | 748.81 | 749.30 | 749.79 | 750.27 | 750.76 | 751.25 | 751.73 |  |  |  | 12.90 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B4.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F.*

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 32.00 | 32.69 | 33.39 | 34.08 | 34.78 | 35.47 | 36.16 | 36.86 | 37.55 | 38.24 | 38.93 | 0.00 |
| 0.10 | 38.93 | 39.62 | 40.32 | 41.01 | 41.70 | 42.39 | 43.08 | 43.77 | 44.45 | 45.14 | 45.83 | 0.10 |
| 0.20 | 45.83 | 46.52 | 47.21 | 47.89 | 48.58 | 49.27 | 49.95 | 50.64 | 51.33 | 52.01 | 52.70 | 0.20 |
| 0.30 | 52.70 | 53.38 | 54.06 | 54.75 | 55.43 | 56.11 | 56.80 | 57.48 | 58.16 | 58.84 | 59.52 | 0.30 |
| 0.40 | 59.52 | 60.20 | 60.89 | 61.57 | 62.25 | 62.93 | 63.60 | 64.28 | 64.96 | 65.64 | 66.32 | 0.40 |
| 0.50 | 66.32 | 67.00 | 67.67 | 68.35 | 69.03 | 69.70 | 70.38 | 71.05 | 71.73 | 72.40 | 73.08 | 0.50 |
| 0.60 | 73.08 | 73.75 | 74.42 | 75.10 | 75.77 | 76.44 | 77.12 | 77.79 | 78.46 | 79.13 | 79.80 | 0.60 |
| 0.70 | 79.80 | 80.47 | 81.14 | 81.81 | 82.48 | 83.15 | 83.82 | 84.49 | 85.16 | 85.82 | 86.49 | 0.70 |
| 0.80 | 86.49 | 87.16 | 87.83 | 88.49 | 89.16 | 89.82 | 90.49 | 91.15 | 91.82 | 92.48 | 93.15 | 0.80 |
| 0.90 | 93.15 | 93.81 | 94.47 | 95.14 | 95.80 | 96.46 | 97.12 | 97.79 | 98.45 | 99.11 | 99.77 | 0.90 |
| 1.00 | 99.77 | 100.43 | 101.09 | 101.75 | 102.41 | 103.07 | 103.73 | 104.38 | 105.04 | 105.70 | 106.36 | 1.00 |
| 1.10 | 106.36 | 107.01 | 107.67 | 108.33 | 108.98 | 109.64 | 110.29 | 110.95 | 111.60 | 112.26 | 112.91 | 1.10 |
| 1.20 | 112.91 | 113.57 | 114.22 | 114.87 | 115.53 | 116.18 | 116.83 | 117.48 | 118.13 | 118.78 | 119.44 | 1.20 |
| 1.30 | 119.44 | 120.09 | 120.74 | 121.39 | 122.03 | 122.68 | 123.33 | 123.98 | 124.63 | 125.28 | 125.92 | 1.30 |
| 1.40 | 125.92 | 126.57 | 127.22 | 127.87 | 128.51 | 129.16 | 129.80 | 130.45 | 131.09 | 131.74 | 132.38 | 1.40 |
| 1.50 | 132.38 | 133.03 | 133.67 | 134.31 | 134.96 | 135.60 | 136.24 | 136.88 | 137.53 | 138.17 | 138.81 | 1.50 |
| 1.60 | 138.81 | 139.45 | 140.09 | 140.73 | 141.37 | 142.01 | 142.65 | 143.29 | 143.93 | 144.56 | 145.20 | 1.60 |
| 1.70 | 145.20 | 145.84 | 146.48 | 147.11 | 147.75 | 148.39 | 149.02 | 149.66 | 150.30 | 150.93 | 151.57 | 1.70 |
| 1.80 | 151.57 | 152.20 | 152.83 | 153.47 | 154.10 | 154.74 | 155.37 | 156.00 | 156.63 | 157.27 | 157.90 | 1.80 |
| 1.90 | 157.90 | 158.53 | 159.16 | 159.79 | 160.42 | 161.05 | 161.68 | 162.31 | 162.94 | 163.57 | 164.20 | 1.90 |
| 2.00 | 164.20 | 164.83 | 165.46 | 166.09 | 166.72 | 167.34 | 167.97 | 168.60 | 169.22 | 169.85 | 170.48 | 2.00 |
| 2.10 | 170.48 | 171.10 | 171.73 | 172.35 | 172.98 | 173.60 | 174.23 | 174.85 | 175.47 | 176.10 | 176.72 | 2.10 |
| 2.20 | 176.72 | 177.34 | 177.97 | 178.59 | 179.21 | 179.83 | 180.45 | 181.07 | 181.70 | 182.32 | 182.94 | 2.20 |
| 2.30 | 182.94 | 183.56 | 184.18 | 184.80 | 185.42 | 186.03 | 186.65 | 187.27 | 187.89 | 188.51 | 189.12 | 2.30 |
| 2.40 | 189.12 | 189.74 | 190.36 | 190.98 | 191.59 | 192.21 | 192.82 | 193.44 | 194.06 | 194.67 | 195.28 | 2.40 |
| 2.50 | 195.28 | 195.90 | 196.51 | 197.13 | 197.74 | 198.35 | 198.97 | 199.58 | 200.19 | 200.81 | 201.42 | 2.50 |
| 2.60 | 201.42 | 202.03 | 202.64 | 203.25 | 203.86 | 204.47 | 205.09 | 205.70 | 206.31 | 206.92 | 207.52 | 2.60 |
| 2.70 | 207.52 | 208.13 | 208.74 | 209.35 | 209.96 | 210.57 | 211.18 | 211.78 | 212.39 | 213.00 | 213.60 | 2.70 |
| 2.80 | 213.60 | 214.21 | 214.82 | 215.42 | 216.03 | 216.64 | 217.24 | 217.85 | 218.45 | 219.05 | 219.66 | 2.80 |
| 2.90 | 219.66 | 220.26 | 220.87 | 221.47 | 222.07 | 222.68 | 223.28 | 223.88 | 224.48 | 225.09 | 225.69 | 2.90 |
| 3.00 | 225.69 | 226.29 | 226.89 | 227.49 | 228.09 | 228.69 | 229.29 | 229.89 | 230.49 | 231.09 | 231.69 | 3.00 |
| 3.10 | 231.69 | 232.29 | 232.89 | 233.49 | 234.09 | 234.69 | 235.28 | 235.88 | 236.48 | 237.08 | 237.67 | 3.10 |
| 3.20 | 237.67 | 238.27 | 238.87 | 239.46 | 240.06 | 240.65 | 241.25 | 241.84 | 242.44 | 243.03 | 243.63 | 3.20 |
| 3.30 | 243.63 | 244.22 | 244.82 | 245.41 | 246.00 | 246.60 | 247.19 | 247.78 | 248.38 | 248.97 | 249.56 | 3.30 |
| 3.40 | 249.56 | 250.15 | 250.74 | 251.34 | 251.93 | 252.52 | 253.11 | 253.70 | 254.29 | 254.88 | 255.47 | 3.40 |
| 3.50 | 255.47 | 256.06 | 256.65 | 257.24 | 257.83 | 258.42 | 259.00 | 259.59 | 260.18 | 260.77 | 261.36 | 3.50 |
| 3.60 | 261.36 | 261.94 | 262.53 | 263.12 | 263.70 | 264.29 | 264.88 | 265.46 | 266.05 | 266.63 | 267.22 | 3.60 |
| 3.70 | 267.22 | 267.80 | 268.39 | 268.97 | 269.56 | 270.14 | 270.73 | 271.31 | 271.90 | 272.48 | 273.06 | 3.70 |
| 3.80 | 273.06 | 273.64 | 274.23 | 274.81 | 275.39 | 275.97 | 276.56 | 277.14 | 277.72 | 278.30 | 278.88 | 3.80 |
| 3.90 | 278.88 | 279.46 | 280.04 | 280.62 | 281.20 | 281.79 | 282.36 | 282.94 | 283.52 | 284.10 | 284.68 | 3.90 |
| 4.00 | 284.68 | 285.26 | 285.84 | 286.42 | 287.00 | 287.57 | 288.15 | 288.73 | 289.31 | 289.88 | 290.46 | 4.00 |
| 4.10 | 290.46 | 291.04 | 291.61 | 292.19 | 292.77 | 293.34 | 293.92 | 294.49 | 295.07 | 295.64 | 296.22 | 4.10 |
| 4.20 | 296.22 | 296.79 | 297.37 | 297.94 | 298.52 | 299.09 | 299.67 | 300.24 | 300.81 | 301.39 | 301.96 | 4.20 |
| 4.30 | 301.96 | 302.53 | 303.10 | 303.68 | 304.25 | 304.82 | 305.39 | 305.96 | 306.54 | 307.11 | 307.68 | 4.30 |
| 4.40 | 307.68 | 308.25 | 308.82 | 309.39 | 309.96 | 310.53 | 311.10 | 311.67 | 312.24 | 312.81 | 313.38 | 4.40 |
| 4.50 | 313.38 | 313.95 | 314.52 | 315.08 | 315.65 | 316.22 | 316.79 | 317.36 | 317.92 | 318.49 | 319.06 | 4.50 |
| 4.60 | 319.06 | 319.63 | 320.19 | 320.76 | 321.33 | 321.89 | 322.46 | 323.02 | 323.59 | 324.16 | 324.72 | 4.60 |
| 4.70 | 324.72 | 325.29 | 325.85 | 326.42 | 326.98 | 327.55 | 328.11 | 328.67 | 329.24 | 329.80 | 330.37 | 4.70 |
| 4.80 | 330.37 | 330.93 | 331.49 | 332.06 | 332.62 | 333.18 | 333.74 | 334.31 | 334.87 | 335.43 | 335.99 | 4.80 |
| 4.90 | 335.99 | 336.55 | 337.12 | 337.68 | 338.24 | 338.80 | 339.36 | 339.92 | 340.48 | 341.04 | 341.60 | 4.90 |
| 5.00 | 341.60 | 342.16 | 342.72 | 343.28 | 343.84 | 344.40 | 344.96 | 345.52 | 346.08 | 346.64 | 347.19 | 5.00 |
| 5.10 | 347.19 | 347.75 | 348.31 | 348.87 | 349.43 | 349.98 | 350.54 | 351.10 | 351.66 | 352.21 | 352.77 | 5.10 |
| 5.20 | 352.77 | 353.33 | 353.88 | 354.44 | 354.99 | 355.55 | 356.11 | 356.66 | 357.22 | 357.77 | 358.33 | 5.20 |
| 5.30 | 358.33 | 358.88 | 359.44 | 359.99 | 360.55 | 361.10 | 361.66 | 362.21 | 362.76 | 363.32 | 363.87 | 5.30 |
| 5.40 | 363.87 | 364.42 | 364.98 | 365.53 | 366.08 | 366.64 | 367.19 | 367.74 | 368.29 | 368.84 | 369.40 | 5.40 |
| 5.50 | 369.40 | 369.95 | 370.50 | 371.05 | 371.60 | 372.15 | 372.71 | 373.26 | 373.81 | 374.36 | 374.91 | 5.50 |
| 5.60 | 374.91 | 375.46 | 376.01 | 376.56 | 377.11 | 377.66 | 378.21 | 378.76 | 379.31 | 379.85 | 380.40 | 5.60 |
| 5.70 | 380.40 | 380.95 | 381.50 | 382.05 | 382.60 | 383.15 | 383.69 | 384.24 | 384.79 | 385.34 | 385.88 | 5.70 |
| 5.80 | 385.88 | 386.43 | 386.98 | 387.52 | 388.07 | 388.62 | 389.16 | 389.71 | 390.26 | 390.80 | 391.35 | 5.80 |
| 5.90 | 391.35 | 391.89 | 392.44 | 392.99 | 393.53 | 394.08 | 394.62 | 395.17 | 395.71 | 396.26 | 396.80 | 5.90 |
| 6.00 | 396.80 | 397.34 | 397.89 | 398.43 | 398.98 | 399.52 | 400.06 | 400.61 | 401.15 | 401.69 | 402.24 | 6.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**TABLE B4.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.00 | 396.80 | 397.34 | 397.89 | 398.43 | 398.98 | 399.52 | 400.06 | 400.61 | 401.15 | 401.69 | 402.24 | 6.00 |
| 6.10 | 402.24 | 402.78 | 403.32 | 403.87 | 404.41 | 404.95 | 405.49 | 406.03 | 406.58 | 407.12 | 407.66 | 6.10 |
| 6.20 | 407.66 | 408.20 | 408.74 | 409.28 | 409.82 | 410.37 | 410.91 | 411.45 | 411.99 | 412.53 | 413.07 | 6.20 |
| 6.30 | 413.07 | 413.61 | 414.15 | 414.69 | 415.23 | 415.77 | 416.31 | 416.85 | 417.39 | 417.92 | 418.46 | 6.30 |
| 6.40 | 418.46 | 419.00 | 419.54 | 420.08 | 420.62 | 421.16 | 421.69 | 422.23 | 422.77 | 423.31 | 423.85 | 6.40 |
| 6.50 | 423.85 | 424.38 | 424.92 | 425.46 | 425.99 | 426.53 | 427.07 | 427.61 | 428.14 | 428.68 | 429.21 | 6.50 |
| 6.60 | 429.21 | 429.75 | 430.29 | 430.82 | 431.36 | 431.89 | 432.43 | 432.97 | 433.50 | 434.04 | 434.57 | 6.60 |
| 6.70 | 434.57 | 435.11 | 435.64 | 436.18 | 436.71 | 437.24 | 437.78 | 438.31 | 438.85 | 439.38 | 439.91 | 6.70 |
| 6.80 | 439.91 | 440.45 | 440.98 | 441.51 | 442.05 | 442.58 | 443.11 | 443.65 | 444.18 | 444.71 | 445.25 | 6.80 |
| 6.90 | 445.25 | 445.78 | 446.31 | 446.84 | 447.37 | 447.91 | 448.44 | 448.97 | 449.50 | 450.03 | 450.56 | 6.90 |
| 7.00 | 450.56 | 451.10 | 451.63 | 452.16 | 452.69 | 453.22 | 453.75 | 454.28 | 454.81 | 455.34 | 455.87 | 7.00 |
| 7.10 | 455.87 | 456.40 | 456.93 | 457.46 | 457.99 | 458.52 | 459.05 | 459.58 | 460.11 | 460.64 | 461.17 | 7.10 |
| 7.20 | 461.17 | 461.70 | 462.22 | 462.75 | 463.28 | 463.81 | 464.34 | 464.87 | 465.39 | 465.92 | 466.45 | 7.20 |
| 7.30 | 466.45 | 466.98 | 467.51 | 468.03 | 468.56 | 469.09 | 469.61 | 470.14 | 470.67 | 471.20 | 471.72 | 7.30 |
| 7.40 | 471.72 | 472.25 | 472.78 | 473.30 | 473.83 | 474.35 | 474.88 | 475.41 | 475.93 | 476.46 | 476.98 | 7.40 |
| 7.50 | 476.98 | 477.51 | 478.03 | 478.56 | 479.08 | 479.61 | 480.13 | 480.66 | 481.18 | 481.71 | 482.23 | 7.50 |
| 7.60 | 482.23 | 482.76 | 483.28 | 483.81 | 484.33 | 484.85 | 485.38 | 485.90 | 486.43 | 486.95 | 487.47 | 7.60 |
| 7.70 | 487.47 | 488.00 | 488.52 | 489.04 | 489.56 | 490.09 | 490.61 | 491.13 | 491.66 | 492.18 | 492.70 | 7.70 |
| 7.80 | 492.70 | 493.22 | 493.75 | 494.27 | 494.79 | 495.31 | 495.83 | 496.35 | 496.88 | 497.40 | 497.92 | 7.80 |
| 7.90 | 497.92 | 498.44 | 498.96 | 499.48 | 500.00 | 500.52 | 501.04 | 501.57 | 502.09 | 502.61 | 503.13 | 7.90 |
| 8.00 | 503.13 | 503.65 | 504.17 | 504.69 | 505.21 | 505.73 | 506.25 | 506.77 | 507.29 | 507.81 | 508.32 | 8.00 |
| 8.10 | 508.32 | 508.84 | 509.36 | 509.88 | 510.40 | 510.92 | 511.44 | 511.96 | 512.48 | 512.99 | 513.51 | 8.10 |
| 8.20 | 513.51 | 514.03 | 514.55 | 515.07 | 515.58 | 516.10 | 516.62 | 517.14 | 517.66 | 518.17 | 518.69 | 8.20 |
| 8.30 | 518.69 | 519.21 | 519.72 | 520.24 | 520.76 | 521.28 | 521.79 | 522.31 | 522.83 | 523.34 | 523.86 | 8.30 |
| 8.40 | 523.86 | 524.37 | 524.89 | 525.41 | 525.92 | 526.44 | 526.95 | 527.47 | 527.99 | 528.50 | 529.02 | 8.40 |
| 8.50 | 529.02 | 529.53 | 530.05 | 530.56 | 531.08 | 531.59 | 532.11 | 532.62 | 533.14 | 533.65 | 534.17 | 8.50 |
| 8.60 | 534.17 | 534.68 | 535.20 | 535.71 | 536.22 | 536.74 | 537.25 | 537.77 | 538.28 | 538.79 | 539.31 | 8.60 |
| 8.70 | 539.31 | 539.82 | 540.33 | 540.85 | 541.36 | 541.87 | 542.39 | 542.90 | 543.41 | 543.93 | 544.44 | 8.70 |
| 8.80 | 544.44 | 544.95 | 545.46 | 545.98 | 546.49 | 547.00 | 547.51 | 548.03 | 548.54 | 549.05 | 549.56 | 8.80 |
| 8.90 | 549.56 | 550.07 | 550.58 | 551.10 | 551.61 | 552.12 | 552.63 | 553.14 | 553.65 | 554.16 | 554.67 | 8.90 |
| 9.00 | 554.67 | 555.19 | 555.70 | 556.21 | 556.72 | 557.23 | 557.74 | 558.25 | 558.76 | 559.27 | 559.78 | 9.00 |
| 9.10 | 559.78 | 560.29 | 560.80 | 561.31 | 561.82 | 562.33 | 562.84 | 563.35 | 563.86 | 564.37 | 564.88 | 9.10 |
| 9.20 | 564.88 | 565.39 | 565.89 | 566.40 | 566.91 | 567.42 | 567.93 | 568.44 | 568.95 | 569.46 | 569.96 | 9.20 |
| 9.30 | 569.96 | 570.47 | 570.98 | 571.49 | 572.00 | 572.51 | 573.01 | 573.52 | 574.03 | 574.54 | 575.04 | 9.30 |
| 9.40 | 575.04 | 575.55 | 576.06 | 576.57 | 577.07 | 577.58 | 578.09 | 578.60 | 579.10 | 579.61 | 580.12 | 9.40 |
| 9.50 | 580.12 | 580.62 | 581.13 | 581.64 | 582.14 | 582.65 | 583.16 | 583.66 | 584.17 | 584.67 | 585.18 | 9.50 |
| 9.60 | 585.18 | 585.69 | 586.19 | 586.70 | 587.20 | 587.71 | 588.22 | 588.72 | 589.23 | 589.73 | 590.24 | 9.60 |
| 9.70 | 590.24 | 590.74 | 591.25 | 591.75 | 592.26 | 592.76 | 593.27 | 593.77 | 594.28 | 594.78 | 595.29 | 9.70 |
| 9.80 | 595.29 | 595.79 | 596.29 | 596.80 | 597.30 | 597.81 | 598.31 | 598.81 | 599.32 | 599.82 | 600.33 | 9.80 |
| 9.90 | 600.33 | 600.83 | 601.33 | 601.84 | 602.34 | 602.84 | 603.35 | 603.85 | 604.35 | 604.86 | 605.36 | 9.90 |
| 10.00 | 605.36 | 605.86 | 606.36 | 606.87 | 607.37 | 607.87 | 608.38 | 608.88 | 609.38 | 609.88 | 610.39 | 10.00 |
| 10.10 | 610.39 | 610.89 | 611.39 | 611.89 | 612.39 | 612.90 | 613.40 | 613.90 | 614.40 | 614.90 | 615.40 | 10.10 |
| 10.20 | 615.40 | 615.91 | 616.41 | 616.91 | 617.41 | 617.91 | 618.41 | 618.91 | 619.41 | 619.91 | 620.42 | 10.20 |
| 10.30 | 620.42 | 620.92 | 621.42 | 621.92 | 622.42 | 622.92 | 623.42 | 623.92 | 624.42 | 624.92 | 625.42 | 10.30 |
| 10.40 | 625.42 | 625.92 | 626.42 | 626.92 | 627.42 | 627.92 | 628.42 | 628.92 | 629.42 | 629.92 | 630.42 | 10.40 |
| 10.50 | 630.42 | 630.92 | 631.42 | 631.91 | 632.41 | 632.91 | 633.41 | 633.91 | 634.41 | 634.91 | 635.41 | 10.50 |
| 10.60 | 635.41 | 635.91 | 636.40 | 636.90 | 637.40 | 637.90 | 638.40 | 638.90 | 639.39 | 639.89 | 640.39 | 10.60 |
| 10.70 | 640.39 | 640.89 | 641.39 | 641.88 | 642.38 | 642.88 | 643.38 | 643.88 | 644.37 | 644.87 | 645.37 | 10.70 |
| 10.80 | 645.37 | 645.87 | 646.36 | 646.86 | 647.36 | 647.85 | 648.35 | 648.85 | 649.34 | 649.84 | 650.34 | 10.80 |
| 10.90 | 650.34 | 650.84 | 651.33 | 651.83 | 652.32 | 652.82 | 653.32 | 653.81 | 654.31 | 654.81 | 655.30 | 10.90 |
| 11.00 | 655.30 | 655.80 | 656.29 | 656.79 | 657.29 | 657.78 | 658.28 | 658.77 | 659.27 | 659.76 | 660.26 | 11.00 |
| 11.10 | 660.26 | 660.76 | 661.25 | 661.75 | 662.24 | 662.74 | 663.23 | 663.73 | 664.22 | 664.72 | 665.21 | 11.10 |
| 11.20 | 665.21 | 665.71 | 666.20 | 666.70 | 667.19 | 667.68 | 668.18 | 668.67 | 669.17 | 669.66 | 670.16 | 11.20 |
| 11.30 | 670.16 | 670.65 | 671.14 | 671.64 | 672.13 | 672.63 | 673.12 | 673.61 | 674.11 | 674.60 | 675.10 | 11.30 |
| 11.40 | 675.10 | 675.59 | 676.08 | 676.58 | 677.07 | 677.56 | 678.06 | 678.55 | 679.04 | 679.54 | 680.03 | 11.40 |
| 11.50 | 680.03 | 680.52 | 681.01 | 681.51 | 682.00 | 682.49 | 682.99 | 683.48 | 683.97 | 684.46 | 684.96 | 11.50 |
| 11.60 | 684.96 | 685.45 | 685.94 | 686.43 | 686.92 | 687.42 | 687.91 | 688.40 | 688.89 | 689.38 | 689.88 | 11.60 |
| 11.70 | 689.88 | 690.37 | 690.86 | 691.35 | 691.84 | 692.33 | 692.83 | 693.32 | 693.81 | 694.30 | 694.79 | 11.70 |
| 11.80 | 694.79 | 695.28 | 695.77 | 696.27 | 696.76 | 697.25 | 697.74 | 698.23 | 698.72 | 699.21 | 699.70 | 11.80 |
| 11.90 | 699.70 | 700.19 | 700.68 | 701.17 | 701.66 | 702.15 | 702.64 | 703.13 | 703.62 | 704.11 | 704.61 | 11.90 |
| 12.00 | 704.61 | 705.10 | 705.59 | 706.08 | 706.57 | 707.05 | 707.54 | 708.03 | 708.52 | 709.01 | 709.50 | 12.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**TABLE B4.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TEMPERATURES IN DEGREES F | | | | | | |
| 12.00 | 704.61 | 705.10 | 705.59 | 706.08 | 706.57 | 707.05 | 707.54 | 708.03 | 708.52 | 709.01 | 709.50 | 12.00 |
| 12.10 | 709.50 | 709.99 | 710.48 | 710.97 | 711.46 | 711.95 | 712.44 | 712.93 | 713.42 | 713.91 | 714.40 | 12.10 |
| 12.20 | 714.40 | 714.89 | 715.37 | 715.86 | 716.35 | 716.84 | 717.33 | 717.82 | 718.31 | 718.80 | 719.28 | 12.20 |
| 12.30 | 719.28 | 719.77 | 720.26 | 720.75 | 721.24 | 721.73 | 722.21 | 722.70 | 723.19 | 723.68 | 724.17 | 12.30 |
| 12.40 | 724.17 | 724.65 | 725.14 | 725.63 | 726.12 | 726.60 | 727.09 | 727.58 | 728.07 | 728.56 | 729.04 | 12.40 |
| 12.50 | 729.04 | 729.53 | 730.02 | 730.50 | 730.99 | 731.48 | 731.97 | 732.45 | 732.94 | 733.43 | 733.91 | 12.50 |
| 12.60 | 733.91 | 734.40 | 734.89 | 735.37 | 735.86 | 736.35 | 736.83 | 737.32 | 737.81 | 738.29 | 738.78 | 12.60 |
| 12.70 | 738.78 | 739.27 | 739.75 | 740.24 | 740.73 | 741.21 | 741.70 | 742.18 | 742.67 | 743.16 | 743.64 | 12.70 |
| 12.80 | 743.64 | 744.13 | 744.61 | 745.10 | 745.59 | 746.07 | 746.56 | 747.04 | 747.53 | 748.01 | 748.50 | 12.80 |
| 12.90 | 748.50 | 748.98 | 749.47 | 749.95 | 750.44 | 750.92 | 751.41 | 751.90 | 752.38 | 752.87 | 753.35 | 12.90 |
| 13.00 | 753.35 | 753.83 | 754.32 | 754.80 | 755.29 | 755.77 | 756.26 | 756.74 | 757.23 | 757.71 | 758.20 | 13.00 |
| 13.10 | 758.20 | 758.68 | 759.17 | 759.65 | 760.13 | 760.62 | 761.10 | 761.59 | 762.07 | 762.55 | 763.04 | 13.10 |
| 13.20 | 763.04 | 763.52 | 764.01 | 764.49 | 764.97 | 765.46 | 765.94 | 766.42 | 766.91 | 767.39 | 767.88 | 13.20 |
| 13.30 | 767.88 | 768.36 | 768.84 | 769.33 | 769.81 | 770.29 | 770.78 | 771.26 | 771.74 | 772.22 | 772.71 | 13.30 |
| 13.40 | 772.71 | 773.19 | 773.67 | 774.16 | 774.64 | 775.12 | 775.61 | 776.09 | 776.57 | 777.05 | 777.54 | 13.40 |
| 13.50 | 777.54 | 778.02 | 778.50 | 778.98 | 779.47 | 779.95 | 780.43 | 780.91 | 781.39 | 781.88 | 782.36 | 13.50 |
| 13.60 | 782.36 | 782.84 | 783.32 | 783.80 | 784.29 | 784.77 | 785.25 | 785.73 | 786.21 | 786.70 | 787.18 | 13.60 |
| 13.70 | 787.18 | 787.66 | 788.14 | 788.62 | 789.10 | 789.59 | 790.07 | 790.55 | 791.03 | 791.51 | 791.99 | 13.70 |
| 13.80 | 791.99 | 792.47 | 792.95 | 793.44 | 793.92 | 794.40 | 794.88 | 795.36 | 795.84 | 796.32 | 796.80 | 13.80 |
| 13.90 | 796.80 | 797.28 | 797.76 | 798.24 | 798.72 | 799.21 | 799.69 | 800.17 | 800.65 | 801.13 | 801.61 | 13.90 |
| 14.00 | 801.61 | 802.09 | 802.57 | 803.05 | 803.53 | 804.01 | 804.49 | 804.97 | 805.45 | 805.93 | 806.41 | 14.00 |
| 14.10 | 806.41 | 806.89 | 807.37 | 807.85 | 808.33 | 808.81 | 809.29 | 809.77 | 810.25 | 810.73 | 811.21 | 14.10 |
| 14.20 | 811.21 | 811.69 | 812.16 | 812.64 | 813.12 | 813.60 | 814.08 | 814.56 | 815.04 | 815.52 | 816.00 | 14.20 |
| 14.30 | 816.00 | 816.48 | 816.96 | 817.44 | 817.91 | 818.39 | 818.87 | 819.35 | 819.83 | 820.31 | 820.79 | 14.30 |
| 14.40 | 820.79 | 821.27 | 821.74 | 822.22 | 822.70 | 823.18 | 823.66 | 824.14 | 824.62 | 825.09 | 825.57 | 14.40 |
| 14.50 | 825.57 | 826.05 | 826.53 | 827.01 | 827.48 | 827.96 | 828.44 | 828.92 | 829.40 | 829.88 | 830.35 | 14.50 |
| 14.60 | 830.35 | 830.83 | 831.31 | 831.79 | 832.26 | 832.74 | 833.22 | 833.70 | 834.17 | 834.65 | 835.13 | 14.60 |
| 14.70 | 835.13 | 835.61 | 836.08 | 836.56 | 837.04 | 837.52 | 837.99 | 838.47 | 838.95 | 839.43 | 839.90 | 14.70 |
| 14.80 | 839.90 | 840.38 | 840.86 | 841.33 | 841.81 | 842.29 | 842.76 | 843.24 | 843.72 | 844.19 | 844.67 | 14.80 |
| 14.90 | 844.67 | 845.15 | 845.63 | 846.10 | 846.58 | 847.05 | 847.53 | 848.01 | 848.48 | 848.96 | 849.44 | 14.90 |
| 15.00 | 849.44 | 849.91 | 850.39 | 850.87 | 851.34 | 851.82 | 852.29 | 852.77 | 853.25 | 853.72 | 854.20 | 15.00 |
| 15.10 | 854.20 | 854.67 | 855.15 | 855.63 | 856.10 | 856.58 | 857.05 | 857.53 | 858.00 | 858.48 | 858.96 | 15.10 |
| 15.20 | 858.96 | 859.43 | 859.91 | 860.38 | 860.86 | 861.33 | 861.81 | 862.28 | 862.76 | 863.24 | 863.71 | 15.20 |
| 15.30 | 863.71 | 864.19 | 864.66 | 865.14 | 865.61 | 866.09 | 866.56 | 867.04 | 867.51 | 867.99 | 868.46 | 15.30 |
| 15.40 | 868.46 | 868.94 | 869.41 | 869.89 | 870.36 | 870.83 | 871.31 | 871.78 | 872.26 | 872.73 | 873.21 | 15.40 |
| 15.50 | 873.21 | 873.68 | 874.16 | 874.63 | 875.11 | 875.58 | 876.05 | 876.53 | 877.00 | 877.48 | 877.95 | 15.50 |
| 15.60 | 877.95 | 878.43 | 878.90 | 879.37 | 879.85 | 880.32 | 880.80 | 881.27 | 881.74 | 882.22 | 882.69 | 15.60 |
| 15.70 | 882.69 | 883.17 | 883.64 | 884.11 | 884.59 | 885.06 | 885.53 | 886.01 | 886.48 | 886.95 | 887.43 | 15.70 |
| 15.80 | 887.43 | 887.90 | 888.37 | 888.85 | 889.32 | 889.80 | 890.27 | 890.74 | 891.21 | 891.69 | 892.16 | 15.80 |
| 15.90 | 892.16 | 892.63 | 893.11 | 893.58 | 894.05 | 894.53 | 895.00 | 895.47 | 895.95 | 896.42 | 896.89 | 15.90 |
| 16.00 | 896.89 | 897.36 | 897.84 | 898.31 | 898.78 | 899.25 | 899.73 | 900.20 | 900.67 | 901.15 | 901.62 | 16.00 |
| 16.10 | 901.62 | 902.09 | 902.56 | 903.04 | 903.51 | 903.98 | 904.45 | 904.92 | 905.40 | 905.87 | 906.34 | 16.10 |
| 16.20 | 906.34 | 906.81 | 907.29 | 907.76 | 908.23 | 908.70 | 909.17 | 909.65 | 910.12 | 910.59 | 911.06 | 16.20 |
| 16.30 | 911.06 | 911.53 | 912.00 | 912.48 | 912.95 | 913.42 | 913.89 | 914.36 | 914.84 | 915.31 | 915.78 | 16.30 |
| 16.40 | 915.78 | 916.25 | 916.72 | 917.19 | 917.66 | 918.14 | 918.61 | 919.08 | 919.55 | 920.02 | 920.49 | 16.40 |
| 16.50 | 920.49 | 920.96 | 921.43 | 921.91 | 922.38 | 922.85 | 923.32 | 923.79 | 924.26 | 924.73 | 925.20 | 16.50 |
| 16.60 | 925.20 | 925.67 | 926.14 | 926.62 | 927.09 | 927.50 | 928.03 | 928.50 | 928.97 | 929.44 | 929.91 | 16.60 |
| 16.70 | 929.91 | 930.38 | 930.85 | 931.32 | 931.79 | 932.26 | 932.73 | 933.20 | 933.67 | 934.15 | 934.62 | 16.70 |
| 16.80 | 934.62 | 935.09 | 935.56 | 936.03 | 936.50 | 936.97 | 937.44 | 937.91 | 938.38 | 938.85 | 939.32 | 16.80 |
| 16.90 | 939.32 | 939.79 | 940.26 | 940.73 | 941.20 | 941.67 | 942.14 | 942.61 | 943.08 | 943.55 | 944.02 | 16.90 |
| 17.00 | 944.02 | 944.49 | 944.96 | 945.43 | 945.90 | 946.36 | 946.83 | 947.30 | 947.77 | 948.24 | 948.71 | 17.00 |
| 17.10 | 948.71 | 949.18 | 949.65 | 950.12 | 950.59 | 951.06 | 951.53 | 952.00 | 952.47 | 952.94 | 953.41 | 17.10 |
| 17.20 | 953.41 | 953.88 | 954.34 | 954.81 | 955.28 | 955.75 | 956.22 | 956.69 | 957.16 | 957.63 | 958.10 | 17.20 |
| 17.30 | 958.10 | 958.57 | 959.03 | 959.50 | 959.97 | 960.44 | 960.91 | 961.38 | 961.85 | 962.32 | 962.78 | 17.30 |
| 17.40 | 962.78 | 963.25 | 963.72 | 964.19 | 964.66 | 965.13 | 965.60 | 966.06 | 966.53 | 967.00 | 967.47 | 17.40 |
| 17.50 | 967.47 | 967.94 | 968.41 | 968.87 | 969.34 | 969.81 | 970.28 | 970.75 | 971.22 | 971.68 | 972.15 | 17.50 |
| 17.60 | 972.15 | 972.62 | 973.09 | 973.56 | 974.02 | 974.49 | 974.96 | 975.43 | 975.90 | 976.36 | 976.83 | 17.60 |
| 17.70 | 976.83 | 977.30 | 977.77 | 978.23 | 978.70 | 979.17 | 979.64 | 980.11 | 980.57 | 981.04 | 981.51 | 17.70 |
| 17.80 | 981.51 | 981.98 | 982.44 | 982.91 | 983.38 | 983.85 | 984.31 | 984.78 | 985.25 | 985.72 | 986.18 | 17.80 |
| 17.90 | 986.18 | 986.65 | 987.12 | 987.59 | 988.05 | 988.52 | 988.99 | 989.45 | 989.92 | 990.39 | 990.86 | 17.90 |
| 18.00 | 990.86 | 991.32 | 991.79 | 992.26 | 992.72 | 993.19 | 993.66 | 994.12 | 994.59 | 995.06 | 995.52 | 18.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B4.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.00 | 990.86 | 991.32 | 991.79 | 992.26 | 992.72 | 993.19 | 993.66 | 994.12 | 994.59 | 995.06 | 995.52 | 18.00 |
| 18.10 | 995.52 | 995.99 | 996.46 | 996.93 | 997.39 | 997.86 | 998.33 | 998.79 | 999.26 | 999.73 | 1000.19 | 18.10 |
| 18.20 | 1000.19 | 1000.66 | 1001.13 | 1001.59 | 1002.06 | 1002.52 | 1002.99 | 1003.46 | 1003.92 | 1004.39 | 1004.86 | 18.20 |
| 18.30 | 1004.86 | 1005.32 | 1005.79 | 1006.26 | 1006.72 | 1007.19 | 1007.65 | 1008.12 | 1008.59 | 1009.05 | 1009.52 | 18.30 |
| 18.40 | 1009.52 | 1009.99 | 1010.45 | 1010.92 | 1011.38 | 1011.85 | 1012.32 | 1012.78 | 1013.25 | 1013.71 | 1014.18 | 18.40 |
| 18.50 | 1014.18 | 1014.65 | 1015.11 | 1015.58 | 1016.04 | 1016.51 | 1016.97 | 1017.44 | 1017.91 | 1018.37 | 1018.84 | 18.50 |
| 18.60 | 1018.84 | 1019.30 | 1019.77 | 1020.23 | 1020.70 | 1021.17 | 1021.63 | 1022.10 | 1022.56 | 1023.03 | 1023.49 | 18.60 |
| 18.70 | 1023.49 | 1023.96 | 1024.42 | 1024.89 | 1025.35 | 1025.82 | 1026.29 | 1026.75 | 1027.22 | 1027.68 | 1028.15 | 18.70 |
| 18.80 | 1028.15 | 1028.61 | 1029.08 | 1029.54 | 1030.01 | 1030.47 | 1030.94 | 1031.40 | 1031.87 | 1032.33 | 1032.80 | 18.80 |
| 18.90 | 1032.80 | 1033.26 | 1033.73 | 1034.19 | 1034.66 | 1035.12 | 1035.59 | 1036.05 | 1036.52 | 1036.98 | 1037.45 | 18.90 |
| 19.00 | 1037.45 | 1037.91 | 1038.38 | 1038.84 | 1039.31 | 1039.77 | 1040.24 | 1040.70 | 1041.16 | 1041.63 | 1042.09 | 19.00 |
| 19.10 | 1042.09 | 1042.56 | 1043.02 | 1043.49 | 1043.95 | 1044.42 | 1044.88 | 1045.35 | 1045.81 | 1046.27 | 1046.74 | 19.10 |
| 19.20 | 1046.74 | 1047.20 | 1047.67 | 1048.13 | 1048.60 | 1049.06 | 1049.52 | 1049.99 | 1050.45 | 1050.92 | 1051.38 | 19.20 |
| 19.30 | 1051.38 | 1051.85 | 1052.31 | 1052.77 | 1053.24 | 1053.70 | 1054.17 | 1054.63 | 1055.09 | 1055.56 | 1056.02 | 19.30 |
| 19.40 | 1056.02 | 1056.49 | 1056.95 | 1057.41 | 1057.88 | 1058.34 | 1058.81 | 1059.27 | 1059.73 | 1060.20 | 1060.66 | 19.40 |
| 19.50 | 1060.66 | 1061.12 | 1061.59 | 1062.05 | 1062.52 | 1062.98 | 1063.44 | 1063.91 | 1064.37 | 1064.83 | 1065.30 | 19.50 |
| 19.60 | 1065.30 | 1065.76 | 1066.23 | 1066.69 | 1067.15 | 1067.62 | 1068.08 | 1068.54 | 1069.01 | 1069.47 | 1069.93 | 19.60 |
| 19.70 | 1069.93 | 1070.40 | 1070.86 | 1071.32 | 1071.79 | 1072.25 | 1072.71 | 1073.18 | 1073.64 | 1074.10 | 1074.57 | 19.70 |
| 19.80 | 1074.57 | 1075.03 | 1075.49 | 1075.96 | 1076.42 | 1076.88 | 1077.35 | 1077.81 | 1078.27 | 1078.73 | 1079.20 | 19.80 |
| 19.90 | 1079.20 | 1079.66 | 1080.12 | 1080.59 | 1081.05 | 1081.51 | 1081.98 | 1082.44 | 1082.90 | 1083.36 | 1083.83 | 19.90 |
| 20.00 | 1083.83 | 1084.29 | 1084.75 | 1085.22 | 1085.68 | 1086.14 | 1086.60 | 1087.07 | 1087.53 | 1087.99 | 1088.45 | 20.00 |
| 20.10 | 1088.45 | 1088.92 | 1089.38 | 1089.84 | 1090.31 | 1090.77 | 1091.23 | 1091.69 | 1092.16 | 1092.62 | 1093.08 | 20.10 |
| 20.20 | 1093.08 | 1093.54 | 1094.01 | 1094.47 | 1094.93 | 1095.39 | 1095.86 | 1096.32 | 1096.78 | 1097.24 | 1097.71 | 20.20 |
| 20.30 | 1097.71 | 1098.17 | 1098.63 | 1099.09 | 1099.55 | 1100.02 | 1100.48 | 1100.94 | 1101.40 | 1101.87 | 1102.33 | 20.30 |
| 20.40 | 1102.33 | 1102.79 | 1103.25 | 1103.71 | 1104.18 | 1104.64 | 1105.10 | 1105.56 | 1106.02 | 1106.49 | 1106.95 | 20.40 |
| 20.50 | 1106.95 | 1107.41 | 1107.87 | 1108.33 | 1108.80 | 1109.26 | 1109.72 | 1110.18 | 1110.64 | 1111.11 | 1111.57 | 20.50 |
| 20.60 | 1111.57 | 1112.03 | 1112.49 | 1112.95 | 1113.42 | 1113.88 | 1114.34 | 1114.80 | 1115.26 | 1115.72 | 1116.19 | 20.60 |
| 20.70 | 1116.19 | 1116.65 | 1117.11 | 1117.57 | 1118.03 | 1118.49 | 1118.96 | 1119.42 | 1119.88 | 1120.34 | 1120.80 | 20.70 |
| 20.80 | 1120.80 | 1121.26 | 1121.73 | 1122.19 | 1122.65 | 1123.11 | 1123.57 | 1124.03 | 1124.49 | 1124.96 | 1125.42 | 20.80 |
| 20.90 | 1125.42 | 1125.88 | 1126.34 | 1126.80 | 1127.26 | 1127.72 | 1128.19 | 1128.65 | 1129.11 | 1129.57 | 1130.03 | 20.90 |
| 21.00 | 1130.03 | 1130.49 | 1130.95 | 1131.41 | 1131.88 | 1132.34 | 1132.80 | 1133.26 | 1133.72 | 1134.18 | 1134.64 | 21.00 |
| 21.10 | 1134.64 | 1135.10 | 1135.57 | 1136.03 | 1136.49 | 1136.95 | 1137.41 | 1137.87 | 1138.33 | 1138.79 | 1139.25 | 21.10 |
| 21.20 | 1139.25 | 1139.71 | 1140.18 | 1140.64 | 1141.10 | 1141.56 | 1142.02 | 1142.48 | 1142.94 | 1143.40 | 1143.86 | 21.20 |
| 21.30 | 1143.86 | 1144.32 | 1144.78 | 1145.25 | 1145.71 | 1146.17 | 1146.63 | 1147.09 | 1147.55 | 1148.01 | 1148.47 | 21.30 |
| 21.40 | 1148.47 | 1148.93 | 1149.39 | 1149.85 | 1150.31 | 1150.77 | 1151.23 | 1151.70 | 1152.16 | 1152.62 | 1153.08 | 21.40 |
| 21.50 | 1153.08 | 1153.54 | 1154.00 | 1154.46 | 1154.92 | 1155.38 | 1155.84 | 1156.30 | 1156.76 | 1157.22 | 1157.68 | 21.50 |
| 21.60 | 1157.68 | 1158.14 | 1158.60 | 1159.06 | 1159.52 | 1159.98 | 1160.44 | 1160.91 | 1161.37 | 1161.83 | 1162.29 | 21.60 |
| 21.70 | 1162.29 | 1162.75 | 1163.21 | 1163.67 | 1164.13 | 1164.59 | 1165.05 | 1165.51 | 1165.97 | 1166.43 | 1166.89 | 21.70 |
| 21.80 | 1166.89 | 1167.35 | 1167.81 | 1168.27 | 1168.73 | 1169.19 | 1169.65 | 1170.11 | 1170.57 | 1171.03 | 1171.49 | 21.80 |
| 21.90 | 1171.49 | 1171.95 | 1172.41 | 1172.87 | 1173.33 | 1173.79 | 1174.25 | 1174.71 | 1175.17 | 1175.63 | 1176.09 | 21.90 |
| 22.00 | 1176.09 | 1176.55 | 1177.01 | 1177.47 | 1177.93 | 1178.39 | 1178.85 | 1179.31 | 1179.77 | 1180.23 | 1180.69 | 22.00 |
| 22.10 | 1180.69 | 1181.15 | 1181.61 | 1182.07 | 1182.53 | 1182.99 | 1183.45 | 1183.91 | 1184.37 | 1184.83 | 1185.29 | 22.10 |
| 22.20 | 1185.29 | 1185.75 | 1186.21 | 1186.67 | 1187.13 | 1187.59 | 1188.05 | 1188.51 | 1188.97 | 1189.43 | 1189.89 | 22.20 |
| 22.30 | 1189.89 | 1190.35 | 1190.81 | 1191.27 | 1191.72 | 1192.18 | 1192.64 | 1193.10 | 1193.56 | 1194.02 | 1194.48 | 22.30 |
| 22.40 | 1194.48 | 1194.94 | 1195.40 | 1195.86 | 1196.32 | 1196.78 | 1197.24 | 1197.70 | 1198.16 | 1198.62 | 1199.08 | 22.40 |
| 22.50 | 1199.08 | 1199.54 | 1200.00 | 1200.46 | 1200.92 | 1201.37 | 1201.83 | 1202.29 | 1202.75 | 1203.21 | 1203.67 | 22.50 |
| 22.60 | 1203.67 | 1204.13 | 1204.59 | 1205.05 | 1205.51 | 1205.97 | 1206.43 | 1206.89 | 1207.35 | 1207.81 | 1208.27 | 22.60 |
| 22.70 | 1208.27 | 1208.72 | 1209.18 | 1209.64 | 1210.10 | 1210.56 | 1211.02 | 1211.48 | 1211.94 | 1212.40 | 1212.86 | 22.70 |
| 22.80 | 1212.86 | 1213.32 | 1213.78 | 1214.24 | 1214.69 | 1215.15 | 1215.61 | 1216.07 | 1216.53 | 1216.99 | 1217.45 | 22.80 |
| 22.90 | 1217.45 | 1217.91 | 1218.37 | 1218.83 | 1219.29 | 1219.74 | 1220.20 | 1220.66 | 1221.12 | 1221.58 | 1222.04 | 22.90 |
| 23.00 | 1222.04 | 1222.50 | 1222.96 | 1223.42 | 1223.88 | 1224.33 | 1224.79 | 1225.25 | 1225.71 | 1226.17 | 1226.63 | 23.00 |
| 23.10 | 1226.63 | 1227.09 | 1227.55 | 1228.01 | 1228.47 | 1228.92 | 1229.38 | 1229.84 | 1230.30 | 1230.76 | 1231.22 | 23.10 |
| 23.20 | 1231.22 | 1231.68 | 1232.14 | 1232.60 | 1233.05 | 1233.51 | 1233.97 | 1234.43 | 1234.89 | 1235.35 | 1235.81 | 23.20 |
| 23.30 | 1235.81 | 1236.27 | 1236.72 | 1237.18 | 1237.64 | 1238.10 | 1238.56 | 1239.02 | 1239.48 | 1239.94 | 1240.39 | 23.30 |
| 23.40 | 1240.39 | 1240.85 | 1241.31 | 1241.77 | 1242.23 | 1242.69 | 1243.15 | 1243.61 | 1244.06 | 1244.52 | 1244.98 | 23.40 |
| 23.50 | 1244.98 | 1245.44 | 1245.90 | 1246.36 | 1246.82 | 1247.27 | 1247.73 | 1248.19 | 1248.65 | 1249.11 | 1249.57 | 23.50 |
| 23.60 | 1249.57 | 1250.03 | 1250.48 | 1250.94 | 1251.40 | 1251.86 | 1252.32 | 1252.78 | 1253.24 | 1253.69 | 1254.15 | 23.60 |
| 23.70 | 1254.15 | 1254.61 | 1255.07 | 1255.53 | 1255.99 | 1256.45 | 1256.90 | 1257.36 | 1257.82 | 1258.28 | 1258.74 | 23.70 |
| 23.80 | 1258.74 | 1259.20 | 1259.65 | 1260.11 | 1260.57 | 1261.03 | 1261.49 | 1261.95 | 1262.41 | 1262.86 | 1263.32 | 23.80 |
| 23.90 | 1263.32 | 1263.78 | 1264.24 | 1264.70 | 1265.16 | 1265.61 | 1266.07 | 1266.53 | 1266.99 | 1267.45 | 1267.91 | 23.90 |
| 24.00 | 1267.91 | 1268.36 | 1268.82 | 1269.28 | 1269.74 | 1270.20 | 1270.66 | 1271.11 | 1271.57 | 1272.03 | 1272.49 | 24.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**Table B4.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | TEMPERATURES IN DEGREES F | | | | | | |
| 24.00 | 1267.91 | 1268.36 | 1268.82 | 1269.28 | 1269.74 | 1270.20 | 1270.66 | 1271.11 | 1271.57 | 1272.03 | 1272.49 | 24.00 |
| 24.10 | 1272.49 | 1272.95 | 1273.41 | 1273.86 | 1274.32 | 1274.78 | 1275.24 | 1275.70 | 1276.16 | 1276.61 | 1277.07 | 24.10 |
| 24.20 | 1277.07 | 1277.53 | 1277.99 | 1278.45 | 1278.90 | 1279.36 | 1279.82 | 1280.28 | 1280.74 | 1281.20 | 1281.65 | 24.20 |
| 24.30 | 1281.65 | 1282.11 | 1282.57 | 1283.03 | 1283.49 | 1283.95 | 1284.40 | 1284.86 | 1285.32 | 1285.78 | 1286.24 | 24.30 |
| 24.40 | 1286.24 | 1286.69 | 1287.15 | 1287.61 | 1288.07 | 1288.53 | 1288.98 | 1289.44 | 1289.90 | 1290.36 | 1290.82 | 24.40 |
| 24.50 | 1290.82 | 1291.28 | 1291.73 | 1292.19 | 1292.65 | 1293.11 | 1293.57 | 1294.02 | 1294.48 | 1294.94 | 1295.40 | 24.50 |
| 24.60 | 1295.40 | 1295.86 | 1296.31 | 1296.77 | 1297.23 | 1297.69 | 1298.15 | 1298.60 | 1299.06 | 1299.52 | 1299.98 | 24.60 |
| 24.70 | 1299.98 | 1300.44 | 1300.89 | 1301.35 | 1301.81 | 1302.27 | 1302.73 | 1303.18 | 1303.64 | 1304.10 | 1304.56 | 24.70 |
| 24.80 | 1304.56 | 1305.02 | 1305.48 | 1305.93 | 1306.39 | 1306.85 | 1307.31 | 1307.76 | 1308.22 | 1308.68 | 1309.14 | 24.80 |
| 24.90 | 1309.14 | 1309.60 | 1310.05 | 1310.51 | 1310.97 | 1311.43 | 1311.89 | 1312.34 | 1312.80 | 1313.26 | 1313.72 | 24.90 |
| 25.00 | 1313.72 | 1314.18 | 1314.63 | 1315.09 | 1315.55 | 1316.01 | 1316.47 | 1316.92 | 1317.38 | 1317.84 | 1318.30 | 25.00 |
| 25.10 | 1318.30 | 1318.76 | 1319.21 | 1319.67 | 1320.13 | 1320.59 | 1321.05 | 1321.50 | 1321.96 | 1322.42 | 1322.88 | 25.10 |
| 25.20 | 1322.88 | 1323.33 | 1323.79 | 1324.25 | 1324.71 | 1325.17 | 1325.62 | 1326.08 | 1326.54 | 1327.00 | 1327.46 | 25.20 |
| 25.30 | 1327.46 | 1327.91 | 1328.37 | 1328.83 | 1329.29 | 1329.75 | 1330.20 | 1330.66 | 1331.12 | 1331.58 | 1332.03 | 25.30 |
| 25.40 | 1332.03 | 1332.49 | 1332.95 | 1333.41 | 1333.87 | 1334.32 | 1334.78 | 1335.24 | 1335.70 | 1336.16 | 1336.61 | 25.40 |
| 25.50 | 1336.61 | 1337.07 | 1337.53 | 1337.99 | 1338.44 | 1338.90 | 1339.36 | 1339.82 | 1340.28 | 1340.73 | 1341.19 | 25.50 |
| 25.60 | 1341.19 | 1341.65 | 1342.11 | 1342.56 | 1343.02 | 1343.48 | 1343.94 | 1344.40 | 1344.85 | 1345.31 | 1345.77 | 25.60 |
| 25.70 | 1345.77 | 1346.23 | 1346.69 | 1347.14 | 1347.60 | 1348.06 | 1348.52 | 1348.97 | 1349.43 | 1349.89 | 1350.35 | 25.70 |
| 25.80 | 1350.35 | 1350.81 | 1351.26 | 1351.72 | 1352.18 | 1352.64 | 1353.09 | 1353.55 | 1354.01 | 1354.47 | 1354.93 | 25.80 |
| 25.90 | 1354.93 | 1355.38 | 1355.84 | 1356.30 | 1356.76 | 1357.22 | 1357.67 | 1358.13 | 1358.59 | 1359.05 | 1359.50 | 25.90 |
| 26.00 | 1359.50 | 1359.96 | 1360.42 | 1360.83 | 1361.34 | 1361.79 | 1362.25 | 1362.71 | 1363.17 | 1363.62 | 1364.08 | 26.00 |
| 26.10 | 1364.08 | 1364.54 | 1365.00 | 1365.46 | 1365.91 | 1366.37 | 1366.83 | 1367.29 | 1367.74 | 1368.20 | 1368.66 | 26.10 |
| 26.20 | 1368.66 | 1369.12 | 1369.58 | 1370.03 | 1370.49 | 1370.95 | 1371.41 | 1371.86 | 1372.32 | 1372.78 | 1373.24 | 26.20 |
| 26.30 | 1373.24 | 1373.70 | 1374.15 | 1374.61 | 1375.07 | 1375.53 | 1375.99 | 1376.44 | 1376.90 | 1377.36 | 1377.82 | 26.30 |
| 26.40 | 1377.82 | 1378.27 | 1378.73 | 1379.19 | 1379.65 | 1380.11 | 1380.56 | 1381.02 | 1381.48 | 1381.94 | 1382.39 | 26.40 |
| 26.50 | 1382.39 | 1382.85 | 1383.31 | 1383.77 | 1384.23 | 1384.68 | 1385.14 | 1385.60 | 1386.06 | 1386.52 | 1386.97 | 26.50 |
| 26.60 | 1386.97 | 1387.43 | 1387.89 | 1388.35 | 1388.80 | 1389.26 | 1389.72 | 1390.18 | 1390.64 | 1391.09 | 1391.55 | 26.60 |
| 26.70 | 1391.55 | 1392.01 | 1392.47 | 1392.93 | 1393.38 | 1393.84 | 1394.30 | 1394.76 | 1395.21 | 1395.67 | 1396.13 | 26.70 |
| 26.80 | 1396.13 | 1396.59 | 1397.05 | 1397.50 | 1397.96 | 1398.42 | 1398.88 | 1399.34 | 1399.79 | 1400.25 | 1400.71 | 26.80 |
| 26.90 | 1400.71 | 1401.17 | 1401.62 | 1402.08 | 1402.54 | 1403.00 | 1403.46 | 1403.91 | 1404.37 | 1404.83 | 1405.29 | 26.90 |
| 27.00 | 1405.29 | 1405.75 | 1406.20 | 1406.66 | 1407.12 | 1407.58 | 1408.04 | 1408.49 | 1408.95 | 1409.41 | 1409.87 | 27.00 |
| 27.10 | 1409.87 | 1410.32 | 1410.78 | 1411.24 | 1411.70 | 1412.16 | 1412.61 | 1413.07 | 1413.53 | 1413.99 | 1414.45 | 27.10 |
| 27.20 | 1414.45 | 1414.90 | 1415.36 | 1415.82 | 1416.28 | 1416.74 | 1417.19 | 1417.65 | 1418.11 | 1418.57 | 1419.03 | 27.20 |
| 27.30 | 1419.03 | 1419.48 | 1419.94 | 1420.40 | 1420.86 | 1421.32 | 1421.77 | 1422.23 | 1422.69 | 1423.15 | 1423.61 | 27.30 |
| 27.40 | 1423.61 | 1424.06 | 1424.52 | 1424.98 | 1425.44 | 1425.90 | 1426.35 | 1426.81 | 1427.27 | 1427.73 | 1428.19 | 27.40 |
| 27.50 | 1428.19 | 1428.64 | 1429.10 | 1429.56 | 1430.02 | 1430.48 | 1430.93 | 1431.39 | 1431.85 | 1432.31 | 1432.77 | 27.50 |
| 27.60 | 1432.77 | 1433.22 | 1433.68 | 1434.14 | 1434.60 | 1435.06 | 1435.52 | 1435.97 | 1436.43 | 1436.89 | 1437.35 | 27.60 |
| 27.70 | 1437.35 | 1437.81 | 1438.26 | 1438.72 | 1439.18 | 1439.64 | 1440.10 | 1440.55 | 1441.01 | 1441.47 | 1441.93 | 27.70 |
| 27.80 | 1441.93 | 1442.39 | 1442.85 | 1443.30 | 1443.76 | 1444.22 | 1444.68 | 1445.14 | 1445.59 | 1446.05 | 1446.51 | 27.80 |
| 27.90 | 1446.51 | 1446.97 | 1447.43 | 1447.89 | 1448.34 | 1448.80 | 1449.26 | 1449.72 | 1450.18 | 1450.63 | 1451.09 | 27.90 |
| 28.00 | 1451.09 | 1451.55 | 1452.01 | 1452.47 | 1452.93 | 1453.38 | 1453.84 | 1454.30 | 1454.76 | 1455.22 | 1455.68 | 28.00 |
| 28.10 | 1455.68 | 1456.13 | 1456.59 | 1457.05 | 1457.51 | 1457.97 | 1458.42 | 1458.88 | 1459.34 | 1459.80 | 1460.26 | 28.10 |
| 28.20 | 1460.26 | 1460.72 | 1461.17 | 1461.63 | 1462.09 | 1462.55 | 1463.01 | 1463.47 | 1463.92 | 1464.38 | 1464.84 | 28.20 |
| 28.30 | 1464.84 | 1465.30 | 1465.76 | 1466.22 | 1466.68 | 1467.13 | 1467.59 | 1468.05 | 1468.51 | 1468.97 | 1469.43 | 28.30 |
| 28.40 | 1469.43 | 1469.88 | 1470.34 | 1470.80 | 1471.26 | 1471.72 | 1472.18 | 1472.63 | 1473.09 | 1473.55 | 1474.01 | 28.40 |
| 28.50 | 1474.01 | 1474.47 | 1474.93 | 1475.39 | 1475.84 | 1476.30 | 1476.76 | 1477.22 | 1477.68 | 1478.14 | 1478.59 | 28.50 |
| 28.60 | 1478.59 | 1479.05 | 1479.51 | 1479.97 | 1480.43 | 1480.89 | 1481.35 | 1481.80 | 1482.26 | 1482.72 | 1483.18 | 28.60 |
| 28.70 | 1483.18 | 1483.64 | 1484.10 | 1484.56 | 1485.01 | 1485.47 | 1485.93 | 1486.39 | 1486.85 | 1487.31 | 1487.77 | 28.70 |
| 28.80 | 1487.77 | 1488.22 | 1488.68 | 1489.14 | 1489.60 | 1490.06 | 1490.52 | 1490.98 | 1491.44 | 1491.89 | 1492.35 | 28.80 |
| 28.90 | 1492.35 | 1492.81 | 1493.27 | 1493.73 | 1494.19 | 1494.65 | 1495.11 | 1495.56 | 1496.02 | 1496.48 | 1496.94 | 28.90 |
| 29.00 | 1496.94 | 1497.40 | 1497.86 | 1498.32 | 1498.78 | 1499.23 | 1499.69 | 1500.15 | 1500.61 | 1501.07 | 1501.53 | 29.00 |
| 29.10 | 1501.53 | 1501.99 | 1502.45 | 1502.90 | 1503.36 | 1503.82 | 1504.28 | 1504.74 | 1505.20 | 1505.66 | 1506.12 | 29.10 |
| 29.20 | 1506.12 | 1506.58 | 1507.03 | 1507.49 | 1507.95 | 1508.41 | 1508.87 | 1509.33 | 1509.79 | 1510.25 | 1510.71 | 29.20 |
| 29.30 | 1510.71 | 1511.16 | 1511.62 | 1512.03 | 1512.54 | 1513.00 | 1513.46 | 1513.92 | 1514.38 | 1514.84 | 1515.30 | 29.30 |
| 29.40 | 1515.30 | 1515.75 | 1516.21 | 1516.67 | 1517.13 | 1517.59 | 1518.05 | 1518.51 | 1518.97 | 1519.43 | 1519.89 | 29.40 |
| 29.50 | 1519.89 | 1520.34 | 1520.80 | 1521.26 | 1521.72 | 1522.18 | 1522.64 | 1523.10 | 1523.56 | 1524.02 | 1524.48 | 29.50 |
| 29.60 | 1524.48 | 1524.94 | 1525.40 | 1525.85 | 1526.31 | 1526.77 | 1527.23 | 1527.69 | 1528.15 | 1528.61 | 1529.07 | 29.60 |
| 29.70 | 1529.07 | 1529.53 | 1529.99 | 1530.45 | 1530.91 | 1531.36 | 1531.82 | 1532.28 | 1532.74 | 1533.20 | 1533.66 | 29.70 |
| 29.80 | 1533.66 | 1534.12 | 1534.58 | 1535.04 | 1535.50 | 1535.96 | 1536.42 | 1536.88 | 1537.34 | 1537.80 | 1538.25 | 29.80 |
| 29.90 | 1538.25 | 1538.71 | 1539.17 | 1539.63 | 1540.09 | 1540.55 | 1541.01 | 1541.47 | 1541.93 | 1542.39 | 1542.85 | 29.90 |
| 30.00 | 1542.85 | 1543.31 | 1543.77 | 1544.23 | 1544.69 | 1545.15 | 1545.61 | 1546.07 | 1546.52 | 1546.98 | 1547.44 | 30.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

## TABLE B4. AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30.00 | 1542.85 | 1543.31 | 1543.77 | 1544.23 | 1544.69 | 1545.15 | 1545.61 | 1546.07 | 1546.52 | 1546.98 | 1547.44 | 30.00 |
| 30.10 | 1547.44 | 1547.90 | 1548.36 | 1548.82 | 1549.28 | 1549.74 | 1550.20 | 1550.66 | 1551.12 | 1551.58 | 1552.04 | 30.10 |
| 30.20 | 1552.04 | 1552.50 | 1552.96 | 1553.42 | 1553.88 | 1554.34 | 1554.80 | 1555.26 | 1555.72 | 1556.18 | 1556.64 | 30.20 |
| 30.30 | 1556.64 | 1557.10 | 1557.56 | 1558.02 | 1558.47 | 1558.93 | 1559.39 | 1559.85 | 1560.31 | 1560.77 | 1561.23 | 30.30 |
| 30.40 | 1561.23 | 1561.69 | 1562.15 | 1562.61 | 1563.07 | 1563.53 | 1563.99 | 1564.45 | 1564.91 | 1565.37 | 1565.83 | 30.40 |
| 30.50 | 1565.83 | 1566.29 | 1566.75 | 1567.21 | 1567.67 | 1568.13 | 1568.59 | 1569.05 | 1569.51 | 1569.97 | 1570.43 | 30.50 |
| 30.60 | 1570.43 | 1570.89 | 1571.35 | 1571.81 | 1572.27 | 1572.73 | 1573.19 | 1573.65 | 1574.11 | 1574.57 | 1575.03 | 30.60 |
| 30.70 | 1575.03 | 1575.49 | 1575.95 | 1576.41 | 1576.87 | 1577.33 | 1577.79 | 1578.25 | 1578.71 | 1579.17 | 1579.63 | 30.70 |
| 30.80 | 1579.63 | 1580.09 | 1580.55 | 1581.01 | 1581.47 | 1581.93 | 1582.39 | 1582.85 | 1583.31 | 1583.77 | 1584.23 | 30.80 |
| 30.90 | 1584.23 | 1584.69 | 1585.15 | 1585.61 | 1586.07 | 1586.53 | 1586.99 | 1587.45 | 1587.92 | 1588.38 | 1588.84 | 30.90 |
| 31.00 | 1588.84 | 1589.30 | 1589.76 | 1590.22 | 1590.68 | 1591.14 | 1591.60 | 1592.06 | 1592.52 | 1592.98 | 1593.44 | 31.00 |
| 31.10 | 1593.44 | 1593.90 | 1594.36 | 1594.82 | 1595.28 | 1595.74 | 1596.20 | 1596.66 | 1597.12 | 1597.58 | 1598.04 | 31.10 |
| 31.20 | 1598.04 | 1598.50 | 1598.97 | 1599.43 | 1599.89 | 1600.35 | 1600.81 | 1601.27 | 1601.73 | 1602.19 | 1602.65 | 31.20 |
| 31.30 | 1602.65 | 1603.11 | 1603.57 | 1604.03 | 1604.49 | 1604.95 | 1605.41 | 1605.87 | 1606.33 | 1606.80 | 1607.26 | 31.30 |
| 31.40 | 1607.26 | 1607.72 | 1608.18 | 1608.64 | 1609.10 | 1609.56 | 1610.02 | 1610.48 | 1610.94 | 1611.40 | 1611.86 | 31.40 |
| 31.50 | 1611.86 | 1612.32 | 1612.79 | 1613.25 | 1613.71 | 1614.17 | 1614.63 | 1615.09 | 1615.55 | 1616.01 | 1616.47 | 31.50 |
| 31.60 | 1616.47 | 1616.93 | 1617.39 | 1617.85 | 1618.32 | 1618.78 | 1619.24 | 1619.70 | 1620.16 | 1620.62 | 1621.08 | 31.60 |
| 31.70 | 1621.08 | 1621.54 | 1622.00 | 1622.46 | 1622.93 | 1623.39 | 1623.85 | 1624.31 | 1624.77 | 1625.23 | 1625.69 | 31.70 |
| 31.80 | 1625.69 | 1626.15 | 1626.61 | 1627.08 | 1627.54 | 1628.00 | 1628.46 | 1628.92 | 1629.38 | 1629.84 | 1630.30 | 31.80 |
| 31.90 | 1630.30 | 1630.76 | 1631.23 | 1631.69 | 1632.15 | 1632.61 | 1633.07 | 1633.53 | 1633.99 | 1634.46 | 1634.92 | 31.90 |
| 32.00 | 1634.92 | 1635.38 | 1635.84 | 1636.30 | 1636.76 | 1637.22 | 1637.68 | 1638.15 | 1638.61 | 1639.07 | 1639.53 | 32.00 |
| 32.10 | 1639.53 | 1639.99 | 1640.45 | 1640.91 | 1641.38 | 1641.84 | 1642.30 | 1642.76 | 1643.22 | 1643.68 | 1644.14 | 32.10 |
| 32.20 | 1644.14 | 1644.61 | 1645.07 | 1645.53 | 1645.99 | 1646.45 | 1646.91 | 1647.38 | 1647.84 | 1648.30 | 1648.76 | 32.20 |
| 32.30 | 1648.76 | 1649.22 | 1649.68 | 1650.15 | 1650.61 | 1651.07 | 1651.53 | 1651.99 | 1652.45 | 1652.92 | 1653.38 | 32.30 |
| 32.40 | 1653.38 | 1653.84 | 1654.30 | 1654.76 | 1655.22 | 1655.69 | 1656.15 | 1656.61 | 1657.07 | 1657.53 | 1658.00 | 32.40 |
| 32.50 | 1658.00 | 1658.46 | 1658.92 | 1659.38 | 1659.84 | 1660.31 | 1660.77 | 1661.23 | 1661.69 | 1662.15 | 1662.62 | 32.50 |
| 32.60 | 1662.62 | 1663.08 | 1663.54 | 1664.00 | 1664.46 | 1664.93 | 1665.39 | 1665.85 | 1666.31 | 1666.77 | 1667.24 | 32.60 |
| 32.70 | 1667.24 | 1667.70 | 1668.16 | 1668.62 | 1669.08 | 1669.55 | 1670.01 | 1670.47 | 1670.93 | 1671.39 | 1671.86 | 32.70 |
| 32.80 | 1671.86 | 1672.32 | 1672.78 | 1673.24 | 1673.71 | 1674.17 | 1674.63 | 1675.09 | 1675.55 | 1676.02 | 1676.48 | 32.80 |
| 32.90 | 1676.48 | 1676.94 | 1677.40 | 1677.87 | 1678.33 | 1678.79 | 1679.25 | 1679.72 | 1680.18 | 1680.64 | 1681.10 | 32.90 |
| 33.00 | 1681.10 | 1681.57 | 1682.03 | 1682.49 | 1682.95 | 1683.42 | 1683.88 | 1684.34 | 1684.80 | 1685.27 | 1685.73 | 33.00 |
| 33.10 | 1685.73 | 1686.19 | 1686.65 | 1687.12 | 1687.58 | 1688.04 | 1688.50 | 1688.97 | 1689.43 | 1689.89 | 1690.35 | 33.10 |
| 33.20 | 1690.35 | 1690.82 | 1691.28 | 1691.74 | 1692.21 | 1692.67 | 1693.13 | 1693.59 | 1694.06 | 1694.52 | 1694.98 | 33.20 |
| 33.30 | 1694.98 | 1695.45 | 1695.91 | 1696.37 | 1696.83 | 1697.30 | 1697.76 | 1698.22 | 1698.69 | 1699.15 | 1699.61 | 33.30 |
| 33.40 | 1699.61 | 1700.07 | 1700.54 | 1701.00 | 1701.46 | 1701.93 | 1702.39 | 1702.85 | 1703.31 | 1703.78 | 1704.24 | 33.40 |
| 33.50 | 1704.24 | 1704.70 | 1705.17 | 1705.63 | 1706.09 | 1706.56 | 1707.02 | 1707.48 | 1707.95 | 1708.41 | 1708.87 | 33.50 |
| 33.60 | 1708.87 | 1709.34 | 1709.80 | 1710.26 | 1710.72 | 1711.19 | 1711.65 | 1712.11 | 1712.58 | 1713.04 | 1713.50 | 33.60 |
| 33.70 | 1713.50 | 1713.97 | 1714.43 | 1714.89 | 1715.36 | 1715.82 | 1716.28 | 1716.75 | 1717.21 | 1717.67 | 1718.14 | 33.70 |
| 33.80 | 1718.14 | 1718.60 | 1719.06 | 1719.53 | 1719.99 | 1720.46 | 1720.92 | 1721.38 | 1721.85 | 1722.31 | 1722.77 | 33.80 |
| 33.90 | 1722.77 | 1723.24 | 1723.70 | 1724.16 | 1724.63 | 1725.09 | 1725.55 | 1726.02 | 1726.48 | 1726.95 | 1727.41 | 33.90 |
| 34.00 | 1727.41 | 1727.87 | 1728.34 | 1728.80 | 1729.26 | 1729.73 | 1730.19 | 1730.66 | 1731.12 | 1731.58 | 1732.05 | 34.00 |
| 34.10 | 1732.05 | 1732.51 | 1732.97 | 1733.44 | 1733.90 | 1734.37 | 1734.83 | 1735.29 | 1735.76 | 1736.22 | 1736.69 | 34.10 |
| 34.20 | 1736.69 | 1737.15 | 1737.61 | 1738.08 | 1738.54 | 1739.01 | 1739.47 | 1739.93 | 1740.40 | 1740.86 | 1741.33 | 34.20 |
| 34.30 | 1741.33 | 1741.79 | 1742.25 | 1742.72 | 1743.18 | 1743.65 | 1744.11 | 1744.57 | 1745.04 | 1745.50 | 1745.97 | 34.30 |
| 34.40 | 1745.97 | 1746.43 | 1746.90 | 1747.36 | 1747.82 | 1748.29 | 1748.75 | 1749.22 | 1749.68 | 1750.15 | 1750.61 | 34.40 |
| 34.50 | 1750.61 | 1751.07 | 1751.54 | 1752.00 | 1752.47 | 1752.93 | 1753.40 | 1753.86 | 1754.33 | 1754.79 | 1755.25 | 34.50 |
| 34.60 | 1755.25 | 1755.72 | 1756.18 | 1756.65 | 1757.11 | 1757.58 | 1758.04 | 1758.51 | 1758.97 | 1759.43 | 1759.90 | 34.60 |
| 34.70 | 1759.90 | 1760.36 | 1760.83 | 1761.29 | 1761.76 | 1762.22 | 1762.69 | 1763.15 | 1763.62 | 1764.08 | 1764.55 | 34.70 |
| 34.80 | 1764.55 | 1765.01 | 1765.48 | 1765.94 | 1766.41 | 1766.87 | 1767.34 | 1767.80 | 1768.26 | 1768.73 | 1769.19 | 34.80 |
| 34.90 | 1769.19 | 1769.66 | 1770.12 | 1770.59 | 1771.05 | 1771.52 | 1771.98 | 1772.45 | 1772.91 | 1773.38 | 1773.84 | 34.90 |
| 35.00 | 1773.84 | 1774.31 | 1774.77 | 1775.24 | 1775.70 | 1776.17 | 1776.63 | 1777.10 | 1777.57 | 1778.03 | 1778.50 | 35.00 |
| 35.10 | 1778.50 | 1778.96 | 1779.43 | 1779.89 | 1780.36 | 1780.82 | 1781.29 | 1781.75 | 1782.22 | 1782.68 | 1783.15 | 35.10 |
| 35.20 | 1783.15 | 1783.61 | 1784.08 | 1784.54 | 1785.01 | 1785.47 | 1785.94 | 1786.41 | 1786.87 | 1787.34 | 1787.80 | 35.20 |
| 35.30 | 1787.80 | 1788.27 | 1788.73 | 1789.20 | 1789.66 | 1790.13 | 1790.59 | 1791.06 | 1791.53 | 1791.99 | 1792.46 | 35.30 |
| 35.40 | 1792.46 | 1792.92 | 1793.39 | 1793.85 | 1794.32 | 1794.79 | 1795.25 | 1795.72 | 1796.18 | 1796.65 | 1797.11 | 35.40 |
| 35.50 | 1797.11 | 1797.58 | 1798.05 | 1798.51 | 1798.98 | 1799.44 | 1799.91 | 1800.37 | 1800.84 | 1801.31 | 1801.77 | 35.50 |
| 35.60 | 1801.77 | 1802.24 | 1802.70 | 1803.17 | 1803.64 | 1804.10 | 1804.57 | 1805.03 | 1805.50 | 1805.97 | 1806.43 | 35.60 |
| 35.70 | 1806.43 | 1806.90 | 1807.36 | 1807.83 | 1808.30 | 1808.76 | 1809.23 | 1809.69 | 1810.16 | 1810.63 | 1811.09 | 35.70 |
| 35.80 | 1811.09 | 1811.56 | 1812.03 | 1812.49 | 1812.96 | 1813.42 | 1813.89 | 1814.36 | 1814.82 | 1815.29 | 1815.76 | 35.80 |
| 35.90 | 1815.76 | 1816.22 | 1816.69 | 1817.15 | 1817.62 | 1818.09 | 1818.55 | 1819.02 | 1819.49 | 1819.95 | 1820.42 | 35.90 |
| 36.00 | 1820.42 | 1820.89 | 1821.35 | 1821.82 | 1822.29 | 1822.75 | 1823.22 | 1823.69 | 1824.15 | 1824.62 | 1825.09 | 36.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

**TABLE B4.** AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.00 | 1820.42 | 1820.89 | 1821.35 | 1821.82 | 1822.29 | 1822.75 | 1823.22 | 1823.69 | 1824.15 | 1824.62 | 1825.09 | 36.00 |
| 36.10 | 1825.09 | 1825.55 | 1826.02 | 1826.49 | 1826.95 | 1827.42 | 1827.89 | 1828.35 | 1828.82 | 1829.29 | 1829.75 | 36.10 |
| 36.20 | 1829.75 | 1830.22 | 1830.69 | 1831.15 | 1831.62 | 1832.09 | 1832.55 | 1833.02 | 1833.49 | 1833.95 | 1834.42 | 36.20 |
| 36.30 | 1834.42 | 1834.89 | 1835.36 | 1835.82 | 1836.29 | 1836.76 | 1837.22 | 1837.69 | 1838.16 | 1838.62 | 1839.09 | 36.30 |
| 36.40 | 1839.09 | 1839.56 | 1840.03 | 1840.49 | 1840.96 | 1841.43 | 1841.89 | 1842.36 | 1842.83 | 1843.30 | 1843.76 | 36.40 |
| 36.50 | 1843.76 | 1844.23 | 1844.70 | 1845.17 | 1845.63 | 1846.10 | 1846.57 | 1847.04 | 1847.50 | 1847.97 | 1848.44 | 36.50 |
| 36.60 | 1848.44 | 1848.90 | 1849.37 | 1849.84 | 1850.31 | 1850.77 | 1851.24 | 1851.71 | 1852.18 | 1852.64 | 1853.11 | 36.60 |
| 36.70 | 1853.11 | 1853.58 | 1854.05 | 1854.52 | 1854.98 | 1855.45 | 1855.92 | 1856.39 | 1856.85 | 1857.32 | 1857.79 | 36.70 |
| 36.80 | 1857.79 | 1858.26 | 1858.72 | 1859.19 | 1859.66 | 1860.13 | 1860.60 | 1861.06 | 1861.53 | 1862.00 | 1862.47 | 36.80 |
| 36.90 | 1862.47 | 1862.94 | 1863.40 | 1863.87 | 1864.34 | 1864.81 | 1865.28 | 1865.74 | 1866.21 | 1866.68 | 1867.15 | 36.90 |
| 37.00 | 1867.15 | 1867.62 | 1868.08 | 1868.55 | 1869.02 | 1869.49 | 1869.96 | 1870.42 | 1870.89 | 1871.36 | 1871.83 | 37.00 |
| 37.10 | 1871.83 | 1872.30 | 1872.77 | 1873.23 | 1873.70 | 1874.17 | 1874.64 | 1875.11 | 1875.58 | 1876.04 | 1876.51 | 37.10 |
| 37.20 | 1876.51 | 1876.98 | 1877.45 | 1877.92 | 1878.39 | 1878.85 | 1879.32 | 1879.79 | 1880.26 | 1880.73 | 1881.20 | 37.20 |
| 37.30 | 1881.20 | 1881.67 | 1882.13 | 1882.60 | 1883.07 | 1883.54 | 1884.01 | 1884.48 | 1884.95 | 1885.41 | 1885.88 | 37.30 |
| 37.40 | 1885.88 | 1886.35 | 1886.82 | 1887.29 | 1887.76 | 1888.23 | 1888.70 | 1889.17 | 1889.63 | 1890.10 | 1890.57 | 37.40 |
| 37.50 | 1890.57 | 1891.04 | 1891.51 | 1891.98 | 1892.45 | 1892.92 | 1893.39 | 1893.85 | 1894.32 | 1894.79 | 1895.26 | 37.50 |
| 37.60 | 1895.26 | 1895.73 | 1896.20 | 1896.67 | 1897.14 | 1897.61 | 1898.08 | 1898.55 | 1899.02 | 1899.48 | 1899.95 | 37.60 |
| 37.70 | 1899.95 | 1900.42 | 1900.89 | 1901.36 | 1901.83 | 1902.30 | 1902.77 | 1903.24 | 1903.71 | 1904.18 | 1904.65 | 37.70 |
| 37.80 | 1904.65 | 1905.12 | 1905.59 | 1906.06 | 1906.52 | 1906.99 | 1907.46 | 1907.93 | 1908.40 | 1908.87 | 1909.34 | 37.80 |
| 37.90 | 1909.34 | 1909.81 | 1910.28 | 1910.75 | 1911.22 | 1911.69 | 1912.16 | 1912.63 | 1913.10 | 1913.57 | 1914.04 | 37.90 |
| 38.00 | 1914.04 | 1914.51 | 1914.98 | 1915.45 | 1915.92 | 1916.39 | 1916.86 | 1917.33 | 1917.80 | 1918.27 | 1918.74 | 38.00 |
| 38.10 | 1918.74 | 1919.21 | 1919.68 | 1920.15 | 1920.62 | 1921.09 | 1921.56 | 1922.03 | 1922.50 | 1922.97 | 1923.44 | 38.10 |
| 38.20 | 1923.44 | 1923.91 | 1924.38 | 1924.85 | 1925.32 | 1925.79 | 1926.26 | 1926.73 | 1927.20 | 1927.67 | 1928.14 | 38.20 |
| 38.30 | 1928.14 | 1928.61 | 1929.08 | 1929.55 | 1930.02 | 1930.49 | 1930.96 | 1931.43 | 1931.90 | 1932.37 | 1932.85 | 38.30 |
| 38.40 | 1932.85 | 1933.32 | 1933.79 | 1934.26 | 1934.73 | 1935.20 | 1935.67 | 1936.14 | 1936.61 | 1937.08 | 1937.55 | 38.40 |
| 38.50 | 1937.55 | 1938.02 | 1938.49 | 1938.96 | 1939.43 | 1939.91 | 1940.38 | 1940.85 | 1941.32 | 1941.79 | 1942.26 | 38.50 |
| 38.60 | 1942.26 | 1942.73 | 1943.20 | 1943.67 | 1944.14 | 1944.61 | 1945.09 | 1945.56 | 1946.03 | 1946.50 | 1946.97 | 38.60 |
| 38.70 | 1946.97 | 1947.44 | 1947.91 | 1948.38 | 1948.85 | 1949.33 | 1949.80 | 1950.27 | 1950.74 | 1951.21 | 1951.68 | 38.70 |
| 38.80 | 1951.68 | 1952.15 | 1952.62 | 1953.10 | 1953.57 | 1954.04 | 1954.51 | 1954.98 | 1955.45 | 1955.92 | 1956.40 | 38.80 |
| 38.90 | 1956.40 | 1956.87 | 1957.34 | 1957.81 | 1958.28 | 1958.75 | 1959.22 | 1959.70 | 1960.17 | 1960.64 | 1961.11 | 38.90 |
| 39.00 | 1961.11 | 1961.58 | 1962.05 | 1962.53 | 1963.00 | 1963.47 | 1963.94 | 1964.41 | 1964.89 | 1965.36 | 1965.83 | 39.00 |
| 39.10 | 1965.83 | 1966.30 | 1966.77 | 1967.24 | 1967.72 | 1968.19 | 1968.66 | 1969.13 | 1969.60 | 1970.08 | 1970.55 | 39.10 |
| 39.20 | 1970.55 | 1971.02 | 1971.49 | 1971.96 | 1972.44 | 1972.91 | 1973.38 | 1973.85 | 1974.33 | 1974.80 | 1975.27 | 39.20 |
| 39.30 | 1975.27 | 1975.74 | 1976.21 | 1976.69 | 1977.16 | 1977.63 | 1978.10 | 1978.58 | 1979.05 | 1979.52 | 1979.99 | 39.30 |
| 39.40 | 1979.99 | 1980.47 | 1980.94 | 1981.41 | 1981.88 | 1982.36 | 1982.83 | 1983.30 | 1983.77 | 1984.25 | 1984.72 | 39.40 |
| 39.50 | 1984.72 | 1985.19 | 1985.67 | 1986.14 | 1986.61 | 1987.08 | 1987.56 | 1988.03 | 1988.50 | 1988.97 | 1989.45 | 39.50 |
| 39.60 | 1989.45 | 1989.92 | 1990.39 | 1990.87 | 1991.34 | 1991.81 | 1992.29 | 1992.76 | 1993.23 | 1993.70 | 1994.18 | 39.60 |
| 39.70 | 1994.18 | 1994.65 | 1995.12 | 1995.60 | 1996.07 | 1996.54 | 1997.02 | 1997.49 | 1997.96 | 1998.44 | 1998.91 | 39.70 |
| 39.80 | 1998.91 | 1999.38 | 1999.86 | 2000.33 | 2000.80 | 2001.28 | 2001.75 | 2002.22 | 2002.70 | 2003.17 | 2003.64 | 39.80 |
| 39.90 | 2003.64 | 2004.12 | 2004.59 | 2005.07 | 2005.54 | 2006.01 | 2006.49 | 2006.96 | 2007.43 | 2007.91 | 2008.38 | 39.90 |
| 40.00 | 2008.38 | 2008.85 | 2009.33 | 2009.80 | 2010.28 | 2010.75 | 2011.22 | 2011.70 | 2012.17 | 2012.65 | 2013.12 | 40.00 |
| 40.10 | 2013.12 | 2013.59 | 2014.07 | 2014.54 | 2015.02 | 2015.49 | 2015.96 | 2016.44 | 2016.91 | 2017.39 | 2017.86 | 40.10 |
| 40.20 | 2017.86 | 2018.33 | 2018.81 | 2019.28 | 2019.76 | 2020.23 | 2020.71 | 2021.18 | 2021.65 | 2022.13 | 2022.60 | 40.20 |
| 40.30 | 2022.60 | 2023.08 | 2023.55 | 2024.03 | 2024.50 | 2024.98 | 2025.45 | 2025.93 | 2026.40 | 2026.87 | 2027.35 | 40.30 |
| 40.40 | 2027.35 | 2027.82 | 2028.30 | 2028.77 | 2029.25 | 2029.72 | 2030.20 | 2030.67 | 2031.15 | 2031.62 | 2032.10 | 40.40 |
| 40.50 | 2032.10 | 2032.57 | 2033.05 | 2033.52 | 2034.00 | 2034.47 | 2034.95 | 2035.42 | 2035.90 | 2036.37 | 2036.85 | 40.50 |
| 40.60 | 2036.85 | 2037.32 | 2037.80 | 2038.27 | 2038.75 | 2039.22 | 2039.70 | 2040.17 | 2040.65 | 2041.12 | 2041.60 | 40.60 |
| 40.70 | 2041.60 | 2042.07 | 2042.55 | 2043.03 | 2043.50 | 2043.98 | 2044.45 | 2044.93 | 2045.40 | 2045.88 | 2046.35 | 40.70 |
| 40.80 | 2046.35 | 2046.83 | 2047.31 | 2047.78 | 2048.26 | 2048.73 | 2049.21 | 2049.68 | 2050.16 | 2050.64 | 2051.11 | 40.80 |
| 40.90 | 2051.11 | 2051.59 | 2052.06 | 2052.54 | 2053.01 | 2053.49 | 2053.97 | 2054.44 | 2054.92 | 2055.39 | 2055.87 | 40.90 |
| 41.00 | 2055.87 | 2056.35 | 2056.82 | 2057.30 | 2057.78 | 2058.25 | 2058.73 | 2059.20 | 2059.68 | 2060.16 | 2060.63 | 41.00 |
| 41.10 | 2060.63 | 2061.11 | 2061.59 | 2062.06 | 2062.54 | 2063.01 | 2063.49 | 2063.97 | 2064.44 | 2064.92 | 2065.40 | 41.10 |
| 41.20 | 2065.40 | 2065.87 | 2066.35 | 2066.83 | 2067.30 | 2067.78 | 2068.26 | 2068.73 | 2069.21 | 2069.69 | 2070.16 | 41.20 |
| 41.30 | 2070.16 | 2070.64 | 2071.12 | 2071.60 | 2072.07 | 2072.55 | 2073.03 | 2073.50 | 2073.98 | 2074.46 | 2074.93 | 41.30 |
| 41.40 | 2074.93 | 2075.41 | 2075.89 | 2076.37 | 2076.84 | 2077.32 | 2077.80 | 2078.27 | 2078.75 | 2079.23 | 2079.71 | 41.40 |
| 41.50 | 2079.71 | 2080.18 | 2080.66 | 2081.14 | 2081.62 | 2082.09 | 2082.57 | 2083.05 | 2083.53 | 2084.00 | 2084.48 | 41.50 |
| 41.60 | 2084.48 | 2084.96 | 2085.44 | 2085.91 | 2086.39 | 2086.87 | 2087.35 | 2087.83 | 2088.30 | 2088.78 | 2089.26 | 41.60 |
| 41.70 | 2089.26 | 2089.74 | 2090.21 | 2090.69 | 2091.17 | 2091.65 | 2092.13 | 2092.60 | 2093.08 | 2093.56 | 2094.04 | 41.70 |
| 41.80 | 2094.04 | 2094.52 | 2094.99 | 2095.47 | 2095.95 | 2096.43 | 2096.91 | 2097.39 | 2097.86 | 2098.34 | 2098.82 | 41.80 |
| 41.90 | 2098.82 | 2099.30 | 2099.78 | 2100.26 | 2100.74 | 2101.21 | 2101.69 | 2102.17 | 2102.65 | 2103.13 | 2103.61 | 41.90 |
| 42.00 | 2103.61 | 2104.09 | 2104.56 | 2105.04 | 2105.52 | 2106.00 | 2106.48 | 2106.96 | 2107.44 | 2107.92 | 2108.40 | 42.00 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

TABLE B4. AWG 14 *Nicrosil versus Nisil thermocouples—temperature (°F) as a function of thermoelectric voltage, reference junctions at 32 °F*—Continued

TEMPERATURES IN DEGREES F

| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42.00 | 2103.61 | 2104.09 | 2104.56 | 2105.04 | 2105.52 | 2106.00 | 2106.48 | 2106.96 | 2107.44 | 2107.92 | 2108.40 | 42.00 |
| 42.10 | 2108.40 | 2108.87 | 2109.35 | 2109.83 | 2110.31 | 2110.79 | 2111.27 | 2111.75 | 2112.23 | 2112.71 | 2113.19 | 42.10 |
| 42.20 | 2113.19 | 2113.67 | 2114.14 | 2114.62 | 2115.10 | 2115.58 | 2116.06 | 2116.54 | 2117.02 | 2117.50 | 2117.98 | 42.20 |
| 42.30 | 2117.98 | 2118.46 | 2118.94 | 2119.42 | 2119.90 | 2120.38 | 2120.86 | 2121.34 | 2121.82 | 2122.30 | 2122.78 | 42.30 |
| 42.40 | 2122.78 | 2123.26 | 2123.74 | 2124.22 | 2124.70 | 2125.18 | 2125.66 | 2126.14 | 2126.62 | 2127.10 | 2127.58 | 42.40 |
| 42.50 | 2127.58 | 2128.06 | 2128.54 | 2129.02 | 2129.50 | 2129.98 | 2130.46 | 2130.94 | 2131.42 | 2131.90 | 2132.38 | 42.50 |
| 42.60 | 2132.38 | 2132.86 | 2133.34 | 2133.82 | 2134.30 | 2134.78 | 2135.26 | 2135.74 | 2136.22 | 2136.70 | 2137.18 | 42.60 |
| 42.70 | 2137.18 | 2137.67 | 2138.15 | 2138.63 | 2139.11 | 2139.59 | 2140.07 | 2140.55 | 2141.03 | 2141.51 | 2141.99 | 42.70 |
| 42.80 | 2141.99 | 2142.47 | 2142.96 | 2143.44 | 2143.92 | 2144.40 | 2144.88 | 2145.36 | 2145.84 | 2146.32 | 2146.81 | 42.80 |
| 42.90 | 2146.81 | 2147.29 | 2147.77 | 2148.25 | 2148.73 | 2149.21 | 2149.69 | 2150.17 | 2150.66 | 2151.14 | 2151.62 | 42.90 |
| 43.00 | 2151.62 | 2152.10 | 2152.58 | 2153.06 | 2153.55 | 2154.03 | 2154.51 | 2154.99 | 2155.47 | 2155.96 | 2156.44 | 43.00 |
| 43.10 | 2156.44 | 2156.92 | 2157.40 | 2157.88 | 2158.37 | 2158.85 | 2159.33 | 2159.81 | 2160.29 | 2160.78 | 2161.26 | 43.10 |
| 43.20 | 2161.26 | 2161.74 | 2162.22 | 2162.71 | 2163.19 | 2163.67 | 2164.15 | 2164.63 | 2165.12 | 2165.60 | 2166.08 | 43.20 |
| 43.30 | 2166.08 | 2166.56 | 2167.05 | 2167.53 | 2168.01 | 2168.50 | 2168.98 | 2169.46 | 2169.94 | 2170.43 | 2170.91 | 43.30 |
| 43.40 | 2170.91 | 2171.39 | 2171.88 | 2172.36 | 2172.84 | 2173.32 | 2173.81 | 2174.29 | 2174.77 | 2175.26 | 2175.74 | 43.40 |
| 43.50 | 2175.74 | 2176.22 | 2176.71 | 2177.19 | 2177.67 | 2178.16 | 2178.64 | 2179.12 | 2179.61 | 2180.09 | 2180.57 | 43.50 |
| 43.60 | 2180.57 | 2181.06 | 2181.54 | 2182.02 | 2182.51 | 2182.99 | 2183.48 | 2183.96 | 2184.44 | 2184.93 | 2185.41 | 43.60 |
| 43.70 | 2185.41 | 2185.89 | 2186.38 | 2186.86 | 2187.35 | 2187.83 | 2188.31 | 2188.80 | 2189.28 | 2189.77 | 2190.25 | 43.70 |
| 43.80 | 2190.25 | 2190.73 | 2191.22 | 2191.70 | 2192.19 | 2192.67 | 2193.16 | 2193.64 | 2194.13 | 2194.61 | 2195.09 | 43.80 |
| 43.90 | 2195.09 | 2195.58 | 2196.06 | 2196.55 | 2197.03 | 2197.52 | 2198.00 | 2198.49 | 2198.97 | 2199.46 | 2199.94 | 43.90 |
| 44.00 | 2199.94 | 2200.43 | 2200.91 | 2201.40 | 2201.88 | 2202.37 | 2202.85 | 2203.34 | 2203.82 | 2204.31 | 2204.79 | 44.00 |
| 44.10 | 2204.79 | 2205.28 | 2205.76 | 2206.25 | 2206.73 | 2207.22 | 2207.70 | 2208.19 | 2208.67 | 2209.16 | 2209.65 | 44.10 |
| 44.20 | 2209.65 | 2210.13 | 2210.62 | 2211.10 | 2211.59 | 2212.07 | 2212.56 | 2213.05 | 2213.53 | 2214.02 | 2214.50 | 44.20 |
| 44.30 | 2214.50 | 2214.99 | 2215.47 | 2215.96 | 2216.45 | 2216.93 | 2217.42 | 2217.91 | 2218.39 | 2218.88 | 2219.36 | 44.30 |
| 44.40 | 2219.36 | 2219.85 | 2220.34 | 2220.82 | 2221.31 | 2221.80 | 2222.28 | 2222.77 | 2223.26 | 2223.74 | 2224.23 | 44.40 |
| 44.50 | 2224.23 | 2224.72 | 2225.20 | 2225.69 | 2226.18 | 2226.66 | 2227.15 | 2227.64 | 2228.12 | 2228.61 | 2229.10 | 44.50 |
| 44.60 | 2229.10 | 2229.58 | 2230.07 | 2230.56 | 2231.04 | 2231.53 | 2232.02 | 2232.51 | 2232.99 | 2233.48 | 2233.97 | 44.60 |
| 44.70 | 2233.97 | 2234.46 | 2234.94 | 2235.43 | 2235.92 | 2236.41 | 2236.89 | 2237.38 | 2237.87 | 2238.36 | 2238.84 | 44.70 |
| 44.80 | 2238.84 | 2239.33 | 2239.82 | 2240.31 | 2240.79 | 2241.28 | 2241.77 | 2242.26 | 2242.75 | 2243.23 | 2243.72 | 44.80 |
| 44.90 | 2243.72 | 2244.21 | 2244.70 | 2245.19 | 2245.67 | 2246.16 | 2246.65 | 2247.14 | 2247.63 | 2248.12 | 2248.60 | 44.90 |
| 45.00 | 2248.60 | 2249.09 | 2249.58 | 2250.07 | 2250.56 | 2251.05 | 2251.54 | 2252.02 | 2252.51 | 2253.00 | 2253.49 | 45.00 |
| 45.10 | 2253.49 | 2253.98 | 2254.47 | 2254.96 | 2255.45 | 2255.94 | 2256.42 | 2256.91 | 2257.40 | 2257.89 | 2258.38 | 45.10 |
| 45.20 | 2258.38 | 2258.87 | 2259.36 | 2259.85 | 2260.34 | 2260.83 | 2261.32 | 2261.81 | 2262.30 | 2262.79 | 2263.27 | 45.20 |
| 45.30 | 2263.27 | 2263.76 | 2264.25 | 2264.74 | 2265.23 | 2265.72 | 2266.21 | 2266.70 | 2267.19 | 2267.68 | 2268.17 | 45.30 |
| 45.40 | 2268.17 | 2268.66 | 2269.15 | 2269.64 | 2270.13 | 2270.62 | 2271.11 | 2271.60 | 2272.09 | 2272.58 | 2273.07 | 45.40 |
| 45.50 | 2273.07 | 2273.56 | 2274.05 | 2274.54 | 2275.04 | 2275.53 | 2276.02 | 2276.51 | 2277.00 | 2277.49 | 2277.98 | 45.50 |
| 45.60 | 2277.98 | 2278.47 | 2278.96 | 2279.45 | 2279.94 | 2280.43 | 2280.92 | 2281.41 | 2281.91 | 2282.40 | 2282.89 | 45.60 |
| 45.70 | 2282.89 | 2283.38 | 2283.87 | 2284.36 | 2284.85 | 2285.34 | 2285.84 | 2286.33 | 2286.82 | 2287.31 | 2287.80 | 45.70 |
| 45.80 | 2287.80 | 2288.29 | 2288.78 | 2289.28 | 2289.77 | 2290.26 | 2290.75 | 2291.24 | 2291.73 | 2292.23 | 2292.72 | 45.80 |
| 45.90 | 2292.72 | 2293.21 | 2293.70 | 2294.19 | 2294.69 | 2295.18 | 2295.67 | 2296.16 | 2296.65 | 2297.15 | 2297.64 | 45.90 |
| 46.00 | 2297.64 | 2298.13 | 2298.62 | 2299.11 | 2299.61 | 2300.10 | 2300.59 | 2301.08 | 2301.58 | 2302.07 | 2302.56 | 46.00 |
| 46.10 | 2302.56 | 2303.06 | 2303.55 | 2304.04 | 2304.53 | 2305.02 | 2305.52 | 2306.01 | 2306.50 | 2307.00 | 2307.49 | 46.10 |
| 46.20 | 2307.49 | 2307.98 | 2308.48 | 2308.97 | 2309.46 | 2309.96 | 2310.45 | 2310.94 | 2311.44 | 2311.93 | 2312.42 | 46.20 |
| 46.30 | 2312.42 | 2312.92 | 2313.41 | 2313.90 | 2314.40 | 2314.89 | 2315.38 | 2315.88 | 2316.37 | 2316.87 | 2317.36 | 46.30 |
| 46.40 | 2317.36 | 2317.85 | 2318.35 | 2318.84 | 2319.33 | 2319.83 | 2320.32 | 2320.82 | 2321.31 | 2321.80 | 2322.30 | 46.40 |
| 46.50 | 2322.30 | 2322.79 | 2323.29 | 2323.78 | 2324.28 | 2324.77 | 2325.26 | 2325.76 | 2326.25 | 2326.75 | 2327.24 | 46.50 |
| 46.60 | 2327.24 | 2327.74 | 2328.23 | 2328.73 | 2329.22 | 2329.72 | 2330.21 | 2330.71 | 2331.20 | 2331.70 | 2332.19 | 46.60 |
| 46.70 | 2332.19 | 2332.69 | 2333.18 | 2333.68 | 2334.17 | 2334.67 | 2335.16 | 2335.66 | 2336.15 | 2336.65 | 2337.14 | 46.70 |
| 46.80 | 2337.14 | 2337.64 | 2338.13 | 2338.63 | 2339.12 | 2339.62 | 2340.11 | 2340.61 | 2341.11 | 2341.60 | 2342.10 | 46.80 |
| 46.90 | 2342.10 | 2342.59 | 2343.09 | 2343.58 | 2344.08 | 2344.58 | 2345.07 | 2345.57 | 2346.06 | 2346.56 | 2347.06 | 46.90 |
| 47.00 | 2347.06 | 2347.55 | 2348.05 | 2348.55 | 2349.04 | 2349.54 | 2350.03 | 2350.53 | 2351.03 | 2351.52 | 2352.02 | 47.00 |
| 47.10 | 2352.02 | 2352.52 | 2353.01 | 2353.51 | 2354.01 | 2354.50 | 2355.00 | 2355.50 | 2355.99 | 2356.49 | 2356.99 | 47.10 |
| 47.20 | 2356.99 | 2357.48 | 2357.98 | 2358.48 | 2358.97 | 2359.47 | 2359.97 | 2360.47 | 2360.96 | 2361.46 | 2361.96 | 47.20 |
| 47.30 | 2361.96 | 2362.45 | 2362.95 | 2363.45 | 2363.95 | 2364.44 | 2364.94 | 2365.44 | 2365.94 | 2366.43 | 2366.93 | 47.30 |
| 47.40 | 2366.93 | 2367.43 | 2367.93 | 2368.42 | 2368.92 | 2369.42 | 2369.92 | 2370.42 | 2370.91 | 2371.41 | 2371.91 | 47.40 |
| 47.50 | 2371.91 |  |  |  |  |  |  |  |  |  |  | 47.50 |
| mV | .00 | .01 | .02 | .03 | .04 | .05 | .06 | .07 | .08 | .09 | .10 | mV |

# Appendix C. Abbreviated Tables for Nicrosil versus Nisil Thermocouples, for Nicrosil Thermoelements versus Platinum, Pt–67, and for Platinum, Pt–67, versus Nisil Thermoelements

The primary tables and functions presented in section 7 are more precise than is often necessary. The tables in this appendix present the same data in different formats to satisfy special needs. Table C1 gives the voltage as a function of temperature, *T*, in degrees Celsius, with the voltage expressed in millivolts rather than microvolts (without columns for the Seebeck coefficient and its derivative), for *AWG 28* thermocouples. Table C2 gives the equilavent for *AWG 14* thermocouples. Tables C3, C4, C5, C6, C7, and C8 give similar data with the temperature given in degrees Fahrenheit. Tables C3 and C4 are for the thermocouple combination; tables C5 and C6 are for the Nicrosil thermoelement versus platinum, Pt–67; and tables C7 and C8 are for platinum, Pt–67, versus the Nisil thermoelement.

Table C1. AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°C), reference junctions at 0 °C. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -270 | -4.3452 | | | | | | | | | | | -270 |
| -260 | -4.3357 | -4.3372 | -4.3386 | -4.3399 | -4.3410 | -4.3420 | -4.3429 | -4.3436 | -4.3443 | -4.3448 | -4.3452 | -260 |
| -250 | -4.3133 | -4.3162 | -4.3189 | -4.3215 | -4.3239 | -4.3262 | -4.3284 | -4.3304 | -4.3323 | -4.3341 | -4.3357 | -250 |
| -240 | -4.2770 | -4.2813 | -4.2854 | -4.2894 | -4.2932 | -4.2969 | -4.3005 | -4.3039 | -4.3072 | -4.3103 | -4.3133 | -240 |
| -230 | -4.2265 | -4.2322 | -4.2378 | -4.2432 | -4.2484 | -4.2536 | -4.2585 | -4.2634 | -4.2681 | -4.2726 | -4.2770 | -230 |
| -220 | -4.1618 | -4.1689 | -4.1759 | -4.1827 | -4.1894 | -4.1959 | -4.2023 | -4.2086 | -4.2147 | -4.2207 | -4.2265 | -220 |
| -210 | -4.0829 | -4.0915 | -4.0998 | -4.1081 | -4.1162 | -4.1241 | -4.1319 | -4.1396 | -4.1471 | -4.1545 | -4.1618 | -210 |
| -200 | -3.9904 | -4.0002 | -4.0100 | -4.0196 | -4.0290 | -4.0384 | -4.0475 | -4.0566 | -4.0655 | -4.0743 | -4.0829 | -200 |
| -190 | -3.8844 | -3.8956 | -3.9067 | -3.9176 | -3.9284 | -3.9390 | -3.9496 | -3.9600 | -3.9702 | -3.9804 | -3.9904 | -190 |
| -180 | -3.7656 | -3.7780 | -3.7903 | -3.8025 | -3.8146 | -3.8266 | -3.8384 | -3.8501 | -3.8617 | -3.8731 | -3.8844 | -180 |
| -170 | -3.6343 | -3.6479 | -3.6615 | -3.6749 | -3.6882 | -3.7014 | -3.7145 | -3.7275 | -3.7403 | -3.7530 | -3.7656 | -170 |
| -160 | -3.4910 | -3.5058 | -3.5206 | -3.5352 | -3.5497 | -3.5641 | -3.5783 | -3.5925 | -3.6065 | -3.6205 | -3.6343 | -160 |
| -150 | -3.3362 | -3.3521 | -3.3680 | -3.3838 | -3.3994 | -3.4150 | -3.4304 | -3.4457 | -3.4609 | -3.4760 | -3.4910 | -150 |
| -140 | -3.1703 | -3.1874 | -3.2043 | -3.2212 | -3.2379 | -3.2546 | -3.2711 | -3.2875 | -3.3039 | -3.3201 | -3.3362 | -140 |
| -130 | -2.9939 | -3.0120 | -3.0300 | -3.0479 | -3.0657 | -3.0834 | -3.1010 | -3.1185 | -3.1359 | -3.1531 | -3.1703 | -130 |
| -120 | -2.8075 | -2.8266 | -2.8456 | -2.8644 | -2.8832 | -2.9019 | -2.9205 | -2.9390 | -2.9574 | -2.9757 | -2.9939 | -120 |
| -110 | -2.6115 | -2.6315 | -2.6514 | -2.6713 | -2.6910 | -2.7107 | -2.7302 | -2.7497 | -2.7690 | -2.7883 | -2.8075 | -110 |
| -100 | -2.4066 | -2.4274 | -2.4482 | -2.4690 | -2.4896 | -2.5101 | -2.5306 | -2.5509 | -2.5712 | -2.5914 | -2.6115 | -100 |
| -90 | -2.1932 | -2.2149 | -2.2365 | -2.2581 | -2.2795 | -2.3009 | -2.3222 | -2.3434 | -2.3645 | -2.3856 | -2.4066 | -90 |
| -80 | -1.9721 | -1.9945 | -2.0169 | -2.0392 | -2.0614 | -2.0836 | -2.1057 | -2.1277 | -2.1496 | -2.1714 | -2.1932 | -80 |
| -70 | -1.7438 | -1.7669 | -1.7900 | -1.8130 | -1.8359 | -1.8588 | -1.8816 | -1.9043 | -1.9270 | -1.9496 | -1.9721 | -70 |
| -60 | -1.5090 | -1.5328 | -1.5565 | -1.5801 | -1.6037 | -1.6272 | -1.6506 | -1.6740 | -1.6973 | -1.7206 | -1.7438 | -60 |
| -50 | -1.2684 | -1.2927 | -1.3170 | -1.3412 | -1.3653 | -1.3894 | -1.4134 | -1.4374 | -1.4613 | -1.4852 | -1.5090 | -50 |
| -40 | -1.0226 | -1.0474 | -1.0721 | -1.0968 | -1.1215 | -1.1461 | -1.1707 | -1.1952 | -1.2196 | -1.2440 | -1.2684 | -40 |
| -30 | -0.7722 | -0.7974 | -0.8226 | -0.8478 | -0.8729 | -0.8979 | -0.9229 | -0.9479 | -0.9729 | -0.9977 | -1.0226 | -30 |
| -20 | -0.5179 | -0.5435 | -0.5691 | -0.5946 | -0.6201 | -0.6455 | -0.6709 | -0.6963 | -0.7217 | -0.7470 | -0.7722 | -20 |
| -10 | -0.2603 | -0.2862 | -0.3121 | -0.3379 | -0.3637 | -0.3895 | -0.4153 | -0.4410 | -0.4667 | -0.4923 | -0.5179 | -10 |
| 0 | 0.0000 | | | | | | | | | | | 0 |
| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |

**TABLE C1.** AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°C), reference junctions at 0 °C*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0000 | 0.0262 | 0.0523 | 0.0785 | 0.1048 | 0.1310 | 0.1573 | 0.1836 | 0.2099 | 0.2362 | 0.2626 | 0 |
| 10 | 0.2626 | 0.2890 | 0.3154 | 0.3418 | 0.3683 | 0.3948 | 0.4213 | 0.4479 | 0.4745 | 0.5011 | 0.5278 | 10 |
| 20 | 0.5278 | 0.5544 | 0.5811 | 0.6079 | 0.6347 | 0.6615 | 0.6883 | 0.7152 | 0.7421 | 0.7690 | 0.7960 | 20 |
| 30 | 0.7960 | 0.8230 | 0.8501 | 0.8772 | 0.9043 | 0.9314 | 0.9586 | 0.9859 | 1.0131 | 1.0404 | 1.0678 | 30 |
| 40 | 1.0678 | 1.0951 | 1.1226 | 1.1500 | 1.1775 | 1.2050 | 1.2326 | 1.2602 | 1.2879 | 1.3156 | 1.3433 | 40 |
| 50 | 1.3433 | 1.3710 | 1.3989 | 1.4267 | 1.4546 | 1.4825 | 1.5105 | 1.5385 | 1.5665 | 1.5946 | 1.6227 | 50 |
| 60 | 1.6227 | 1.6509 | 1.6791 | 1.7073 | 1.7356 | 1.7640 | 1.7923 | 1.8207 | 1.8492 | 1.8777 | 1.9062 | 60 |
| 70 | 1.9062 | 1.9348 | 1.9634 | 1.9920 | 2.0207 | 2.0494 | 2.0782 | 2.1070 | 2.1359 | 2.1647 | 2.1937 | 70 |
| 80 | 2.1937 | 2.2226 | 2.2517 | 2.2807 | 2.3098 | 2.3389 | 2.3681 | 2.3973 | 2.4266 | 2.4558 | 2.4852 | 80 |
| 90 | 2.4852 | 2.5145 | 2.5439 | 2.5734 | 2.6029 | 2.6324 | 2.6620 | 2.6915 | 2.7212 | 2.7509 | 2.7806 | 90 |
| 100 | 2.7806 | 2.8103 | 2.8401 | 2.8700 | 2.8998 | 2.9297 | 2.9597 | 2.9897 | 3.0197 | 3.0497 | 3.0798 | 100 |
| 110 | 3.0798 | 3.1100 | 3.1401 | 3.1703 | 3.2006 | 3.2308 | 3.2612 | 3.2915 | 3.3219 | 3.3523 | 3.3828 | 110 |
| 120 | 3.3828 | 3.4133 | 3.4438 | 3.4744 | 3.5050 | 3.5356 | 3.5663 | 3.5970 | 3.6277 | 3.6585 | 3.6893 | 120 |
| 130 | 3.6893 | 3.7202 | 3.7511 | 3.7820 | 3.8129 | 3.8439 | 3.8749 | 3.9060 | 3.9371 | 3.9682 | 3.9993 | 130 |
| 140 | 3.9993 | 4.0305 | 4.0617 | 4.0930 | 4.1243 | 4.1556 | 4.1869 | 4.2183 | 4.2497 | 4.2812 | 4.3127 | 140 |
| 150 | 4.3127 | 4.3442 | 4.3757 | 4.4073 | 4.4389 | 4.4706 | 4.5022 | 4.5339 | 4.5657 | 4.5974 | 4.6292 | 150 |
| 160 | 4.6292 | 4.6611 | 4.6929 | 4.7248 | 4.7567 | 4.7887 | 4.8207 | 4.8527 | 4.8847 | 4.9168 | 4.9489 | 160 |
| 170 | 4.9489 | 4.9810 | 5.0132 | 5.0454 | 5.0776 | 5.1098 | 5.1421 | 5.1744 | 5.2068 | 5.2391 | 5.2715 | 170 |
| 180 | 5.2715 | 5.3040 | 5.3364 | 5.3689 | 5.4014 | 5.4340 | 5.4665 | 5.4991 | 5.5318 | 5.5644 | 5.5971 | 180 |
| 190 | 5.5971 | 5.6298 | 5.6625 | 5.6953 | 5.7281 | 5.7609 | 5.7938 | 5.8267 | 5.8596 | 5.8925 | 5.9255 | 190 |
| 200 | 5.9255 | 5.9585 | 5.9915 | 6.0245 | 6.0576 | 6.0907 | 6.1238 | 6.1570 | 6.1901 | 6.2234 | 6.2566 | 200 |
| 210 | 6.2566 | 6.2898 | 6.3231 | 6.3564 | 6.3898 | 6.4231 | 6.4565 | 6.4900 | 6.5234 | 6.5569 | 6.5904 | 210 |
| 220 | 6.5904 | 6.6239 | 6.6574 | 6.6910 | 6.7246 | 6.7582 | 6.7919 | 6.8256 | 6.8593 | 6.8930 | 6.9268 | 220 |
| 230 | 6.9268 | 6.9605 | 6.9944 | 7.0282 | 7.0620 | 7.0959 | 7.1298 | 7.1638 | 7.1977 | 7.2317 | 7.2657 | 230 |
| 240 | 7.2657 | 7.2997 | 7.3338 | 7.3679 | 7.4020 | 7.4361 | 7.4703 | 7.5044 | 7.5387 | 7.5729 | 7.6071 | 240 |
| 250 | 7.6071 | 7.6414 | 7.6757 | 7.7100 | 7.7444 | 7.7788 | 7.8132 | 7.8476 | 7.8820 | 7.9165 | 7.9510 | 250 |
| 260 | 7.9510 | 7.9855 | 8.0201 | 8.0546 | 8.0892 | 8.1238 | 8.1584 | 8.1931 | 8.2278 | 8.2625 | 8.2972 | 260 |
| 270 | 8.2972 | 8.3320 | 8.3667 | 8.4015 | 8.4364 | 8.4712 | 8.5061 | 8.5409 | 8.5759 | 8.6108 | 8.6457 | 270 |
| 280 | 8.6457 | 8.6807 | 8.7157 | 8.7507 | 8.7858 | 8.8208 | 8.8559 | 8.8910 | 8.9262 | 8.9613 | 8.9965 | 280 |
| 290 | 8.9965 | 9.0317 | 9.0669 | 9.1021 | 9.1374 | 9.1727 | 9.2080 | 9.2433 | 9.2786 | 9.3140 | 9.3494 | 290 |
| 300 | 9.3494 | 9.3848 | 9.4202 | 9.4557 | 9.4911 | 9.5266 | 9.5621 | 9.5976 | 9.6332 | 9.6688 | 9.7043 | 300 |
| 310 | 9.7043 | 9.7399 | 9.7756 | 9.8112 | 9.8469 | 9.8826 | 9.9183 | 9.9540 | 9.9897 | 10.0255 | 10.0613 | 310 |
| 320 | 10.0613 | 10.0971 | 10.1329 | 10.1687 | 10.2046 | 10.2404 | 10.2763 | 10.3122 | 10.3481 | 10.3841 | 10.4200 | 320 |
| 330 | 10.4200 | 10.4560 | 10.4920 | 10.5280 | 10.5641 | 10.6001 | 10.6362 | 10.6722 | 10.7083 | 10.7444 | 10.7806 | 330 |
| 340 | 10.7806 | 10.8167 | 10.8529 | 10.8891 | 10.9253 | 10.9615 | 10.9977 | 11.0339 | 11.0702 | 11.1065 | 11.1428 | 340 |
| 350 | 11.1428 | 11.1791 | 11.2154 | 11.2517 | 11.2881 | 11.3245 | 11.3608 | 11.3972 | 11.4336 | 11.4701 | 11.5065 | 350 |
| 360 | 11.5065 | 11.5430 | 11.5794 | 11.6159 | 11.6524 | 11.6889 | 11.7255 | 11.7620 | 11.7986 | 11.8351 | 11.8717 | 360 |
| 370 | 11.8717 | 11.9083 | 11.9449 | 11.9815 | 12.0182 | 12.0548 | 12.0915 | 12.1282 | 12.1649 | 12.2016 | 12.2383 | 370 |
| 380 | 12.2383 | 12.2750 | 12.3118 | 12.3485 | 12.3853 | 12.4221 | 12.4589 | 12.4957 | 12.5325 | 12.5694 | 12.6062 | 380 |
| 390 | 12.6062 | 12.6431 | 12.6800 | 12.7169 | 12.7538 | 12.7907 | 12.8276 | 12.8646 | 12.9015 | 12.9385 | 12.9755 | 390 |
| 400 | 12.9755 |  |  |  |  |  |  |  |  |  |  | 400 |
| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |

**Table C2.** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°C), reference junctions at 0 °C. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0000 | 0.0259 | 0.0519 | 0.0778 | 0.1039 | 0.1299 | 0.1560 | 0.1821 | 0.2083 | 0.2345 | 0.2607 | 0 |
| 10 | 0.2607 | 0.2869 | 0.3132 | 0.3396 | 0.3659 | 0.3923 | 0.4187 | 0.4452 | 0.4717 | 0.4983 | 0.5248 | 10 |
| 20 | 0.5248 | 0.5515 | 0.5781 | 0.6048 | 0.6315 | 0.6583 | 0.6851 | 0.7119 | 0.7388 | 0.7657 | 0.7926 | 20 |
| 30 | 0.7926 | 0.8196 | 0.8466 | 0.8737 | 0.9008 | 0.9279 | 0.9551 | 0.9823 | 1.0095 | 1.0368 | 1.0642 | 30 |
| 40 | 1.0642 | 1.0915 | 1.1189 | 1.1463 | 1.1738 | 1.2013 | 1.2289 | 1.2565 | 1.2841 | 1.3118 | 1.3395 | 40 |
| 50 | 1.3395 | 1.3672 | 1.3950 | 1.4228 | 1.4507 | 1.4786 | 1.5065 | 1.5345 | 1.5625 | 1.5905 | 1.6186 | 50 |
| 60 | 1.6186 | 1.6467 | 1.6749 | 1.7031 | 1.7313 | 1.7596 | 1.7879 | 1.8163 | 1.8447 | 1.8731 | 1.9016 | 60 |
| 70 | 1.9016 | 1.9301 | 1.9587 | 1.9872 | 2.0159 | 2.0445 | 2.0732 | 2.1020 | 2.1308 | 2.1596 | 2.1884 | 70 |
| 80 | 2.1884 | 2.2173 | 2.2463 | 2.2752 | 2.3042 | 2.3333 | 2.3624 | 2.3915 | 2.4207 | 2.4499 | 2.4791 | 80 |
| 90 | 2.4791 | 2.5084 | 2.5377 | 2.5670 | 2.5964 | 2.6259 | 2.6553 | 2.6848 | 2.7144 | 2.7440 | 2.7736 | 90 |
| 100 | 2.7736 | 2.8032 | 2.8329 | 2.8626 | 2.8924 | 2.9222 | 2.9520 | 2.9819 | 3.0118 | 3.0418 | 3.0718 | 100 |
| 110 | 3.0718 | 3.1018 | 3.1319 | 3.1620 | 3.1921 | 3.2223 | 3.2525 | 3.2827 | 3.3130 | 3.3433 | 3.3737 | 110 |
| 120 | 3.3737 | 3.4041 | 3.4345 | 3.4649 | 3.4954 | 3.5260 | 3.5565 | 3.5871 | 3.6178 | 3.6485 | 3.6792 | 120 |
| 130 | 3.6792 | 3.7099 | 3.7407 | 3.7715 | 3.8024 | 3.8333 | 3.8642 | 3.8951 | 3.9261 | 3.9572 | 3.9882 | 130 |
| 140 | 3.9882 | 4.0193 | 4.0504 | 4.0816 | 4.1128 | 4.1440 | 4.1753 | 4.2066 | 4.2379 | 4.2693 | 4.3007 | 140 |
| 150 | 4.3007 | 4.3322 | 4.3636 | 4.3951 | 4.4267 | 4.4582 | 4.4898 | 4.5215 | 4.5532 | 4.5849 | 4.6166 | 150 |
| 160 | 4.6166 | 4.6484 | 4.6802 | 4.7120 | 4.7439 | 4.7758 | 4.8077 | 4.8397 | 4.8717 | 4.9037 | 4.9357 | 160 |
| 170 | 4.9357 | 4.9678 | 5.0000 | 5.0321 | 5.0643 | 5.0965 | 5.1288 | 5.1611 | 5.1934 | 5.2257 | 5.2581 | 170 |
| 180 | 5.2581 | 5.2905 | 5.3229 | 5.3554 | 5.3879 | 5.4204 | 5.4530 | 5.4856 | 5.5182 | 5.5508 | 5.5835 | 180 |
| 190 | 5.5835 | 5.6162 | 5.6490 | 5.6817 | 5.7145 | 5.7474 | 5.7802 | 5.8131 | 5.8460 | 5.8790 | 5.9119 | 190 |
| 200 | 5.9119 | 5.9449 | 5.9780 | 6.0110 | 6.0441 | 6.0772 | 6.1104 | 6.1435 | 6.1768 | 6.2100 | 6.2432 | 200 |
| 210 | 6.2432 | 6.2765 | 6.3098 | 6.3432 | 6.3766 | 6.4100 | 6.4434 | 6.4768 | 6.5103 | 6.5438 | 6.5774 | 210 |
| 220 | 6.5774 | 6.6109 | 6.6445 | 6.6781 | 6.7118 | 6.7454 | 6.7791 | 6.8129 | 6.8466 | 6.8804 | 6.9142 | 220 |
| 230 | 6.9142 | 6.9480 | 6.9819 | 7.0157 | 7.0496 | 7.0836 | 7.1175 | 7.1515 | 7.1855 | 7.2195 | 7.2536 | 230 |
| 240 | 7.2536 | 7.2877 | 7.3218 | 7.3559 | 7.3901 | 7.4243 | 7.4585 | 7.4927 | 7.5270 | 7.5613 | 7.5956 | 240 |
| 250 | 7.5956 | 7.6299 | 7.6642 | 7.6986 | 7.7330 | 7.7674 | 7.8019 | 7.8364 | 7.8709 | 7.9054 | 7.9399 | 250 |
| 260 | 7.9399 | 7.9745 | 8.0091 | 8.0437 | 8.0784 | 8.1130 | 8.1477 | 8.1824 | 8.2171 | 8.2519 | 8.2867 | 260 |
| 270 | 8.2867 | 8.3215 | 8.3563 | 8.3911 | 8.4260 | 8.4609 | 8.4958 | 8.5307 | 8.5657 | 8.6006 | 8.6356 | 270 |
| 280 | 8.6356 | 8.6707 | 8.7057 | 8.7408 | 8.7758 | 8.8110 | 8.8461 | 8.8812 | 8.9164 | 8.9516 | 8.9868 | 280 |
| 290 | 8.9868 | 9.0220 | 9.0573 | 9.0926 | 9.1278 | 9.1632 | 9.1985 | 9.2339 | 9.2692 | 9.3046 | 9.3400 | 290 |
| 300 | 9.3400 | 9.3755 | 9.4109 | 9.4464 | 9.4819 | 9.5174 | 9.5530 | 9.5885 | 9.6241 | 9.6597 | 9.6953 | 300 |
| 310 | 9.6953 | 9.7309 | 9.7666 | 9.8023 | 9.8380 | 9.8737 | 9.9094 | 9.9452 | 9.9809 | 10.0167 | 10.0525 | 310 |
| 320 | 10.0525 | 10.0884 | 10.1242 | 10.1601 | 10.1959 | 10.2318 | 10.2678 | 10.3037 | 10.3396 | 10.3756 | 10.4116 | 320 |
| 330 | 10.4116 | 10.4476 | 10.4836 | 10.5197 | 10.5558 | 10.5918 | 10.6279 | 10.6640 | 10.7002 | 10.7363 | 10.7725 | 330 |
| 340 | 10.7725 | 10.8087 | 10.8449 | 10.8811 | 10.9173 | 10.9536 | 10.9899 | 11.0262 | 11.0625 | 11.0988 | 11.1351 | 340 |
| 350 | 11.1351 | 11.1715 | 11.2079 | 11.2442 | 11.2806 | 11.3171 | 11.3535 | 11.3900 | 11.4264 | 11.4629 | 11.4994 | 350 |
| 360 | 11.4994 | 11.5359 | 11.5725 | 11.6090 | 11.6456 | 11.6822 | 11.7188 | 11.7554 | 11.7920 | 11.8287 | 11.8653 | 360 |
| 370 | 11.8653 | 11.9020 | 11.9387 | 11.9754 | 12.0121 | 12.0489 | 12.0856 | 12.1224 | 12.1592 | 12.1960 | 12.2328 | 370 |
| 380 | 12.2328 | 12.2696 | 12.3065 | 12.3433 | 12.3802 | 12.4171 | 12.4540 | 12.4909 | 12.5279 | 12.5648 | 12.6018 | 380 |
| 390 | 12.6018 | 12.6387 | 12.6757 | 12.7127 | 12.7498 | 12.7868 | 12.8238 | 12.8609 | 12.8980 | 12.9351 | 12.9722 | 390 |
| 400 | 12.9722 | 13.0093 | 13.0464 | 13.0836 | 13.1207 | 13.1579 | 13.1951 | 13.2323 | 13.2695 | 13.3067 | 13.3440 | 400 |
| 410 | 13.3440 | 13.3812 | 13.4185 | 13.4558 | 13.4930 | 13.5304 | 13.5677 | 13.6050 | 13.6423 | 13.6797 | 13.7171 | 410 |
| 420 | 13.7171 | 13.7545 | 13.7919 | 13.8293 | 13.8667 | 13.9041 | 13.9416 | 13.9790 | 14.0165 | 14.0540 | 14.0915 | 420 |
| 430 | 14.0915 | 14.1290 | 14.1665 | 14.2041 | 14.2416 | 14.2792 | 14.3167 | 14.3543 | 14.3919 | 14.4295 | 14.4671 | 430 |
| 440 | 14.4671 | 14.5048 | 14.5424 | 14.5801 | 14.6177 | 14.6554 | 14.6931 | 14.7308 | 14.7685 | 14.8062 | 14.8440 | 440 |
| 450 | 14.8440 | 14.8817 | 14.9195 | 14.9572 | 14.9950 | 15.0328 | 15.0706 | 15.1084 | 15.1463 | 15.1841 | 15.2219 | 450 |
| 460 | 15.2219 | 15.2598 | 15.2977 | 15.3356 | 15.3734 | 15.4114 | 15.4493 | 15.4872 | 15.5251 | 15.5631 | 15.6010 | 460 |
| 470 | 15.6010 | 15.6390 | 15.6770 | 15.7150 | 15.7530 | 15.7910 | 15.8290 | 15.8670 | 15.9050 | 15.9431 | 15.9812 | 470 |
| 480 | 15.9812 | 16.0192 | 16.0573 | 16.0954 | 16.1335 | 16.1716 | 16.2097 | 16.2478 | 16.2860 | 16.3241 | 16.3623 | 480 |
| 490 | 16.3623 | 16.4005 | 16.4386 | 16.4768 | 16.5150 | 16.5532 | 16.5914 | 16.6297 | 16.6679 | 16.7061 | 16.7444 | 490 |
| 500 | 16.7444 | 16.7827 | 16.8209 | 16.8592 | 16.8975 | 16.9358 | 16.9741 | 17.0124 | 17.0507 | 17.0891 | 17.1274 | 500 |
| 510 | 17.1274 | 17.1658 | 17.2041 | 17.2425 | 17.2809 | 17.3193 | 17.3577 | 17.3961 | 17.4345 | 17.4729 | 17.5113 | 510 |
| 520 | 17.5113 | 17.5498 | 17.5882 | 17.6267 | 17.6651 | 17.7036 | 17.7421 | 17.7806 | 17.8191 | 17.8576 | 17.8961 | 520 |
| 530 | 17.8961 | 17.9346 | 17.9731 | 18.0117 | 18.0502 | 18.0888 | 18.1273 | 18.1659 | 18.2045 | 18.2430 | 18.2816 | 530 |
| 540 | 18.2816 | 18.3202 | 18.3588 | 18.3974 | 18.4361 | 18.4747 | 18.5133 | 18.5520 | 18.5906 | 18.6293 | 18.6679 | 540 |
| 550 | 18.6679 | 18.7066 | 18.7453 | 18.7840 | 18.8226 | 18.8613 | 18.9001 | 18.9388 | 18.9775 | 19.0162 | 19.0549 | 550 |
| 560 | 19.0549 | 19.0937 | 19.1324 | 19.1712 | 19.2099 | 19.2487 | 19.2875 | 19.3263 | 19.3650 | 19.4038 | 19.4426 | 560 |
| 570 | 19.4426 | 19.4814 | 19.5202 | 19.5591 | 19.5979 | 19.6367 | 19.6756 | 19.7144 | 19.7532 | 19.7921 | 19.8310 | 570 |
| 580 | 19.8310 | 19.8698 | 19.9087 | 19.9476 | 19.9865 | 20.0253 | 20.0642 | 20.1031 | 20.1420 | 20.1810 | 20.2199 | 580 |
| 590 | 20.2199 | 20.2588 | 20.2977 | 20.3367 | 20.3756 | 20.4145 | 20.4535 | 20.4924 | 20.5314 | 20.5704 | 20.6093 | 590 |
| 600 | 20.6093 | 20.6483 | 20.6873 | 20.7263 | 20.7653 | 20.8043 | 20.8433 | 20.8823 | 20.9213 | 20.9603 | 20.9993 | 600 |
| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |

**Table C2.** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°C), reference junctions at 0 °C*—Continued

| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS | | | | | | |
| 600 | 20.6093 | 20.6483 | 20.6873 | 20.7263 | 20.7653 | 20.8043 | 20.8433 | 20.8823 | 20.9213 | 20.9603 | 20.9993 | 60 |
| 610 | 20.9993 | 21.0384 | 21.0774 | 21.1164 | 21.1555 | 21.1945 | 21.2336 | 21.2726 | 21.3117 | 21.3507 | 21.3898 | 61 |
| 620 | 21.3898 | 21.4289 | 21.4679 | 21.5070 | 21.5461 | 21.5852 | 21.6243 | 21.6634 | 21.7025 | 21.7416 | 21.7807 | 62 |
| 630 | 21.7807 | 21.8198 | 21.8589 | 21.8980 | 21.9371 | 21.9763 | 22.0154 | 22.0545 | 22.0937 | 22.1328 | 22.1720 | 63 |
| 640 | 22.1720 | 22.2111 | 22.2503 | 22.2894 | 22.3286 | 22.3677 | 22.4069 | 22.4461 | 22.4853 | 22.5244 | 22.5636 | 64 |
| 650 | 22.5636 | 22.6028 | 22.6420 | 22.6812 | 22.7204 | 22.7595 | 22.7987 | 22.8379 | 22.8771 | 22.9164 | 22.9556 | 65 |
| 660 | 22.9556 | 22.9948 | 23.0340 | 23.0732 | 23.1124 | 23.1517 | 23.1909 | 23.2301 | 23.2693 | 23.3086 | 23.3478 | 66 |
| 670 | 23.3478 | 23.3870 | 23.4263 | 23.4655 | 23.5048 | 23.5440 | 23.5833 | 23.6225 | 23.6618 | 23.7010 | 23.7403 | 67 |
| 680 | 23.7403 | 23.7795 | 23.8188 | 23.8581 | 23.8973 | 23.9366 | 23.9759 | 24.0151 | 24.0544 | 24.0937 | 24.1330 | 68 |
| 690 | 24.1330 | 24.1722 | 24.2115 | 24.2508 | 24.2901 | 24.3294 | 24.3687 | 24.4079 | 24.4472 | 24.4865 | 24.5258 | 69 |
| 700 | 24.5258 | 24.5651 | 24.6044 | 24.6437 | 24.6830 | 24.7223 | 24.7616 | 24.8009 | 24.8402 | 24.8795 | 24.9188 | 70 |
| 710 | 24.9188 | 24.9581 | 24.9974 | 25.0367 | 25.0760 | 25.1153 | 25.1546 | 25.1940 | 25.2333 | 25.2726 | 25.3119 | 71 |
| 720 | 25.3119 | 25.3512 | 25.3905 | 25.4298 | 25.4691 | 25.5085 | 25.5478 | 25.5871 | 25.6264 | 25.6657 | 25.7050 | 72 |
| 730 | 25.7050 | 25.7443 | 25.7837 | 25.8230 | 25.8623 | 25.9016 | 25.9409 | 25.9803 | 26.0196 | 26.0589 | 26.0982 | 73 |
| 740 | 26.0982 | 26.1375 | 26.1768 | 26.2162 | 26.2555 | 26.2948 | 26.3341 | 26.3734 | 26.4127 | 26.4521 | 26.4914 | 74 |
| 750 | 26.4914 | 26.5307 | 26.5700 | 26.6093 | 26.6486 | 26.6880 | 26.7273 | 26.7666 | 26.8059 | 26.8452 | 26.8845 | 75 |
| 760 | 26.8845 | 26.9238 | 26.9631 | 27.0024 | 27.0418 | 27.0811 | 27.1204 | 27.1597 | 27.1990 | 27.2383 | 27.2776 | 76 |
| 770 | 27.2776 | 27.3169 | 27.3562 | 27.3955 | 27.4348 | 27.4741 | 27.5134 | 27.5527 | 27.5920 | 27.6313 | 27.6706 | 77 |
| 780 | 27.6706 | 27.7099 | 27.7492 | 27.7885 | 27.8277 | 27.8670 | 27.9063 | 27.9456 | 27.9849 | 28.0242 | 28.0634 | 78 |
| 790 | 28.0634 | 28.1027 | 28.1420 | 28.1813 | 28.2205 | 28.2598 | 28.2991 | 28.3384 | 28.3776 | 28.4169 | 28.4562 | 79 |
| 800 | 28.4562 | 28.4954 | 28.5347 | 28.5739 | 28.6132 | 28.6525 | 28.6917 | 28.7310 | 28.7702 | 28.8095 | 28.8487 | 80 |
| 810 | 28.8487 | 28.8879 | 28.9272 | 28.9664 | 29.0057 | 29.0449 | 29.0841 | 29.1234 | 29.1626 | 29.2018 | 29.2410 | 81 |
| 820 | 29.2410 | 29.2803 | 29.3195 | 29.3587 | 29.3979 | 29.4371 | 29.4764 | 29.5156 | 29.5548 | 29.5940 | 29.6332 | 82 |
| 830 | 29.6332 | 29.6724 | 29.7116 | 29.7508 | 29.7900 | 29.8291 | 29.8683 | 29.9075 | 29.9467 | 29.9859 | 30.0251 | 83 |
| 840 | 30.0251 | 30.0642 | 30.1034 | 30.1426 | 30.1817 | 30.2209 | 30.2601 | 30.2992 | 30.3384 | 30.3775 | 30.4167 | 84 |
| 850 | 30.4167 | 30.4558 | 30.4950 | 30.5341 | 30.5732 | 30.6124 | 30.6515 | 30.6906 | 30.7298 | 30.7689 | 30.8080 | 85 |
| 860 | 30.8080 | 30.8471 | 30.8862 | 30.9254 | 30.9645 | 31.0036 | 31.0427 | 31.0818 | 31.1209 | 31.1600 | 31.1990 | 86 |
| 870 | 31.1990 | 31.2381 | 31.2772 | 31.3163 | 31.3554 | 31.3944 | 31.4335 | 31.4726 | 31.5116 | 31.5507 | 31.5898 | 87 |
| 880 | 31.5898 | 31.6288 | 31.6679 | 31.7069 | 31.7459 | 31.7850 | 31.8240 | 31.8631 | 31.9021 | 31.9411 | 31.9801 | 88 |
| 890 | 31.9801 | 32.0192 | 32.0582 | 32.0972 | 32.1362 | 32.1752 | 32.2142 | 32.2532 | 32.2922 | 32.3312 | 32.3702 | 89 |
| 900 | 32.3702 | 32.4091 | 32.4481 | 32.4871 | 32.5261 | 32.5650 | 32.6040 | 32.6430 | 32.6819 | 32.7209 | 32.7598 | 90 |
| 910 | 32.7598 | 32.7988 | 32.8377 | 32.8766 | 32.9156 | 32.9545 | 32.9934 | 33.0324 | 33.0713 | 33.1102 | 33.1491 | 91 |
| 920 | 33.1491 | 33.1880 | 33.2269 | 33.2658 | 33.3047 | 33.3436 | 33.3825 | 33.4214 | 33.4602 | 33.4991 | 33.5380 | 92 |
| 930 | 33.5380 | 33.5769 | 33.6157 | 33.6546 | 33.6934 | 33.7323 | 33.7711 | 33.8100 | 33.8488 | 33.8876 | 33.9265 | 93 |
| 940 | 33.9265 | 33.9653 | 34.0041 | 34.0429 | 34.0817 | 34.1206 | 34.1594 | 34.1982 | 34.2370 | 34.2757 | 34.3145 | 94 |
| 950 | 34.3145 | 34.3533 | 34.3921 | 34.4309 | 34.4696 | 34.5084 | 34.5472 | 34.5859 | 34.6247 | 34.6634 | 34.7022 | 95 |
| 960 | 34.7022 | 34.7409 | 34.7796 | 34.8184 | 34.8571 | 34.8958 | 34.9345 | 34.9732 | 35.0119 | 35.0507 | 35.0894 | 96 |
| 970 | 35.0894 | 35.1280 | 35.1667 | 35.2054 | 35.2441 | 35.2828 | 35.3214 | 35.3601 | 35.3988 | 35.4374 | 35.4761 | 97 |
| 980 | 35.4761 | 35.5147 | 35.5534 | 35.5920 | 35.6306 | 35.6693 | 35.7079 | 35.7465 | 35.7851 | 35.8237 | 35.8623 | 98 |
| 990 | 35.8623 | 35.9009 | 35.9395 | 35.9781 | 36.0167 | 36.0553 | 36.0939 | 36.1325 | 36.1710 | 36.2096 | 36.2481 | 99 |
| 1,000 | 36.2481 | 36.2867 | 36.3252 | 36.3638 | 36.4023 | 36.4408 | 36.4794 | 36.5179 | 36.5564 | 36.5949 | 36.6334 | 1,000 |
| 1,010 | 36.6334 | 36.6719 | 36.7104 | 36.7489 | 36.7874 | 36.8259 | 36.8644 | 36.9028 | 36.9413 | 36.9798 | 37.0182 | 1,010 |
| 1,020 | 37.0182 | 37.0567 | 37.0951 | 37.1336 | 37.1720 | 37.2104 | 37.2488 | 37.2873 | 37.3257 | 37.3641 | 37.4025 | 1,020 |
| 1,030 | 37.4025 | 37.4409 | 37.4793 | 37.5177 | 37.5560 | 37.5944 | 37.6328 | 37.6712 | 37.7095 | 37.7479 | 37.7862 | 1,030 |
| 1,040 | 37.7862 | 37.8246 | 37.8629 | 37.9012 | 37.9396 | 37.9779 | 38.0162 | 38.0545 | 38.0928 | 38.1311 | 38.1694 | 1,040 |
| 1,050 | 38.1694 | 38.2077 | 38.2460 | 38.2842 | 38.3225 | 38.3608 | 38.3990 | 38.4373 | 38.4755 | 38.5138 | 38.5520 | 1,050 |
| 1,060 | 38.5520 | 38.5902 | 38.6285 | 38.6667 | 38.7049 | 38.7431 | 38.7813 | 38.8195 | 38.8577 | 38.8959 | 38.9340 | 1,060 |
| 1,070 | 38.9340 | 38.9722 | 39.0104 | 39.0485 | 39.0867 | 39.1248 | 39.1630 | 39.2011 | 39.2392 | 39.2773 | 39.3155 | 1,070 |
| 1,080 | 39.3155 | 39.3536 | 39.3917 | 39.4298 | 39.4678 | 39.5059 | 39.5440 | 39.5821 | 39.6201 | 39.6582 | 39.6962 | 1,080 |
| 1,090 | 39.6962 | 39.7343 | 39.7723 | 39.8104 | 39.8484 | 39.8864 | 39.9244 | 39.9624 | 40.0004 | 40.0384 | 40.0764 | 1,090 |
| 1,100 | 40.0764 | 40.1144 | 40.1523 | 40.1903 | 40.2282 | 40.2662 | 40.3041 | 40.3421 | 40.3800 | 40.4179 | 40.4558 | 1,100 |
| 1,110 | 40.4558 | 40.4938 | 40.5317 | 40.5695 | 40.6074 | 40.6453 | 40.6832 | 40.7211 | 40.7589 | 40.7968 | 40.8346 | 1,110 |
| 1,120 | 40.8346 | 40.8724 | 40.9103 | 40.9481 | 40.9859 | 41.0237 | 41.0615 | 41.0993 | 41.1371 | 41.1749 | 41.2126 | 1,120 |
| 1,130 | 41.2126 | 41.2504 | 41.2882 | 41.3259 | 41.3636 | 41.4014 | 41.4391 | 41.4768 | 41.5145 | 41.5522 | 41.5899 | 1,130 |
| 1,140 | 41.5899 | 41.6276 | 41.6653 | 41.7030 | 41.7406 | 41.7783 | 41.8159 | 41.8536 | 41.8912 | 41.9288 | 41.9664 | 1,140 |
| 1,150 | 41.9664 | 42.0040 | 42.0416 | 42.0792 | 42.1168 | 42.1544 | 42.1919 | 42.2295 | 42.2670 | 42.3046 | 42.3421 | 1,150 |
| 1,160 | 42.3421 | 42.3796 | 42.4171 | 42.4547 | 42.4922 | 42.5296 | 42.5671 | 42.6046 | 42.6421 | 42.6795 | 42.7170 | 1,160 |
| 1,170 | 42.7170 | 42.7544 | 42.7918 | 42.8292 | 42.8666 | 42.9041 | 42.9414 | 42.9788 | 43.0162 | 43.0536 | 43.0909 | 1,170 |
| 1,180 | 43.0909 | 43.1283 | 43.1656 | 43.2029 | 43.2403 | 43.2776 | 43.3149 | 43.3522 | 43.3895 | 43.4267 | 43.4640 | 1,180 |
| 1,190 | 43.4640 | 43.5012 | 43.5385 | 43.5757 | 43.6130 | 43.6502 | 43.6874 | 43.7246 | 43.7618 | 43.7990 | 43.8361 | 1,190 |
| 1,200 | 43.8361 | 43.8733 | 43.9104 | 43.9476 | 43.9847 | 44.0218 | 44.0589 | 44.0960 | 44.1331 | 44.1702 | 44.2073 | 1,200 |
| °C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °C |

**Table C2.** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°C), reference junctions at 0 °C*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,200 | 43.8361 | 43.8733 | 43.9104 | 43.9476 | 43.9847 | 44.0218 | 44.0589 | 44.0960 | 44.1331 | 44.1702 | 44.2073 | 1,200 |
| 1,210 | 44.2073 | 44.2444 | 44.2814 | 44.3185 | 44.3555 | 44.3925 | 44.4295 | 44.4665 | 44.5035 | 44.5405 | 44.5775 | 1,210 |
| 1,220 | 44.5775 | 44.6144 | 44.6514 | 44.6883 | 44.7253 | 44.7622 | 44.7991 | 44.8360 | 44.8729 | 44.9098 | 44.9467 | 1,220 |
| 1,230 | 44.9467 | 44.9835 | 45.0204 | 45.0572 | 45.0940 | 45.1309 | 45.1677 | 45.2045 | 45.2413 | 45.2780 | 45.3148 | 1,230 |
| 1,240 | 45.3148 | 45.3516 | 45.3883 | 45.4251 | 45.4618 | 45.4985 | 45.5352 | 45.5719 | 45.6086 | 45.6453 | 45.6819 | 1,240 |
| 1,250 | 45.6819 | 45.7186 | 45.7552 | 45.7918 | 45.8285 | 45.8651 | 45.9017 | 45.9383 | 45.9748 | 46.0114 | 46.0480 | 1,250 |
| 1,260 | 46.0480 | 46.0845 | 46.1211 | 46.1576 | 46.1941 | 46.2306 | 46.2671 | 46.3036 | 46.3401 | 46.3765 | 46.4130 | 1,260 |
| 1,270 | 46.4130 | 46.4494 | 46.4859 | 46.5223 | 46.5587 | 46.5951 | 46.6315 | 46.6679 | 46.7042 | 46.7406 | 46.7769 | 1,270 |
| 1,280 | 46.7769 | 46.8133 | 46.8496 | 46.8859 | 46.9222 | 46.9585 | 46.9948 | 47.0311 | 47.0674 | 47.1036 | 47.1399 | 1,280 |
| 1,290 | 47.1399 | 47.1761 | 47.2123 | 47.2486 | 47.2848 | 47.3210 | 47.3572 | 47.3933 | 47.4295 | 47.4657 | 47.5018 | 1,290 |
| 1,300 | 47.5018 |  |  |  |  |  |  |  |  |  |  | 1,300 |
| C | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | C |

TABLE C3. AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -450 | -4.3441 | | | | | | | | | | | -450 |
| -440 | -4.3389 | -4.3396 | -4.3403 | -4.3409 | -4.3415 | -4.3420 | -4.3425 | -4.3430 | -4.3434 | -4.3438 | -4.3441 | -440 |
| -430 | -4.3298 | -4.3309 | -4.3319 | -4.3329 | -4.3339 | -4.3348 | -4.3357 | -4.3366 | -4.3374 | -4.3382 | -4.3389 | -430 |
| -420 | -4.3165 | -4.3180 | -4.3195 | -4.3209 | -4.3223 | -4.3236 | -4.3249 | -4.3262 | -4.3274 | -4.3286 | -4.3298 | -420 |
| -410 | -4.2989 | -4.3009 | -4.3028 | -4.3046 | -4.3065 | -4.3082 | -4.3100 | -4.3117 | -4.3133 | -4.3149 | -4.3165 | -410 |
| -400 | -4.2770 | -4.2794 | -4.2818 | -4.2841 | -4.2863 | -4.2885 | -4.2907 | -4.2928 | -4.2949 | -4.2969 | -4.2989 | -400 |
| -390 | -4.2507 | -4.2536 | -4.2563 | -4.2591 | -4.2618 | -4.2644 | -4.2670 | -4.2696 | -4.2721 | -4.2746 | -4.2770 | -390 |
| -380 | -4.2200 | -4.2233 | -4.2265 | -4.2297 | -4.2328 | -4.2359 | -4.2390 | -4.2420 | -4.2450 | -4.2479 | -4.2507 | -380 |
| -370 | -4.1849 | -4.1886 | -4.1923 | -4.1959 | -4.1995 | -4.2030 | -4.2065 | -4.2100 | -4.2134 | -4.2167 | -4.2200 | -370 |
| -360 | -4.1455 | -4.1496 | -4.1537 | -4.1578 | -4.1618 | -4.1657 | -4.1697 | -4.1736 | -4.1774 | -4.1812 | -4.1849 | -360 |
| -350 | -4.1017 | -4.1062 | -4.1108 | -4.1153 | -4.1197 | -4.1241 | -4.1285 | -4.1328 | -4.1371 | -4.1413 | -4.1455 | -350 |
| -340 | -4.0536 | -4.0586 | -4.0635 | -4.0685 | -4.0733 | -4.0782 | -4.0829 | -4.0877 | -4.0924 | -4.0971 | -4.1017 | -340 |
| -330 | -4.0013 | -4.0067 | -4.0121 | -4.0174 | -4.0227 | -4.0280 | -4.0332 | -4.0384 | -4.0435 | -4.0486 | -4.0536 | -330 |
| -320 | -3.9449 | -3.9507 | -3.9565 | -3.9623 | -3.9680 | -3.9736 | -3.9792 | -3.9848 | -3.9904 | -3.9959 | -4.0013 | -320 |
| -310 | -3.8844 | -3.8906 | -3.8968 | -3.9030 | -3.9091 | -3.9152 | -3.9212 | -3.9272 | -3.9331 | -3.9390 | -3.9449 | -310 |
| -300 | -3.8199 | -3.8266 | -3.8332 | -3.8397 | -3.8462 | -3.8527 | -3.8591 | -3.8655 | -3.8718 | -3.8781 | -3.8844 | -300 |
| -290 | -3.7516 | -3.7586 | -3.7656 | -3.7725 | -3.7794 | -3.7862 | -3.7931 | -3.7998 | -3.8066 | -3.8133 | -3.8199 | -290 |
| -280 | -3.6794 | -3.6868 | -3.6941 | -3.7014 | -3.7087 | -3.7159 | -3.7231 | -3.7303 | -3.7374 | -3.7445 | -3.7516 | -280 |
| -270 | -3.6034 | -3.6112 | -3.6189 | -3.6266 | -3.6343 | -3.6419 | -3.6494 | -3.6570 | -3.6645 | -3.6719 | -3.6794 | -270 |
| -260 | -3.5238 | -3.5319 | -3.5400 | -3.5481 | -3.5561 | -3.5641 | -3.5720 | -3.5799 | -3.5878 | -3.5956 | -3.6034 | -260 |
| -250 | -3.4406 | -3.4491 | -3.4575 | -3.4659 | -3.4743 | -3.4827 | -3.4910 | -3.4992 | -3.5075 | -3.5157 | -3.5238 | -250 |
| -240 | -3.3539 | -3.3627 | -3.3715 | -3.3803 | -3.3890 | -3.3977 | -3.4064 | -3.4150 | -3.4236 | -3.4321 | -3.4406 | -240 |
| -230 | -3.2638 | -3.2730 | -3.2821 | -3.2912 | -3.3002 | -3.3093 | -3.3183 | -3.3272 | -3.3362 | -3.3451 | -3.3539 | -230 |
| -220 | -3.1703 | -3.1798 | -3.1893 | -3.1987 | -3.2081 | -3.2175 | -3.2268 | -3.2361 | -3.2454 | -3.2546 | -3.2638 | -220 |
| -210 | -3.0736 | -3.0834 | -3.0932 | -3.1030 | -3.1127 | -3.1224 | -3.1320 | -3.1416 | -3.1512 | -3.1608 | -3.1703 | -210 |
| -200 | -2.9737 | -2.9838 | -2.9939 | -3.0040 | -3.0140 | -3.0240 | -3.0340 | -3.0440 | -3.0539 | -3.0637 | -3.0736 | -200 |
| -190 | -2.8707 | -2.8812 | -2.8916 | -2.9019 | -2.9123 | -2.9226 | -2.9329 | -2.9431 | -2.9533 | -2.9635 | -2.9737 | -190 |
| -180 | -2.7647 | -2.7755 | -2.7862 | -2.7968 | -2.8075 | -2.8181 | -2.8287 | -2.8392 | -2.8498 | -2.8603 | -2.8707 | -180 |
| -170 | -2.6559 | -2.6669 | -2.6779 | -2.6888 | -2.6998 | -2.7107 | -2.7215 | -2.7324 | -2.7432 | -2.7540 | -2.7647 | -170 |
| -160 | -2.5442 | -2.5555 | -2.5667 | -2.5780 | -2.5892 | -2.6004 | -2.6115 | -2.6226 | -2.6337 | -2.6448 | -2.6559 | -160 |
| -150 | -2.4298 | -2.4413 | -2.4529 | -2.4644 | -2.4758 | -2.4873 | -2.4987 | -2.5101 | -2.5215 | -2.5328 | -2.5442 | -150 |
| -140 | -2.3127 | -2.3246 | -2.3364 | -2.3481 | -2.3599 | -2.3716 | -2.3833 | -2.3949 | -2.4066 | -2.4182 | -2.4298 | -140 |
| -130 | -2.1932 | -2.2053 | -2.2173 | -2.2293 | -2.2413 | -2.2533 | -2.2652 | -2.2771 | -2.2890 | -2.3009 | -2.3127 | -130 |
| -120 | -2.0713 | -2.0836 | -2.0959 | -2.1081 | -2.1203 | -2.1325 | -2.1447 | -2.1569 | -2.1690 | -2.1811 | -2.1932 | -120 |
| -110 | -1.9471 | -1.9596 | -1.9721 | -1.9846 | -1.9970 | -2.0095 | -2.0219 | -2.0343 | -2.0466 | -2.0590 | -2.0713 | -110 |
| -100 | -1.8207 | -1.8334 | -1.8461 | -1.8588 | -1.8715 | -1.8841 | -1.8968 | -1.9094 | -1.9220 | -1.9345 | -1.9471 | -100 |
| -90 | -1.6922 | -1.7051 | -1.7180 | -1.7309 | -1.7438 | -1.7567 | -1.7695 | -1.7823 | -1.7951 | -1.8079 | -1.8207 | -90 |
| -80 | -1.5617 | -1.5749 | -1.5880 | -1.6011 | -1.6141 | -1.6272 | -1.6402 | -1.6532 | -1.6662 | -1.6792 | -1.6922 | -80 |
| -70 | -1.4294 | -1.4427 | -1.4560 | -1.4693 | -1.4826 | -1.4958 | -1.5090 | -1.5222 | -1.5354 | -1.5486 | -1.5617 | -70 |
| -60 | -1.2954 | -1.3089 | -1.3223 | -1.3358 | -1.3492 | -1.3626 | -1.3760 | -1.3894 | -1.4028 | -1.4161 | -1.4294 | -60 |
| -50 | -1.1597 | -1.1734 | -1.1870 | -1.2006 | -1.2142 | -1.2278 | -1.2413 | -1.2549 | -1.2684 | -1.2819 | -1.2954 | -50 |
| -40 | -1.0226 | -1.0364 | -1.0501 | -1.0639 | -1.0776 | -1.0913 | -1.1051 | -1.1187 | -1.1324 | -1.1461 | -1.1597 | -40 |
| -30 | -0.8840 | -0.8979 | -0.9118 | -0.9257 | -0.9396 | -0.9535 | -0.9673 | -0.9812 | -0.9950 | -1.0088 | -1.0226 | -30 |
| -20 | -0.7442 | -0.7582 | -0.7722 | -0.7862 | -0.8002 | -0.8142 | -0.8282 | -0.8422 | -0.8561 | -0.8701 | -0.8840 | -20 |
| -10 | -0.6031 | -0.6173 | -0.6314 | -0.6455 | -0.6597 | -0.6738 | -0.6879 | -0.7020 | -0.7160 | -0.7301 | -0.7442 | -10 |
| - 0 | -0.4610 | -0.4752 | -0.4895 | -0.5037 | -0.5179 | -0.5322 | -0.5464 | -0.5606 | -0.5748 | -0.5889 | -0.6031 | - 0 |
| + 0 | -0.4610 | -0.4467 | -0.4324 | -0.4181 | -0.4038 | -0.3895 | -0.3752 | -0.3609 | -0.3465 | -0.3322 | -0.3179 | + 0 |
| 10 | -0.3179 | -0.3035 | -0.2891 | -0.2747 | -0.2603 | -0.2460 | -0.2315 | -0.2171 | -0.2027 | -0.1883 | -0.1738 | 10 |
| 20 | -0.1738 | -0.1594 | -0.1449 | -0.1305 | -0.1160 | -0.1015 | -0.0871 | -0.0726 | -0.0581 | -0.0436 | -0.0290 | 20 |
| 30 | -0.0290 | -0.0145 | 0.0000 | | | | | | | | | 30 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C3.** AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | 0.0000 | 0.0145 | 0.0291 | 0.0436 | 0.0582 | 0.0727 | 0.0873 | 0.1019 | 0.1164 | 30 |
| 40 | 0.1164 | 0.1310 | 0.1456 | 0.1602 | 0.1748 | 0.1894 | 0.2040 | 0.2187 | 0.2333 | 0.2479 | 0.2626 | 40 |
| 50 | 0.2626 | 0.2773 | 0.2919 | 0.3066 | 0.3213 | 0.3360 | 0.3507 | 0.3654 | 0.3801 | 0.3948 | 0.4095 | 50 |
| 60 | 0.4095 | 0.4243 | 0.4390 | 0.4538 | 0.4686 | 0.4834 | 0.4981 | 0.5129 | 0.5278 | 0.5426 | 0.5574 | 60 |
| 70 | 0.5574 | 0.5722 | 0.5871 | 0.6019 | 0.6168 | 0.6317 | 0.6466 | 0.6615 | 0.6764 | 0.6913 | 0.7062 | 70 |
| 80 | 0.7062 | 0.7212 | 0.7361 | 0.7511 | 0.7660 | 0.7810 | 0.7960 | 0.8110 | 0.8260 | 0.8410 | 0.8561 | 80 |
| 90 | 0.8561 | 0.8711 | 0.8862 | 0.9013 | 0.9163 | 0.9314 | 0.9465 | 0.9616 | 0.9768 | 0.9919 | 1.0071 | 90 |
| 100 | 1.0071 | 1.0222 | 1.0374 | 1.0526 | 1.0678 | 1.0830 | 1.0982 | 1.1134 | 1.1287 | 1.1439 | 1.1592 | 100 |
| 110 | 1.1592 | 1.1745 | 1.1897 | 1.2050 | 1.2204 | 1.2357 | 1.2510 | 1.2664 | 1.2817 | 1.2971 | 1.3125 | 110 |
| 120 | 1.3125 | 1.3279 | 1.3433 | 1.3587 | 1.3741 | 1.3896 | 1.4050 | 1.4205 | 1.4360 | 1.4515 | 1.4670 | 120 |
| 130 | 1.4670 | 1.4825 | 1.4980 | 1.5136 | 1.5291 | 1.5447 | 1.5603 | 1.5759 | 1.5915 | 1.6071 | 1.6227 | 130 |
| 140 | 1.6227 | 1.6384 | 1.6540 | 1.6697 | 1.6854 | 1.7011 | 1.7168 | 1.7325 | 1.7482 | 1.7640 | 1.7797 | 140 |
| 150 | 1.7797 | 1.7955 | 1.8113 | 1.8270 | 1.8428 | 1.8587 | 1.8745 | 1.8903 | 1.9062 | 1.9221 | 1.9379 | 150 |
| 160 | 1.9379 | 1.9538 | 1.9697 | 1.9856 | 2.0016 | 2.0175 | 2.0335 | 2.0494 | 2.0654 | 2.0814 | 2.0974 | 160 |
| 170 | 2.0974 | 2.1134 | 2.1294 | 2.1455 | 2.1615 | 2.1776 | 2.1937 | 2.2098 | 2.2259 | 2.2420 | 2.2581 | 170 |
| 180 | 2.2581 | 2.2742 | 2.2904 | 2.3066 | 2.3227 | 2.3389 | 2.3551 | 2.3713 | 2.3876 | 2.4038 | 2.4200 | 180 |
| 190 | 2.4200 | 2.4363 | 2.4526 | 2.4689 | 2.4852 | 2.5015 | 2.5178 | 2.5341 | 2.5505 | 2.5668 | 2.5832 | 190 |
| 200 | 2.5832 | 2.5996 | 2.6160 | 2.6324 | 2.6488 | 2.6652 | 2.6817 | 2.6981 | 2.7146 | 2.7311 | 2.7476 | 200 |
| 210 | 2.7476 | 2.7641 | 2.7806 | 2.7971 | 2.8136 | 2.8302 | 2.8468 | 2.8633 | 2.8799 | 2.8965 | 2.9131 | 210 |
| 220 | 2.9131 | 2.9297 | 2.9464 | 2.9630 | 2.9797 | 2.9963 | 3.0130 | 3.0297 | 3.0464 | 3.0631 | 3.0798 | 220 |
| 230 | 3.0798 | 3.0966 | 3.1133 | 3.1301 | 3.1468 | 3.1636 | 3.1804 | 3.1972 | 3.2140 | 3.2308 | 3.2477 | 230 |
| 240 | 3.2477 | 3.2645 | 3.2814 | 3.2983 | 3.3151 | 3.2320 | 3.3489 | 3.3659 | 3.3828 | 3.3997 | 3.4167 | 240 |
| 250 | 3.4167 | 3.4336 | 3.4506 | 3.4676 | 3.4846 | 3.5016 | 3.5186 | 3.5356 | 3.5526 | 3.5697 | 3.5868 | 250 |
| 260 | 3.5868 | 3.6038 | 3.6209 | 3.6380 | 3.6551 | 3.6722 | 3.6893 | 3.7065 | 3.7236 | 3.7408 | 3.7579 | 260 |
| 270 | 3.7579 | 3.7751 | 3.7923 | 3.8095 | 3.8267 | 3.8439 | 3.8611 | 3.8784 | 3.8956 | 3.9129 | 3.9301 | 270 |
| 280 | 3.9301 | 3.9474 | 3.9647 | 3.9820 | 3.9993 | 4.0167 | 4.0340 | 4.0513 | 4.0687 | 4.0860 | 4.1034 | 280 |
| 290 | 4.1034 | 4.1208 | 4.1382 | 4.1556 | 4.1730 | 4.1904 | 4.2079 | 4.2253 | 4.2428 | 4.2602 | 4.2777 | 290 |
| 300 | 4.2777 | 4.2952 | 4.3127 | 4.3302 | 4.3477 | 4.3652 | 4.3827 | 4.4003 | 4.4178 | 4.4354 | 4.4530 | 300 |
| 310 | 4.4530 | 4.4706 | 4.4881 | 4.5057 | 4.5234 | 4.5410 | 4.5586 | 4.5763 | 4.5939 | 4.6116 | 4.6292 | 310 |
| 320 | 4.6292 | 4.6469 | 4.6646 | 4.6823 | 4.7000 | 4.7177 | 4.7354 | 4.7532 | 4.7709 | 4.7887 | 4.8064 | 320 |
| 330 | 4.8064 | 4.8242 | 4.8420 | 4.8598 | 4.8776 | 4.8954 | 4.9132 | 4.9310 | 4.9489 | 4.9667 | 4.9846 | 330 |
| 340 | 4.9846 | 5.0025 | 5.0203 | 5.0382 | 5.0561 | 5.0740 | 5.0919 | 5.1098 | 5.1278 | 5.1457 | 5.1637 | 340 |
| 350 | 5.1637 | 5.1816 | 5.1996 | 5.2176 | 5.2355 | 5.2535 | 5.2715 | 5.2896 | 5.3076 | 5.3256 | 5.3436 | 350 |
| 360 | 5.3436 | 5.3617 | 5.3797 | 5.3978 | 5.4159 | 5.4340 | 5.4521 | 5.4702 | 5.4883 | 5.5064 | 5.5245 | 360 |
| 370 | 5.5245 | 5.5426 | 5.5608 | 5.5789 | 5.5971 | 5.6153 | 5.6334 | 5.6516 | 5.6698 | 5.6880 | 5.7062 | 370 |
| 380 | 5.7062 | 5.7245 | 5.7427 | 5.7609 | 5.7792 | 5.7974 | 5.8157 | 5.8340 | 5.8523 | 5.8705 | 5.8888 | 380 |
| 390 | 5.8888 | 5.9072 | 5.9255 | 5.9438 | 5.9621 | 5.9805 | 5.9988 | 6.0172 | 6.0355 | 6.0539 | 6.0723 | 390 |
| 400 | 6.0723 | 6.0907 | 6.1091 | 6.1275 | 6.1459 | 6.1643 | 6.1828 | 6.2012 | 6.2197 | 6.2381 | 6.2566 | 400 |
| 410 | 6.2566 | 6.2751 | 6.2935 | 6.3120 | 6.3305 | 6.3490 | 6.3676 | 6.3861 | 6.4046 | 6.4231 | 6.4417 | 410 |
| 420 | 6.4417 | 6.4603 | 6.4788 | 6.4974 | 6.5160 | 6.5346 | 6.5532 | 6.5718 | 6.5904 | 6.6090 | 6.6276 | 420 |
| 430 | 6.6276 | 6.6463 | 6.6649 | 6.6836 | 6.7022 | 6.7209 | 6.7396 | 6.7582 | 6.7769 | 6.7956 | 6.8143 | 430 |
| 440 | 6.8143 | 6.8331 | 6.8518 | 6.8705 | 6.8893 | 6.9080 | 6.9268 | 6.9455 | 6.9643 | 6.9831 | 7.0019 | 440 |
| 450 | 7.0019 | 7.0207 | 7.0395 | 7.0583 | 7.0771 | 7.0959 | 7.1148 | 7.1336 | 7.1524 | 7.1713 | 7.1902 | 450 |
| 460 | 7.1902 | 7.2090 | 7.2279 | 7.2468 | 7.2657 | 7.2846 | 7.3035 | 7.3224 | 7.3414 | 7.3603 | 7.3792 | 460 |
| 470 | 7.3792 | 7.3982 | 7.4171 | 7.4361 | 7.4551 | 7.4741 | 7.4931 | 7.5120 | 7.5310 | 7.5501 | 7.5691 | 470 |
| 480 | 7.5691 | 7.5881 | 7.6071 | 7.6262 | 7.6452 | 7.6643 | 7.6833 | 7.7024 | 7.7215 | 7.7406 | 7.7597 | 480 |
| 490 | 7.7597 | 7.7788 | 7.7979 | 7.8170 | 7.8361 | 7.8552 | 7.8744 | 7.8935 | 7.9127 | 7.9318 | 7.9510 | 490 |
| 500 | 7.9510 | 7.9702 | 7.9893 | 8.0085 | 8.0277 | 8.0469 | 8.0661 | 8.0854 | 8.1046 | 8.1238 | 8.1431 | 500 |
| 510 | 8.1431 | 8.1623 | 8.1816 | 8.2008 | 8.2201 | 8.2394 | 8.2586 | 8.2779 | 8.2972 | 8.3165 | 8.3358 | 510 |
| 520 | 8.3358 | 8.3551 | 8.3745 | 8.3938 | 8.4131 | 8.4325 | 8.4518 | 8.4712 | 8.4906 | 8.5099 | 8.5293 | 520 |
| 530 | 8.5293 | 8.5487 | 8.5681 | 8.5875 | 8.6069 | 8.6263 | 8.6457 | 8.6652 | 8.6846 | 8.7040 | 8.7235 | 530 |
| 540 | 8.7235 | 8.7430 | 8.7624 | 8.7819 | 8.8014 | 8.8208 | 8.8403 | 8.8598 | 8.8793 | 8.8988 | 8.9184 | 540 |
| 550 | 8.9184 | 8.9379 | 8.9574 | 8.9769 | 8.9965 | 9.0160 | 9.0356 | 9.0552 | 9.0747 | 9.0943 | 9.1139 | 550 |
| 560 | 9.1139 | 9.1335 | 9.1531 | 9.1727 | 9.1923 | 9.2119 | 9.2315 | 9.2512 | 9.2708 | 9.2904 | 9.3101 | 560 |
| 570 | 9.3101 | 9.3297 | 9.3494 | 9.3691 | 9.3887 | 9.4084 | 9.4281 | 9.4478 | 9.4675 | 9.4872 | 9.5069 | 570 |
| 580 | 9.5069 | 9.5266 | 9.5463 | 9.5661 | 9.5858 | 9.6055 | 9.6253 | 9.6450 | 9.6648 | 9.6846 | 9.7043 | 580 |
| 590 | 9.7043 | 9.7241 | 9.7439 | 9.7637 | 9.7835 | 9.8033 | 9.8231 | 9.8429 | 9.8627 | 9.8826 | 9.9024 | 590 |
| 600 | 9.9024 | 9.9222 | 9.9421 | 9.9619 | 9.9818 | 10.0016 | 10.0215 | 10.0414 | 10.0613 | 10.0811 | 10.1010 | 600 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

Table C3. AWG 28 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 600 | 9.9024 | 9.9222 | 9.9421 | 9.9619 | 9.9818 | 10.0016 | 10.0215 | 10.0414 | 10.0613 | 10.0811 | 10.1010 | 600 |
| 610 | 10.1010 | 10.1209 | 10.1408 | 10.1607 | 10.1807 | 10.2006 | 10.2205 | 10.2404 | 10.2604 | 10.2803 | 10.3002 | 610 |
| 620 | 10.3002 | 10.3202 | 10.3402 | 10.3601 | 10.3801 | 10.4001 | 10.4200 | 10.4400 | 10.4600 | 10.4800 | 10.5000 | 620 |
| 630 | 10.5000 | 10.5200 | 10.5400 | 10.5600 | 10.5801 | 10.6001 | 10.6201 | 10.6402 | 10.6602 | 10.6803 | 10.7003 | 630 |
| 640 | 10.7003 | 10.7204 | 10.7404 | 10.7605 | 10.7806 | 10.8007 | 10.8207 | 10.8408 | 10.8609 | 10.8810 | 10.9011 | 640 |
| 650 | 10.9011 | 10.9212 | 10.9414 | 10.9615 | 10.9816 | 11.0017 | 11.0219 | 11.0420 | 11.0621 | 11.0823 | 11.1024 | 650 |
| 660 | 11.1024 | 11.1226 | 11.1428 | 11.1629 | 11.1831 | 11.2033 | 11.2235 | 11.2437 | 11.2638 | 11.2840 | 11.3042 | 660 |
| 670 | 11.3042 | 11.3245 | 11.3447 | 11.3649 | 11.3851 | 11.4053 | 11.4255 | 11.4458 | 11.4660 | 11.4863 | 11.5065 | 670 |
| 680 | 11.5065 | 11.5268 | 11.5470 | 11.5673 | 11.5875 | 11.6078 | 11.6281 | 11.6484 | 11.6686 | 11.6889 | 11.7092 | 680 |
| 690 | 11.7092 | 11.7295 | 11.7498 | 11.7701 | 11.7904 | 11.8107 | 11.8311 | 11.8514 | 11.8717 | 11.8920 | 11.9124 | 690 |
| 700 | 11.9124 | 11.9327 | 11.9531 | 11.9734 | 11.9938 | 12.0141 | 12.0345 | 12.0548 | 12.0752 | 12.0956 | 12.1160 | 700 |
| 710 | 12.1160 | 12.1363 | 12.1567 | 12.1771 | 12.1975 | 12.2179 | 12.2383 | 12.2587 | 12.2791 | 12.2995 | 12.3200 | 710 |
| 720 | 12.3200 | 12.3404 | 12.3608 | 12.3812 | 12.4017 | 12.4221 | 12.4425 | 12.4630 | 12.4834 | 12.5039 | 12.5244 | 720 |
| 730 | 12.5244 | 12.5448 | 12.5653 | 12.5858 | 12.6062 | 12.6267 | 12.6472 | 12.6677 | 12.6882 | 12.7087 | 12.7292 | 730 |
| 740 | 12.7292 | 12.7497 | 12.7702 | 12.7907 | 12.8112 | 12.8317 | 12.8523 | 12.8728 | 12.8933 | 12.9139 | 12.9344 | 740 |
| 750 | 12.9344 | 12.9549 | 12.9755 |  |  |  |  |  |  |  |  | 750 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**TABLE C4.** AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F. Abbreviated table.*

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS | | | | | | | | | | | |
| 30 | | | 0.0000 | 0.0144 | 0.0288 | 0.0432 | 0.0576 | 0.0721 | 0.0865 | 0.1010 | 0.1154 | 30 |
| 40 | 0.1154 | 0.1299 | 0.1444 | 0.1589 | 0.1734 | 0.1879 | 0.2024 | 0.2170 | 0.2315 | 0.2461 | 0.2607 | 40 |
| 50 | 0.2607 | 0.2753 | 0.2898 | 0.3045 | 0.3191 | 0.3337 | 0.3483 | 0.3630 | 0.3776 | 0.3923 | 0.4070 | 50 |
| 60 | 0.4070 | 0.4217 | 0.4364 | 0.4511 | 0.4658 | 0.4806 | 0.4953 | 0.5101 | 0.5248 | 0.5396 | 0.5544 | 60 |
| 70 | 0.5544 | 0.5692 | 0.5840 | 0.5989 | 0.6137 | 0.6285 | 0.6434 | 0.6583 | 0.6732 | 0.6881 | 0.7030 | 70 |
| 80 | 0.7030 | 0.7179 | 0.7328 | 0.7477 | 0.7627 | 0.7777 | 0.7926 | 0.8076 | 0.8226 | 0.8376 | 0.8526 | 80 |
| 90 | 0.8526 | 0.8677 | 0.8827 | 0.8978 | 0.9128 | 0.9279 | 0.9430 | 0.9581 | 0.9732 | 0.9884 | 1.0035 | 90 |
| 100 | 1.0035 | 1.0186 | 1.0338 | 1.0490 | 1.0642 | 1.0793 | 1.0946 | 1.1098 | 1.1250 | 1.1402 | 1.1555 | 100 |
| 110 | 1.1555 | 1.1708 | 1.1860 | 1.2013 | 1.2166 | 1.2319 | 1.2473 | 1.2626 | 1.2780 | 1.2933 | 1.3087 | 110 |
| 120 | 1.3087 | 1.3241 | 1.3395 | 1.3549 | 1.3703 | 1.3857 | 1.4012 | 1.4166 | 1.4321 | 1.4476 | 1.4631 | 120 |
| 130 | 1.4631 | 1.4786 | 1.4941 | 1.5096 | 1.5251 | 1.5407 | 1.5562 | 1.5718 | 1.5874 | 1.6030 | 1.6186 | 130 |
| 140 | 1.6186 | 1.6342 | 1.6499 | 1.6655 | 1.6812 | 1.6968 | 1.7125 | 1.7282 | 1.7439 | 1.7596 | 1.7753 | 140 |
| 150 | 1.7753 | 1.7911 | 1.8068 | 1.8226 | 1.8384 | 1.8542 | 1.8700 | 1.8858 | 1.9016 | 1.9174 | 1.9333 | 150 |
| 160 | 1.9333 | 1.9491 | 1.9650 | 1.9809 | 1.9968 | 2.0127 | 2.0286 | 2.0445 | 2.0605 | 2.0764 | 2.0924 | 160 |
| 170 | 2.0924 | 2.1084 | 2.1244 | 2.1404 | 2.1564 | 2.1724 | 2.1884 | 2.2045 | 2.2205 | 2.2366 | 2.2527 | 170 |
| 180 | 2.2527 | 2.2688 | 2.2849 | 2.3010 | 2.3172 | 2.3333 | 2.3494 | 2.3656 | 2.3818 | 2.3980 | 2.4142 | 180 |
| 190 | 2.4142 | 2.4304 | 2.4466 | 2.4629 | 2.4791 | 2.4954 | 2.5116 | 2.5279 | 2.5442 | 2.5605 | 2.5768 | 190 |
| 200 | 2.5768 | 2.5932 | 2.6095 | 2.6259 | 2.6422 | 2.6586 | 2.6750 | 2.6914 | 2.7078 | 2.7242 | 2.7407 | 200 |
| 210 | 2.7407 | 2.7571 | 2.7736 | 2.7900 | 2.8065 | 2.8230 | 2.8395 | 2.8560 | 2.8726 | 2.8891 | 2.9056 | 210 |
| 220 | 2.9056 | 2.9222 | 2.9388 | 2.9554 | 2.9720 | 2.9886 | 3.0052 | 3.0218 | 3.0385 | 3.0551 | 3.0718 | 220 |
| 230 | 3.0718 | 3.0884 | 3.1051 | 3.1218 | 3.1385 | 3.1553 | 3.1720 | 3.1887 | 3.2055 | 3.2223 | 3.2390 | 230 |
| 240 | 3.2390 | 3.2558 | 3.2726 | 3.2894 | 3.3063 | 3.3231 | 3.3399 | 3.3568 | 3.3737 | 3.3905 | 3.4074 | 240 |
| 250 | 3.4074 | 3.4243 | 3.4412 | 3.4582 | 3.4751 | 3.4920 | 3.5090 | 3.5260 | 3.5429 | 3.5599 | 3.5769 | 250 |
| 260 | 3.5769 | 3.5939 | 3.6110 | 3.6280 | 3.6450 | 3.6621 | 3.6792 | 3.6962 | 3.7133 | 3.7304 | 3.7475 | 260 |
| 270 | 3.7475 | 3.7647 | 3.7818 | 3.7989 | 3.8161 | 3.8333 | 3.8504 | 3.8676 | 3.8848 | 3.9020 | 3.9192 | 270 |
| 280 | 3.9192 | 3.9365 | 3.9537 | 3.9710 | 3.9882 | 4.0055 | 4.0228 | 4.0401 | 4.0574 | 4.0747 | 4.0920 | 280 |
| 290 | 4.0920 | 4.1093 | 4.1267 | 4.1440 | 4.1614 | 4.1788 | 4.1962 | 4.2136 | 4.2310 | 4.2484 | 4.2658 | 290 |
| 300 | 4.2658 | 4.2833 | 4.3007 | 4.3182 | 4.3357 | 4.3531 | 4.3706 | 4.3881 | 4.4056 | 4.4232 | 4.4407 | 300 |
| 310 | 4.4407 | 4.4582 | 4.4758 | 4.4934 | 4.5109 | 4.5285 | 4.5461 | 4.5637 | 4.5813 | 4.5990 | 4.6166 | 310 |
| 320 | 4.6166 | 4.6342 | 4.6519 | 4.6696 | 4.6872 | 4.7049 | 4.7226 | 4.7403 | 4.7580 | 4.7758 | 4.7935 | 320 |
| 330 | 4.7935 | 4.8112 | 4.8290 | 4.8468 | 4.8645 | 4.8823 | 4.9001 | 4.9179 | 4.9357 | 4.9536 | 4.9714 | 330 |
| 340 | 4.9714 | 4.9893 | 5.0071 | 5.0250 | 5.0428 | 5.0607 | 5.0786 | 5.0965 | 5.1144 | 5.1324 | 5.1503 | 340 |
| 350 | 5.1503 | 5.1682 | 5.1862 | 5.2041 | 5.2221 | 5.2401 | 5.2581 | 5.2761 | 5.2941 | 5.3121 | 5.3301 | 350 |
| 360 | 5.3301 | 5.3482 | 5.3662 | 5.3843 | 5.4023 | 5.4204 | 5.4385 | 5.4566 | 5.4747 | 5.4928 | 5.5109 | 360 |
| 370 | 5.5109 | 5.5291 | 5.5472 | 5.5654 | 5.5835 | 5.6017 | 5.6199 | 5.6380 | 5.6562 | 5.6744 | 5.6927 | 370 |
| 380 | 5.6927 | 5.7109 | 5.7291 | 5.7474 | 5.7656 | 5.7839 | 5.8021 | 5.8204 | 5.8387 | 5.8570 | 5.8753 | 380 |
| 390 | 5.8753 | 5.8936 | 5.9119 | 5.9303 | 5.9486 | 5.9669 | 5.9853 | 6.0037 | 6.0220 | 6.0404 | 6.0588 | 390 |
| 400 | 6.0588 | 6.0772 | 6.0956 | 6.1141 | 6.1325 | 6.1509 | 6.1694 | 6.1878 | 6.2063 | 6.2248 | 6.2432 | 400 |
| 410 | 6.2432 | 6.2617 | 6.2802 | 6.2987 | 6.3173 | 6.3358 | 6.3543 | 6.3728 | 6.3914 | 6.4100 | 6.4285 | 410 |
| 420 | 6.4285 | 6.4471 | 6.4657 | 6.4843 | 6.5029 | 6.5215 | 6.5401 | 6.5587 | 6.5774 | 6.5960 | 6.6146 | 420 |
| 430 | 6.6146 | 6.6333 | 6.6520 | 6.6707 | 6.6893 | 6.7080 | 6.7267 | 6.7454 | 6.7642 | 6.7829 | 6.8016 | 430 |
| 440 | 6.8016 | 6.8203 | 6.8391 | 6.8579 | 6.8766 | 6.8954 | 6.9142 | 6.9330 | 6.9518 | 6.9706 | 6.9894 | 440 |
| 450 | 6.9894 | 7.0082 | 7.0270 | 7.0459 | 7.0647 | 7.0836 | 7.1024 | 7.1213 | 7.1402 | 7.1591 | 7.1780 | 450 |
| 460 | 7.1780 | 7.1969 | 7.2158 | 7.2347 | 7.2536 | 7.2725 | 7.2915 | 7.3104 | 7.3294 | 7.3483 | 7.3673 | 460 |
| 470 | 7.3673 | 7.3863 | 7.4053 | 7.4243 | 7.4433 | 7.4623 | 7.4813 | 7.5003 | 7.5194 | 7.5384 | 7.5574 | 470 |
| 480 | 7.5574 | 7.5765 | 7.5956 | 7.6146 | 7.6337 | 7.6528 | 7.6719 | 7.6910 | 7.7101 | 7.7292 | 7.7483 | 480 |
| 490 | 7.7483 | 7.7674 | 7.7866 | 7.8057 | 7.8249 | 7.8440 | 7.8632 | 7.8824 | 7.9016 | 7.9207 | 7.9399 | 490 |
| 500 | 7.9399 | 7.9591 | 7.9783 | 7.9976 | 8.0168 | 8.0360 | 8.0553 | 8.0745 | 8.0938 | 8.1130 | 8.1323 | 500 |
| 510 | 8.1323 | 8.1516 | 8.1708 | 8.1901 | 8.2094 | 8.2287 | 8.2480 | 8.2673 | 8.2867 | 8.3060 | 8.3253 | 510 |
| 520 | 8.3253 | 8.3447 | 8.3640 | 8.3834 | 8.4027 | 8.4221 | 8.4415 | 8.4609 | 8.4803 | 8.4997 | 8.5191 | 520 |
| 530 | 8.5191 | 8.5385 | 8.5579 | 8.5773 | 8.5968 | 8.6162 | 8.6356 | 8.6551 | 8.6746 | 8.6940 | 8.7135 | 530 |
| 540 | 8.7135 | 8.7330 | 8.7525 | 8.7719 | 8.7914 | 8.8110 | 8.8305 | 8.8500 | 8.8695 | 8.8890 | 8.9086 | 540 |
| 550 | 8.9086 | 8.9281 | 8.9477 | 8.9672 | 8.9868 | 9.0064 | 9.0259 | 9.0455 | 9.0651 | 9.0847 | 9.1043 | 550 |
| 560 | 9.1043 | 9.1239 | 9.1435 | 9.1632 | 9.1828 | 9.2024 | 9.2221 | 9.2417 | 9.2614 | 9.2810 | 9.3007 | 560 |
| 570 | 9.3007 | 9.3204 | 9.3400 | 9.3597 | 9.3794 | 9.3991 | 9.4188 | 9.4385 | 9.4582 | 9.4780 | 9.4977 | 570 |
| 580 | 9.4977 | 9.5174 | 9.5372 | 9.5569 | 9.5767 | 9.5964 | 9.6162 | 9.6360 | 9.6557 | 9.6755 | 9.6953 | 580 |
| 590 | 9.6953 | 9.7151 | 9.7349 | 9.7547 | 9.7745 | 9.7943 | 9.8142 | 9.8340 | 9.8538 | 9.8737 | 9.8935 | 590 |
| 600 | 9.8935 | 9.9134 | 9.9332 | 9.9531 | 9.9730 | 9.9929 | 10.0127 | 10.0326 | 10.0525 | 10.0724 | 10.0923 | 600 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

Table C4. AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS | | | | | | | | | | | |
| 600 | 9.8935 | 9.9134 | 9.9332 | 9.9531 | 9.9730 | 9.9929 | 10.0127 | 10.0326 | 10.0525 | 10.0724 | 10.0923 | 600 |
| 610 | 10.0923 | 10.1122 | 10.1322 | 10.1521 | 10.1720 | 10.1920 | 10.2119 | 10.2318 | 10.2518 | 10.2717 | 10.2917 | 610 |
| 620 | 10.2917 | 10.3117 | 10.3317 | 10.3516 | 10.3716 | 10.3916 | 10.4116 | 10.4316 | 10.4516 | 10.4716 | 10.4917 | 620 |
| 630 | 10.4917 | 10.5117 | 10.5317 | 10.5517 | 10.5718 | 10.5918 | 10.6119 | 10.6319 | 10.6520 | 10.6721 | 10.6921 | 630 |
| 640 | 10.6921 | 10.7122 | 10.7323 | 10.7524 | 10.7725 | 10.7926 | 10.8127 | 10.8328 | 10.8529 | 10.8731 | 10.8932 | 640 |
| 650 | 10.8932 | 10.9133 | 10.9335 | 10.9536 | 10.9737 | 10.9939 | 11.0141 | 11.0342 | 11.0544 | 11.0746 | 11.0947 | 650 |
| 660 | 11.0947 | 11.1149 | 11.1351 | 11.1553 | 11.1755 | 11.1957 | 11.2159 | 11.2362 | 11.2564 | 11.2766 | 11.2968 | 660 |
| 670 | 11.2968 | 11.3171 | 11.3373 | 11.3576 | 11.3778 | 11.3981 | 11.4183 | 11.4386 | 11.4589 | 11.4791 | 11.4994 | 670 |
| 680 | 11.4994 | 11.5197 | 11.5400 | 11.5603 | 11.5806 | 11.6009 | 11.6212 | 11.6415 | 11.6619 | 11.6822 | 11.7025 | 680 |
| 690 | 11.7025 | 11.7229 | 11.7432 | 11.7635 | 11.7839 | 11.8042 | 11.8246 | 11.8450 | 11.8653 | 11.8857 | 11.9061 | 690 |
| 700 | 11.9061 | 11.9265 | 11.9469 | 11.9673 | 11.9877 | 12.0081 | 12.0285 | 12.0489 | 12.0693 | 12.0897 | 12.1101 | 700 |
| 710 | 12.1101 | 12.1306 | 12.1510 | 12.1715 | 12.1919 | 12.2123 | 12.2328 | 12.2533 | 12.2737 | 12.2942 | 12.3147 | 710 |
| 720 | 12.3147 | 12.3351 | 12.3556 | 12.3761 | 12.3966 | 12.4171 | 12.4376 | 12.4581 | 12.4786 | 12.4991 | 12.5196 | 720 |
| 730 | 12.5196 | 12.5402 | 12.5607 | 12.5812 | 12.6018 | 12.6223 | 12.6428 | 12.6634 | 12.6840 | 12.7045 | 12.7251 | 730 |
| 740 | 12.7251 | 12.7456 | 12.7662 | 12.7868 | 12.8074 | 12.8280 | 12.8485 | 12.8691 | 12.8897 | 12.9103 | 12.9309 | 740 |
| 750 | 12.9309 | 12.9515 | 12.9722 | 12.9928 | 13.0134 | 13.0340 | 13.0547 | 13.0753 | 13.0959 | 13.1166 | 13.1372 | 750 |
| 760 | 13.1372 | 13.1579 | 13.1785 | 13.1992 | 13.2199 | 13.2405 | 13.2612 | 13.2819 | 13.3026 | 13.3233 | 13.3440 | 760 |
| 770 | 13.3440 | 13.3646 | 13.3853 | 13.4060 | 13.4268 | 13.4475 | 13.4682 | 13.4889 | 13.5096 | 13.5304 | 13.5511 | 770 |
| 780 | 13.5511 | 13.5718 | 13.5926 | 13.6133 | 13.6340 | 13.6548 | 13.6756 | 13.6963 | 13.7171 | 13.7378 | 13.7586 | 780 |
| 790 | 13.7586 | 13.7794 | 13.8002 | 13.8210 | 13.8417 | 13.8625 | 13.8833 | 13.9041 | 13.9249 | 13.9457 | 13.9665 | 790 |
| 800 | 13.9665 | 13.9874 | 14.0082 | 14.0290 | 14.0498 | 14.0707 | 14.0915 | 14.1123 | 14.1332 | 14.1540 | 14.1749 | 800 |
| 810 | 14.1749 | 14.1957 | 14.2166 | 14.2374 | 14.2583 | 14.2792 | 14.3000 | 14.3209 | 14.3418 | 14.3627 | 14.3836 | 810 |
| 820 | 14.3836 | 14.4044 | 14.4253 | 14.4462 | 14.4671 | 14.4880 | 14.5089 | 14.5299 | 14.5508 | 14.5717 | 14.5926 | 820 |
| 830 | 14.5926 | 14.6135 | 14.6345 | 14.6554 | 14.6763 | 14.6973 | 14.7182 | 14.7392 | 14.7601 | 14.7811 | 14.8020 | 830 |
| 840 | 14.8020 | 14.8230 | 14.8440 | 14.8649 | 14.8859 | 14.9069 | 14.9279 | 14.9489 | 14.9698 | 14.9908 | 15.0118 | 840 |
| 850 | 15.0118 | 15.0328 | 15.0538 | 15.0748 | 15.0958 | 15.1168 | 15.1379 | 15.1589 | 15.1799 | 15.2009 | 15.2219 | 850 |
| 860 | 15.2219 | 15.2430 | 15.2640 | 15.2851 | 15.3061 | 15.3271 | 15.3482 | 15.3692 | 15.3903 | 15.4114 | 15.4324 | 860 |
| 870 | 15.4324 | 15.4535 | 15.4745 | 15.4956 | 15.5167 | 15.5378 | 15.5589 | 15.5799 | 15.6010 | 15.6221 | 15.6432 | 870 |
| 880 | 15.6432 | 15.6643 | 15.6854 | 15.7065 | 15.7276 | 15.7487 | 15.7698 | 15.7910 | 15.8121 | 15.8332 | 15.8543 | 880 |
| 890 | 15.8543 | 15.8755 | 15.8966 | 15.9177 | 15.9389 | 15.9600 | 15.9812 | 16.0023 | 16.0235 | 16.0446 | 16.0658 | 890 |
| 900 | 16.0658 | 16.0869 | 16.1081 | 16.1293 | 16.1504 | 16.1716 | 16.1928 | 16.2140 | 16.2351 | 16.2563 | 16.2775 | 900 |
| 910 | 16.2775 | 16.2987 | 16.3199 | 16.3411 | 16.3623 | 16.3835 | 16.4047 | 16.4259 | 16.4471 | 16.4683 | 16.4896 | 910 |
| 920 | 16.4896 | 16.5108 | 16.5320 | 16.5532 | 16.5745 | 16.5957 | 16.6169 | 16.6382 | 16.6594 | 16.6806 | 16.7019 | 920 |
| 930 | 16.7019 | 16.7231 | 16.7444 | 16.7657 | 16.7869 | 16.8082 | 16.8294 | 16.8507 | 16.8720 | 16.8932 | 16.9145 | 930 |
| 940 | 16.9145 | 16.9358 | 16.9571 | 16.9784 | 16.9996 | 17.0209 | 17.0422 | 17.0635 | 17.0848 | 17.1061 | 17.1274 | 940 |
| 950 | 17.1274 | 17.1487 | 17.1700 | 17.1913 | 17.2127 | 17.2340 | 17.2553 | 17.2766 | 17.2979 | 17.3193 | 17.3406 | 950 |
| 960 | 17.3406 | 17.3619 | 17.3833 | 17.4046 | 17.4259 | 17.4473 | 17.4686 | 17.4900 | 17.5113 | 17.5327 | 17.5540 | 960 |
| 970 | 17.5540 | 17.5754 | 17.5968 | 17.6181 | 17.6395 | 17.6609 | 17.6822 | 17.7036 | 17.7250 | 17.7464 | 17.7677 | 970 |
| 980 | 17.7677 | 17.7891 | 17.8105 | 17.8319 | 17.8533 | 17.8747 | 17.8961 | 17.9175 | 17.9389 | 17.9603 | 17.9817 | 980 |
| 990 | 17.9817 | 18.0031 | 18.0245 | 18.0459 | 18.0673 | 18.0888 | 18.1102 | 18.1316 | 18.1530 | 18.1745 | 18.1959 | 990 |
| 1,000 | 18.1959 | 18.2173 | 18.2387 | 18.2602 | 18.2816 | 18.3031 | 18.3245 | 18.3460 | 18.3674 | 18.3889 | 18.4103 | 1,000 |
| 1,010 | 18.4103 | 18.4318 | 18.4532 | 18.4747 | 18.4961 | 18.5176 | 18.5391 | 18.5605 | 18.5820 | 18.6035 | 18.6250 | 1,010 |
| 1,020 | 18.6250 | 18.6464 | 18.6679 | 18.6894 | 18.7109 | 18.7324 | 18.7539 | 18.7754 | 18.7969 | 18.8183 | 18.8398 | 1,020 |
| 1,030 | 18.8398 | 18.8613 | 18.8828 | 18.9044 | 18.9259 | 18.9474 | 18.9689 | 18.9904 | 19.0119 | 19.0334 | 19.0549 | 1,030 |
| 1,040 | 19.0549 | 19.0765 | 19.0980 | 19.1195 | 19.1410 | 19.1626 | 19.1841 | 19.2056 | 19.2272 | 19.2487 | 19.2702 | 1,040 |
| 1,050 | 19.2702 | 19.2918 | 19.3133 | 19.3349 | 19.3564 | 19.3780 | 19.3995 | 19.4211 | 19.4426 | 19.4642 | 19.4857 | 1,050 |
| 1,060 | 19.4857 | 19.5073 | 19.5289 | 19.5504 | 19.5720 | 19.5936 | 19.6151 | 19.6367 | 19.6583 | 19.6799 | 19.7014 | 1,060 |
| 1,070 | 19.7014 | 19.7230 | 19.7446 | 19.7662 | 19.7878 | 19.8094 | 19.8310 | 19.8525 | 19.8741 | 19.8957 | 19.9173 | 1,070 |
| 1,080 | 19.9173 | 19.9389 | 19.9605 | 19.9821 | 20.0037 | 20.0253 | 20.0470 | 20.0686 | 20.0902 | 20.1118 | 20.1334 | 1,080 |
| 1,090 | 20.1334 | 20.1550 | 20.1766 | 20.1983 | 20.2199 | 20.2415 | 20.2631 | 20.2847 | 20.3064 | 20.3280 | 20.3496 | 1,090 |
| 1,100 | 20.3496 | 20.3713 | 20.3929 | 20.4145 | 20.4362 | 20.4578 | 20.4795 | 20.5011 | 20.5228 | 20.5444 | 20.5660 | 1,100 |
| 1,110 | 20.5660 | 20.5877 | 20.6093 | 20.6310 | 20.6527 | 20.6743 | 20.6960 | 20.7176 | 20.7393 | 20.7609 | 20.7826 | 1,110 |
| 1,120 | 20.7826 | 20.8043 | 20.8259 | 20.8476 | 20.8693 | 20.8910 | 20.9126 | 20.9343 | 20.9560 | 20.9777 | 20.9993 | 1,120 |
| 1,130 | 20.9993 | 21.0210 | 21.0427 | 21.0644 | 21.0861 | 21.1077 | 21.1294 | 21.1511 | 21.1728 | 21.1945 | 21.2162 | 1,130 |
| 1,140 | 21.2162 | 21.2379 | 21.2596 | 21.2813 | 21.3030 | 21.3247 | 21.3464 | 21.3681 | 21.3898 | 21.4115 | 21.4332 | 1,140 |
| 1,150 | 21.4332 | 21.4549 | 21.4766 | 21.4983 | 21.5200 | 21.5418 | 21.5635 | 21.5852 | 21.6069 | 21.6286 | 21.6503 | 1,150 |
| 1,160 | 21.6503 | 21.6721 | 21.6938 | 21.7155 | 21.7372 | 21.7590 | 21.7807 | 21.8024 | 21.8241 | 21.8459 | 21.8676 | 1,160 |
| 1,170 | 21.8676 | 21.8893 | 21.9111 | 21.9328 | 21.9545 | 21.9763 | 21.9980 | 22.0198 | 22.0415 | 22.0632 | 22.0850 | 1,170 |
| 1,180 | 22.0850 | 22.1067 | 22.1285 | 22.1502 | 22.1720 | 22.1937 | 22.2155 | 22.2372 | 22.2590 | 22.2807 | 22.3025 | 1,180 |
| 1,190 | 22.3025 | 22.3242 | 22.3460 | 22.3677 | 22.3895 | 22.4113 | 22.4330 | 22.4548 | 22.4765 | 22.4983 | 22.5201 | 1,190 |
| 1,200 | 22.5201 | 22.5418 | 22.5636 | 22.5854 | 22.6071 | 22.6289 | 22.6507 | 22.6725 | 22.6942 | 22.7160 | 22.7378 | 1,200 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

Table C4. AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,200 | 22.5201 | 22.5418 | 22.5636 | 22.5854 | 22.6071 | 22.6289 | 22.6507 | 22.6725 | 22.6942 | 22.7160 | 22.7378 | 1,200 |
| 1,210 | 22.7378 | 22.7595 | 22.7813 | 22.8031 | 22.8249 | 22.8467 | 22.8684 | 22.8902 | 22.9120 | 22.9338 | 22.9556 | 1,210 |
| 1,220 | 22.9556 | 22.9773 | 22.9991 | 23.0209 | 23.0427 | 23.0645 | 23.0863 | 23.1081 | 23.1299 | 23.1517 | 23.1734 | 1,220 |
| 1,230 | 23.1734 | 23.1952 | 23.2170 | 23.2388 | 23.2606 | 23.2824 | 23.3042 | 23.3260 | 23.3478 | 23.3696 | 23.3914 | 1,230 |
| 1,240 | 23.3914 | 23.4132 | 23.4350 | 23.4568 | 23.4786 | 23.5004 | 23.5222 | 23.5440 | 23.5658 | 23.5876 | 23.6094 | 1,240 |
| 1,250 | 23.6094 | 23.6312 | 23.6530 | 23.6749 | 23.6967 | 23.7185 | 23.7403 | 23.7621 | 23.7839 | 23.8057 | 23.8275 | 1,250 |
| 1,260 | 23.8275 | 23.8493 | 23.8712 | 23.8930 | 23.9148 | 23.9366 | 23.9584 | 23.9802 | 24.0021 | 24.0239 | 24.0457 | 1,260 |
| 1,270 | 24.0457 | 24.0675 | 24.0893 | 24.1111 | 24.1330 | 24.1548 | 24.1766 | 24.1984 | 24.2203 | 24.2421 | 24.2639 | 1,270 |
| 1,280 | 24.2639 | 24.2857 | 24.3075 | 24.3294 | 24.3512 | 24.3730 | 24.3949 | 24.4167 | 24.4385 | 24.4603 | 24.4822 | 1,280 |
| 1,290 | 24.4822 | 24.5040 | 24.5258 | 24.5476 | 24.5695 | 24.5913 | 24.6131 | 24.6350 | 24.6568 | 24.6786 | 24.7005 | 1,290 |
| 1,300 | 24.7005 | 24.7223 | 24.7441 | 24.7660 | 24.7878 | 24.8096 | 24.8315 | 24.8533 | 24.8751 | 24.8970 | 24.9188 | 1,300 |
| 1,310 | 24.9188 | 24.9406 | 24.9625 | 24.9843 | 25.0061 | 25.0280 | 25.0498 | 25.0717 | 25.0935 | 25.1153 | 25.1372 | 1,310 |
| 1,320 | 25.1372 | 25.1590 | 25.1808 | 25.2027 | 25.2245 | 25.2464 | 25.2682 | 25.2900 | 25.3119 | 25.3337 | 25.3556 | 1,320 |
| 1,330 | 25.3556 | 25.3774 | 25.3992 | 25.4211 | 25.4429 | 25.4648 | 25.4866 | 25.5085 | 25.5303 | 25.5521 | 25.5740 | 1,330 |
| 1,340 | 25.5740 | 25.5958 | 25.6177 | 25.6395 | 25.6613 | 25.6832 | 25.7050 | 25.7269 | 25.7487 | 25.7706 | 25.7924 | 1,340 |
| 1,350 | 25.7924 | 25.8142 | 25.8361 | 25.8579 | 25.8798 | 25.9016 | 25.9235 | 25.9453 | 25.9671 | 25.9890 | 26.0108 | 1,350 |
| 1,360 | 26.0108 | 26.0327 | 26.0545 | 26.0764 | 26.0982 | 26.1200 | 26.1419 | 26.1637 | 26.1856 | 26.2074 | 26.2293 | 1,360 |
| 1,370 | 26.2293 | 26.2511 | 26.2730 | 26.2948 | 26.3166 | 26.3385 | 26.3603 | 26.3822 | 26.4040 | 26.4259 | 26.4477 | 1,370 |
| 1,380 | 26.4477 | 26.4695 | 26.4914 | 26.5132 | 26.5351 | 26.5569 | 26.5787 | 26.6006 | 26.6224 | 26.6443 | 26.6661 | 1,380 |
| 1,390 | 26.6661 | 26.6880 | 26.7098 | 26.7316 | 26.7535 | 26.7753 | 26.7972 | 26.8190 | 26.8408 | 26.8627 | 26.8845 | 1,390 |
| 1,400 | 26.8845 | 26.9064 | 26.9282 | 26.9500 | 26.9719 | 26.9937 | 27.0156 | 27.0374 | 27.0592 | 27.0811 | 27.1029 | 1,400 |
| 1,410 | 27.1029 | 27.1247 | 27.1466 | 27.1684 | 27.1903 | 27.2121 | 27.2339 | 27.2558 | 27.2776 | 27.2994 | 27.3213 | 1,410 |
| 1,420 | 27.3213 | 27.3431 | 27.3649 | 27.3868 | 27.4086 | 27.4304 | 27.4523 | 27.4741 | 27.4959 | 27.5178 | 27.5396 | 1,420 |
| 1,430 | 27.5396 | 27.5614 | 27.5833 | 27.6051 | 27.6269 | 27.6488 | 27.6706 | 27.6924 | 27.7142 | 27.7361 | 27.7579 | 1,430 |
| 1,440 | 27.7579 | 27.7797 | 27.8015 | 27.8234 | 27.8452 | 27.8670 | 27.8889 | 27.9107 | 27.9325 | 27.9543 | 27.9762 | 1,440 |
| 1,450 | 27.9762 | 27.9980 | 28.0198 | 28.0416 | 28.0634 | 28.0853 | 28.1071 | 28.1289 | 28.1507 | 28.1725 | 28.1944 | 1,450 |
| 1,460 | 28.1944 | 28.2162 | 28.2380 | 28.2598 | 28.2816 | 28.3035 | 28.3253 | 28.3471 | 28.3689 | 28.3907 | 28.4125 | 1,460 |
| 1,470 | 28.4125 | 28.4343 | 28.4562 | 28.4780 | 28.4998 | 28.5216 | 28.5434 | 28.5652 | 28.5870 | 28.6088 | 28.6306 | 1,470 |
| 1,480 | 28.6306 | 28.6525 | 28.6743 | 28.6961 | 28.7179 | 28.7397 | 28.7615 | 28.7833 | 28.8051 | 28.8269 | 28.8487 | 1,480 |
| 1,490 | 28.8487 | 28.8705 | 28.8923 | 28.9141 | 28.9359 | 28.9577 | 28.9795 | 29.0013 | 29.0231 | 29.0449 | 29.0667 | 1,490 |
| 1,500 | 29.0667 | 29.0885 | 29.1103 | 29.1321 | 29.1539 | 29.1757 | 29.1975 | 29.2193 | 29.2410 | 29.2628 | 29.2846 | 1,500 |
| 1,510 | 29.2846 | 29.3064 | 29.3282 | 29.3500 | 29.3718 | 29.3936 | 29.4154 | 29.4371 | 29.4589 | 29.4807 | 29.5025 | 1,510 |
| 1,520 | 29.5025 | 29.5243 | 29.5461 | 29.5678 | 29.5896 | 29.6114 | 29.6332 | 29.6550 | 29.6767 | 29.6985 | 29.7203 | 1,520 |
| 1,530 | 29.7203 | 29.7421 | 29.7638 | 29.7856 | 29.8074 | 29.8291 | 29.8509 | 29.8727 | 29.8945 | 29.9162 | 29.9380 | 1,530 |
| 1,540 | 29.9380 | 29.9598 | 29.9815 | 30.0033 | 30.0251 | 30.0468 | 30.0686 | 30.0903 | 30.1121 | 30.1339 | 30.1556 | 1,540 |
| 1,550 | 30.1556 | 30.1774 | 30.1991 | 30.2209 | 30.2427 | 30.2644 | 30.2862 | 30.3079 | 30.3297 | 30.3514 | 30.3732 | 1,550 |
| 1,560 | 30.3732 | 30.3949 | 30.4167 | 30.4384 | 30.4602 | 30.4819 | 30.5037 | 30.5254 | 30.5472 | 30.5689 | 30.5906 | 1,560 |
| 1,570 | 30.5906 | 30.6124 | 30.6341 | 30.6559 | 30.6776 | 30.6993 | 30.7211 | 30.7428 | 30.7645 | 30.7863 | 30.8080 | 1,570 |
| 1,580 | 30.8080 | 30.8297 | 30.8515 | 30.8732 | 30.8949 | 30.9167 | 30.9384 | 30.9601 | 30.9818 | 31.0036 | 31.0253 | 1,580 |
| 1,590 | 31.0253 | 31.0470 | 31.0687 | 31.0905 | 31.1122 | 31.1339 | 31.1556 | 31.1773 | 31.1990 | 31.2208 | 31.2425 | 1,590 |
| 1,600 | 31.2425 | 31.2642 | 31.2859 | 31.3076 | 31.3293 | 31.3510 | 31.3727 | 31.3944 | 31.4161 | 31.4379 | 31.4596 | 1,600 |
| 1,610 | 31.4596 | 31.4813 | 31.5030 | 31.5247 | 31.5464 | 31.5681 | 31.5898 | 31.6115 | 31.6331 | 31.6548 | 31.6765 | 1,610 |
| 1,620 | 31.6765 | 31.6982 | 31.7199 | 31.7416 | 31.7633 | 31.7850 | 31.8067 | 31.8284 | 31.8500 | 31.8717 | 31.8934 | 1,620 |
| 1,630 | 31.8934 | 31.9151 | 31.9368 | 31.9585 | 31.9801 | 32.0018 | 32.0235 | 32.0452 | 32.0668 | 32.0885 | 32.1102 | 1,630 |
| 1,640 | 32.1102 | 32.1319 | 32.1535 | 32.1752 | 32.1969 | 32.2185 | 32.2402 | 32.2619 | 32.2835 | 32.3052 | 32.3268 | 1,640 |
| 1,650 | 32.3268 | 32.3485 | 32.3702 | 32.3918 | 32.4135 | 32.4351 | 32.4568 | 32.4784 | 32.5001 | 32.5217 | 32.5434 | 1,650 |
| 1,660 | 32.5434 | 32.5650 | 32.5867 | 32.6083 | 32.6300 | 32.6516 | 32.6733 | 32.6949 | 32.7165 | 32.7382 | 32.7598 | 1,660 |
| 1,670 | 32.7598 | 32.7815 | 32.8031 | 32.8247 | 32.8464 | 32.8680 | 32.8896 | 32.9113 | 32.9329 | 32.9545 | 32.9761 | 1,670 |
| 1,680 | 32.9761 | 32.9978 | 33.0194 | 33.0410 | 33.0626 | 33.0843 | 33.1059 | 33.1275 | 33.1491 | 33.1707 | 33.1923 | 1,680 |
| 1,690 | 33.1923 | 33.2139 | 33.2356 | 33.2572 | 33.2788 | 33.3004 | 33.3220 | 33.3436 | 33.3652 | 33.3868 | 33.4084 | 1,690 |
| 1,700 | 33.4084 | 33.4300 | 33.4516 | 33.4732 | 33.4948 | 33.5164 | 33.5380 | 33.5596 | 33.5812 | 33.6028 | 33.6244 | 1,700 |
| 1,710 | 33.6244 | 33.6459 | 33.6675 | 33.6891 | 33.7107 | 33.7323 | 33.7539 | 33.7754 | 33.7970 | 33.8186 | 33.8402 | 1,710 |
| 1,720 | 33.8402 | 33.8618 | 33.8833 | 33.9049 | 33.9265 | 33.9480 | 33.9696 | 33.9912 | 34.0127 | 34.0343 | 34.0559 | 1,720 |
| 1,730 | 34.0559 | 34.0774 | 34.0990 | 34.1206 | 34.1421 | 34.1637 | 34.1852 | 34.2068 | 34.2283 | 34.2499 | 34.2714 | 1,730 |
| 1,740 | 34.2714 | 34.2930 | 34.3145 | 34.3361 | 34.3576 | 34.3792 | 34.4007 | 34.4223 | 34.4438 | 34.4653 | 34.4869 | 1,740 |
| 1,750 | 34.4869 | 34.5084 | 34.5299 | 34.5515 | 34.5730 | 34.5945 | 34.6161 | 34.6376 | 34.6591 | 34.6806 | 34.7022 | 1,750 |
| 1,760 | 34.7022 | 34.7237 | 34.7452 | 34.7667 | 34.7882 | 34.8098 | 34.8313 | 34.8528 | 34.8743 | 34.8958 | 34.9173 | 1,760 |
| 1,770 | 34.9173 | 34.9388 | 34.9603 | 34.9818 | 35.0033 | 35.0249 | 35.0464 | 35.0679 | 35.0894 | 35.1108 | 35.1323 | 1,770 |
| 1,780 | 35.1323 | 35.1538 | 35.1753 | 35.1968 | 35.2183 | 35.2398 | 35.2613 | 35.2828 | 35.3043 | 35.3257 | 35.3472 | 1,780 |
| 1,790 | 35.3472 | 35.3687 | 35.3902 | 35.4117 | 35.4331 | 35.4546 | 35.4761 | 35.4976 | 35.5190 | 35.5405 | 35.5620 | 1,790 |
| 1,800 | 35.5620 | 35.5834 | 35.6049 | 35.6264 | 35.6478 | 35.6693 | 35.6907 | 35.7122 | 35.7336 | 35.7551 | 35.7766 | 1,800 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

TABLE C4. AWG 14 *Nicrosil versus Nisil thermocouples—thermoelectric voltage as a function of temperature (°F), referenc junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,800 | 35.5620 | 35.5834 | 35.6049 | 35.6264 | 35.6478 | 35.6693 | 35.6907 | 35.7122 | 35.7336 | 35.7551 | 35.7766 | 1,800 |
| 1,810 | 35.7766 | 35.7980 | 35.8195 | 35.8409 | 35.8623 | 35.8838 | 35.9052 | 35.9267 | 35.9481 | 35.9696 | 35.9910 | 1,810 |
| 1,820 | 35.9910 | 36.0124 | 36.0339 | 36.0553 | 36.0767 | 36.0982 | 36.1196 | 36.1410 | 36.1624 | 36.1839 | 36.2053 | 1,820 |
| 1,830 | 36.2053 | 36.2267 | 36.2481 | 36.2696 | 36.2910 | 36.3124 | 36.3338 | 36.3552 | 36.3766 | 36.3980 | 36.4194 | 1,830 |
| 1,840 | 36.4194 | 36.4408 | 36.4622 | 36.4837 | 36.5051 | 36.5265 | 36.5479 | 36.5692 | 36.5906 | 36.6120 | 36.6334 | 1,840 |
| 1,850 | 36.6334 | 36.6548 | 36.6762 | 36.6976 | 36.7190 | 36.7404 | 36.7617 | 36.7831 | 36.8045 | 36.8259 | 36.8473 | 1,850 |
| 1,860 | 36.8473 | 36.8686 | 36.8900 | 36.9114 | 36.9328 | 36.9541 | 36.9755 | 36.9969 | 37.0182 | 37.0396 | 37.0609 | 1,860 |
| 1,870 | 37.0609 | 37.0823 | 37.1037 | 37.1250 | 37.1464 | 37.1677 | 37.1891 | 37.2104 | 37.2318 | 37.2531 | 37.2745 | 1,870 |
| 1,880 | 37.2745 | 37.2958 | 37.3171 | 37.3385 | 37.3598 | 37.3811 | 37.4025 | 37.4238 | 37.4451 | 37.4665 | 37.4878 | 1,880 |
| 1,890 | 37.4878 | 37.5091 | 37.5305 | 37.5518 | 37.5731 | 37.5944 | 37.6157 | 37.6371 | 37.6584 | 37.6797 | 37.7010 | 1,890 |
| 1,900 | 37.7010 | 37.7223 | 37.7436 | 37.7649 | 37.7862 | 37.8075 | 37.8288 | 37.8501 | 37.8714 | 37.8927 | 37.9140 | 1,900 |
| 1,910 | 37.9140 | 37.9353 | 37.9566 | 37.9779 | 37.9992 | 38.0204 | 38.0417 | 38.0630 | 38.0843 | 38.1056 | 38.1268 | 1,910 |
| 1,920 | 38.1268 | 38.1481 | 38.1694 | 38.1907 | 38.2119 | 38.2332 | 38.2545 | 38.2757 | 38.2970 | 38.3183 | 38.3395 | 1,920 |
| 1,930 | 38.3395 | 38.3608 | 38.3820 | 38.4033 | 38.4245 | 38.4458 | 38.4670 | 38.4883 | 38.5095 | 38.5308 | 38.5520 | 1,930 |
| 1,940 | 38.5520 | 38.5732 | 38.5945 | 38.6157 | 38.6370 | 38.6582 | 38.6794 | 38.7006 | 38.7219 | 38.7431 | 38.7643 | 1,940 |
| 1,950 | 38.7643 | 38.7855 | 38.8068 | 38.8280 | 38.8492 | 38.8704 | 38.8916 | 38.9128 | 38.9340 | 38.9552 | 38.9764 | 1,950 |
| 1,960 | 38.9764 | 38.9976 | 39.0188 | 39.0400 | 39.0612 | 39.0824 | 39.1036 | 39.1248 | 39.1460 | 39.1672 | 39.1884 | 1,960 |
| 1,970 | 39.1884 | 39.2096 | 39.2307 | 39.2519 | 39.2731 | 39.2943 | 39.3155 | 39.3366 | 39.3578 | 39.3790 | 39.4001 | 1,970 |
| 1,980 | 39.4001 | 39.4213 | 39.4425 | 39.4636 | 39.4848 | 39.5059 | 39.5271 | 39.5482 | 39.5694 | 39.5905 | 39.6117 | 1,980 |
| 1,990 | 39.6117 | 39.6328 | 39.6540 | 39.6751 | 39.6962 | 39.7174 | 39.7385 | 39.7596 | 39.7808 | 39.8019 | 39.8230 | 1,990 |
| 2,000 | 39.8230 | 39.8442 | 39.8653 | 39.8864 | 39.9075 | 39.9286 | 39.9497 | 39.9709 | 39.9920 | 40.0131 | 40.0342 | 2,000 |
| 2,010 | 40.0342 | 40.0553 | 40.0764 | 40.0975 | 40.1186 | 40.1397 | 40.1608 | 40.1819 | 40.2029 | 40.2240 | 40.2451 | 2,010 |
| 2,020 | 40.2451 | 40.2662 | 40.2873 | 40.3084 | 40.3294 | 40.3505 | 40.3716 | 40.3926 | 40.4137 | 40.4348 | 40.4558 | 2,020 |
| 2,030 | 40.4558 | 40.4769 | 40.4980 | 40.5190 | 40.5401 | 40.5611 | 40.5822 | 40.6032 | 40.6243 | 40.6453 | 40.6664 | 2,030 |
| 2,040 | 40.6664 | 40.6874 | 40.7084 | 40.7295 | 40.7505 | 40.7715 | 40.7926 | 40.8136 | 40.8346 | 40.8556 | 40.8766 | 2,040 |
| 2,050 | 40.8766 | 40.8977 | 40.9187 | 40.9397 | 40.9607 | 40.9817 | 41.0027 | 41.0237 | 41.0447 | 41.0657 | 41.0867 | 2,050 |
| 2,060 | 41.0867 | 41.1077 | 41.1287 | 41.1497 | 41.1707 | 41.1917 | 41.2126 | 41.2336 | 41.2546 | 41.2756 | 41.2966 | 2,060 |
| 2,070 | 41.2966 | 41.3175 | 41.3385 | 41.3595 | 41.3804 | 41.4014 | 41.4223 | 41.4433 | 41.4643 | 41.4852 | 41.5062 | 2,070 |
| 2,080 | 41.5062 | 41.5271 | 41.5480 | 41.5690 | 41.5899 | 41.6109 | 41.6318 | 41.6527 | 41.6737 | 41.6946 | 41.7155 | 2,080 |
| 2,090 | 41.7155 | 41.7364 | 41.7574 | 41.7783 | 41.7992 | 41.8201 | 41.8410 | 41.8619 | 41.8828 | 41.9037 | 41.9246 | 2,090 |
| 2,100 | 41.9246 | 41.9455 | 41.9664 | 41.9873 | 42.0082 | 42.0291 | 42.0500 | 42.0709 | 42.0917 | 42.1126 | 42.1335 | 2,100 |
| 2,110 | 42.1335 | 42.1544 | 42.1752 | 42.1961 | 42.2170 | 42.2378 | 42.2587 | 42.2796 | 42.3004 | 42.3213 | 42.3421 | 2,110 |
| 2,120 | 42.3421 | 42.3630 | 42.3838 | 42.4046 | 42.4255 | 42.4463 | 42.4672 | 42.4880 | 42.5088 | 42.5296 | 42.5505 | 2,120 |
| 2,130 | 42.5505 | 42.5713 | 42.5921 | 42.6129 | 42.6337 | 42.6545 | 42.6753 | 42.6962 | 42.7170 | 42.7378 | 42.7586 | 2,130 |
| 2,140 | 42.7586 | 42.7793 | 42.8001 | 42.8209 | 42.8417 | 42.8625 | 42.8833 | 42.9041 | 42.9248 | 42.9456 | 42.9664 | 2,140 |
| 2,150 | 42.9664 | 42.9871 | 43.0079 | 43.0287 | 43.0494 | 43.0702 | 43.0909 | 43.1117 | 43.1324 | 43.1532 | 43.1739 | 2,150 |
| 2,160 | 43.1739 | 43.1946 | 43.2154 | 43.2361 | 43.2568 | 43.2776 | 43.2983 | 43.3190 | 43.3397 | 43.3605 | 43.3812 | 2,160 |
| 2,170 | 43.3812 | 43.4019 | 43.4226 | 43.4433 | 43.4640 | 43.4847 | 43.5054 | 43.5261 | 43.5468 | 43.5675 | 43.5881 | 2,170 |
| 2,180 | 43.5881 | 43.6088 | 43.6295 | 43.6502 | 43.6708 | 43.6915 | 43.7122 | 43.7328 | 43.7535 | 43.7742 | 43.7948 | 2,180 |
| 2,190 | 43.7948 | 43.8155 | 43.8361 | 43.8568 | 43.8774 | 43.8981 | 43.9187 | 43.9393 | 43.9600 | 43.9806 | 44.0012 | 2,190 |
| 2,200 | 44.0012 | 44.0218 | 44.0425 | 44.0631 | 44.0837 | 44.1043 | 44.1249 | 44.1455 | 44.1661 | 44.1867 | 44.2073 | 2,200 |
| 2,210 | 44.2073 | 44.2279 | 44.2485 | 44.2691 | 44.2896 | 44.3102 | 44.3308 | 44.3514 | 44.3719 | 44.3925 | 44.4131 | 2,210 |
| 2,220 | 44.4131 | 44.4336 | 44.4542 | 44.4748 | 44.4953 | 44.5159 | 44.5364 | 44.5569 | 44.5775 | 44.5980 | 44.6186 | 2,220 |
| 2,230 | 44.6186 | 44.6391 | 44.6596 | 44.6801 | 44.7007 | 44.7212 | 44.7417 | 44.7622 | 44.7827 | 44.8032 | 44.8237 | 2,230 |
| 2,240 | 44.8237 | 44.8442 | 44.8647 | 44.8852 | 44.9057 | 44.9262 | 44.9467 | 44.9671 | 44.9876 | 45.0081 | 45.0286 | 2,240 |
| 2,250 | 45.0286 | 45.0490 | 45.0695 | 45.0900 | 45.1104 | 45.1309 | 45.1513 | 45.1718 | 45.1922 | 45.2126 | 45.2331 | 2,250 |
| 2,260 | 45.2331 | 45.2535 | 45.2740 | 45.2944 | 45.3148 | 45.3352 | 45.3557 | 45.3761 | 45.3965 | 45.4169 | 45.4373 | 2,260 |
| 2,270 | 45.4373 | 45.4577 | 45.4781 | 45.4985 | 45.5189 | 45.5393 | 45.5597 | 45.5800 | 45.6004 | 45.6208 | 45.6412 | 2,270 |
| 2,280 | 45.6412 | 45.6615 | 45.6819 | 45.7023 | 45.7226 | 45.7430 | 45.7634 | 45.7837 | 45.8041 | 45.8244 | 45.8447 | 2,280 |
| 2,290 | 45.8447 | 45.8651 | 45.8854 | 45.9057 | 45.9261 | 45.9464 | 45.9667 | 45.9870 | 46.0074 | 46.0277 | 46.0480 | 2,290 |
| 2,300 | 46.0480 | 46.0683 | 46.0886 | 46.1089 | 46.1292 | 46.1495 | 46.1698 | 46.1900 | 46.2103 | 46.2306 | 46.2509 | 2,300 |
| 2,310 | 46.2509 | 46.2712 | 46.2914 | 46.3117 | 46.3320 | 46.3522 | 46.3725 | 46.3927 | 46.4130 | 46.4332 | 46.4535 | 2,310 |
| 2,320 | 46.4535 | 46.4737 | 46.4940 | 46.5142 | 46.5344 | 46.5546 | 46.5749 | 46.5951 | 46.6153 | 46.6355 | 46.6557 | 2,320 |
| 2,330 | 46.6557 | 46.6759 | 46.6962 | 46.7164 | 46.7366 | 46.7568 | 46.7769 | 46.7971 | 46.8173 | 46.8375 | 46.8577 | 2,330 |
| 2,340 | 46.8577 | 46.8779 | 46.8980 | 46.9182 | 46.9384 | 46.9585 | 46.9787 | 46.9989 | 47.0190 | 47.0392 | 47.0593 | 2,340 |
| 2,350 | 47.0593 | 47.0795 | 47.0996 | 47.1197 | 47.1399 | 47.1600 | 47.1801 | 47.2003 | 47.2204 | 47.2405 | 47.2606 | 2,350 |
| 2,360 | 47.2606 | 47.2808 | 47.3009 | 47.3210 | 47.3411 | 47.3612 | 47.3813 | 47.4014 | 47.4215 | 47.4416 | 47.4617 | 2,360 |
| 2,370 | 47.4617 | 47.4817 | 47.5018 |  |  |  |  |  |  |  |  | 2,370 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C5.** AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -320 | -1.5900 | -1.5895 | -1.5889 | -1.5883 | -1.5877 | -1.5871 | -1.5864 | -1.5857 | -1.5850 | | | -320 |
| -310 | -1.5939 | -1.5937 | -1.5934 | -1.5931 | -1.5927 | -1.5923 | -1.5919 | -1.5915 | -1.5910 | -1.5906 | -1.5900 | -310 |
| -300 | -1.5949 | -1.5949 | -1.5949 | -1.5949 | -1.5948 | -1.5948 | -1.5947 | -1.5945 | -1.5943 | -1.5941 | -1.5939 | -300 |
| -290 | -1.5927 | -1.5931 | -1.5934 | -1.5937 | -1.5940 | -1.5942 | -1.5944 | -1.5946 | -1.5947 | -1.5948 | -1.5949 | -290 |
| -280 | -1.5874 | -1.5881 | -1.5888 | -1.5894 | -1.5899 | -1.5905 | -1.5910 | -1.5915 | -1.5919 | -1.5924 | -1.5927 | -280 |
| -270 | -1.5789 | -1.5799 | -1.5809 | -1.5818 | -1.5827 | -1.5836 | -1.5844 | -1.5852 | -1.5860 | -1.5867 | -1.5874 | -270 |
| -260 | -1.5671 | -1.5685 | -1.5698 | -1.5710 | -1.5722 | -1.5734 | -1.5746 | -1.5757 | -1.5768 | -1.5779 | -1.5789 | -260 |
| -250 | -1.5521 | -1.5538 | -1.5554 | -1.5570 | -1.5585 | -1.5600 | -1.5615 | -1.5630 | -1.5644 | -1.5658 | -1.5671 | -250 |
| -240 | -1.5338 | -1.5358 | -1.5377 | -1.5396 | -1.5415 | -1.5434 | -1.5452 | -1.5470 | -1.5487 | -1.5504 | -1.5521 | -240 |
| -230 | -1.5123 | -1.5146 | -1.5169 | -1.5191 | -1.5213 | -1.5235 | -1.5256 | -1.5277 | -1.5298 | -1.5318 | -1.5338 | -230 |
| -220 | -1.4877 | -1.4903 | -1.4929 | -1.4954 | -1.4979 | -1.5004 | -1.5028 | -1.5053 | -1.5077 | -1.5100 | -1.5123 | -220 |
| -210 | -1.4599 | -1.4628 | -1.4657 | -1.4686 | -1.4714 | -1.4742 | -1.4769 | -1.4797 | -1.4824 | -1.4850 | -1.4877 | -210 |
| -200 | -1.4291 | -1.4323 | -1.4355 | -1.4386 | -1.4418 | -1.4449 | -1.4479 | -1.4510 | -1.4540 | -1.4570 | -1.4599 | -200 |
| -190 | -1.3952 | -1.3988 | -1.4022 | -1.4057 | -1.4091 | -1.4125 | -1.4159 | -1.4192 | -1.4225 | -1.4258 | -1.4291 | -190 |
| -180 | -1.3585 | -1.3623 | -1.3661 | -1.3698 | -1.3735 | -1.3772 | -1.3809 | -1.3845 | -1.3881 | -1.3917 | -1.3952 | -180 |
| -170 | -1.3188 | -1.3229 | -1.3270 | -1.3310 | -1.3350 | -1.3390 | -1.3430 | -1.3469 | -1.3508 | -1.3546 | -1.3585 | -170 |
| -160 | -1.2764 | -1.2808 | -1.2851 | -1.2894 | -1.2937 | -1.2980 | -1.3022 | -1.3064 | -1.3106 | -1.3147 | -1.3188 | -160 |
| -150 | -1.2312 | -1.2358 | -1.2405 | -1.2450 | -1.2496 | -1.2541 | -1.2586 | -1.2631 | -1.2676 | -1.2720 | -1.2764 | -150 |
| -140 | -1.1833 | -1.1882 | -1.1931 | -1.1980 | -1.2028 | -1.2076 | -1.2124 | -1.2171 | -1.2218 | -1.2265 | -1.2312 | -140 |
| -130 | -1.1329 | -1.1380 | -1.1432 | -1.1483 | -1.1534 | -1.1584 | -1.1635 | -1.1685 | -1.1735 | -1.1784 | -1.1833 | -130 |
| -120 | -1.0798 | -1.0852 | -1.0906 | -1.0960 | -1.1013 | -1.1067 | -1.1119 | -1.1172 | -1.1225 | -1.1277 | -1.1329 | -120 |
| -110 | -1.0243 | -1.0299 | -1.0356 | -1.0412 | -1.0468 | -1.0524 | -1.0579 | -1.0634 | -1.0689 | -1.0744 | -1.0798 | -110 |
| -100 | -0.9663 | -0.9722 | -0.9781 | -0.9840 | -0.9898 | -0.9956 | -1.0014 | -1.0071 | -1.0129 | -1.0186 | -1.0243 | -100 |
| -90 | -0.9060 | -0.9121 | -0.9182 | -0.9243 | -0.9304 | -0.9364 | -0.9425 | -0.9485 | -0.9544 | -0.9604 | -0.9663 | -90 |
| -80 | -0.8433 | -0.8497 | -0.8560 | -0.8624 | -0.8687 | -0.8749 | -0.8812 | -0.8874 | -0.8936 | -0.8998 | -0.9060 | -80 |
| -70 | -0.7784 | -0.7850 | -0.7916 | -0.7981 | -0.8046 | -0.8111 | -0.8176 | -0.8241 | -0.8305 | -0.8369 | -0.8433 | -70 |
| -60 | -0.7113 | -0.7181 | -0.7249 | -0.7317 | -0.7384 | -0.7451 | -0.7518 | -0.7585 | -0.7652 | -0.7718 | -0.7784 | -60 |
| -50 | -0.6421 | -0.6491 | -0.6561 | -0.6631 | -0.6700 | -0.6769 | -0.6839 | -0.6908 | -0.6976 | -0.7045 | -0.7113 | -50 |
| -40 | -0.5707 | -0.5779 | -0.5851 | -0.5923 | -0.5995 | -0.6066 | -0.6138 | -0.6209 | -0.6280 | -0.6350 | -0.6421 | -40 |
| -30 | -0.4973 | -0.5048 | -0.5122 | -0.5196 | -0.5269 | -0.5343 | -0.5416 | -0.5489 | -0.5562 | -0.5635 | -0.5707 | -30 |
| -20 | -0.4220 | -0.4296 | -0.4372 | -0.4448 | -0.4524 | -0.4599 | -0.4674 | -0.4749 | -0.4824 | -0.4899 | -0.4973 | -20 |
| -10 | -0.3447 | -0.3525 | -0.3603 | -0.3681 | -0.3758 | -0.3836 | -0.3913 | -0.3990 | -0.4067 | -0.4143 | -0.4220 | -10 |
| - 0 | -0.2655 | -0.2735 | -0.2815 | -0.2895 | -0.2974 | -0.3053 | -0.3132 | -0.3211 | -0.3290 | -0.3369 | -0.3447 | - 0 |
| + 0 | -0.2655 | -0.2575 | -0.2495 | -0.2414 | -0.2333 | -0.2252 | -0.2171 | -0.2090 | -0.2008 | -0.1927 | -0.1845 | + 0 |
| 10 | -0.1845 | -0.1763 | -0.1681 | -0.1598 | -0.1516 | -0.1433 | -0.1350 | -0.1267 | -0.1184 | -0.1100 | -0.1017 | 10 |
| 20 | -0.1017 | -0.0933 | -0.0849 | -0.0765 | -0.0681 | -0.0596 | -0.0512 | -0.0427 | -0.0342 | -0.0257 | -0.0171 | 20 |
| 30 | -0.0171 | -0.0086 | 0.0000 | | | | | | | | | 30 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C5.** AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS | | | | | | | |
| 30 | | | 0.0000 | 0.0086 | 0.0172 | 0.0258 | 0.0344 | 0.0431 | 0.0518 | 0.0605 | 0.0692 | 30 |
| 40 | 0.0692 | 0.0779 | 0.0866 | 0.0954 | 0.1042 | 0.1129 | 0.1217 | 0.1306 | 0.1394 | 0.1483 | 0.1571 | 40 |
| 50 | 0.1571 | 0.1660 | 0.1749 | 0.1838 | 0.1928 | 0.2017 | 0.2107 | 0.2197 | 0.2287 | 0.2377 | 0.2467 | 50 |
| 60 | 0.2467 | 0.2558 | 0.2649 | 0.2739 | 0.2830 | 0.2922 | 0.3013 | 0.3104 | 0.3196 | 0.3288 | 0.3380 | 60 |
| 70 | 0.3380 | 0.3472 | 0.3564 | 0.3656 | 0.3749 | 0.3842 | 0.3935 | 0.4028 | 0.4121 | 0.4214 | 0.4308 | 70 |
| 80 | 0.4308 | 0.4401 | 0.4495 | 0.4589 | 0.4683 | 0.4777 | 0.4872 | 0.4966 | 0.5061 | 0.5156 | 0.5251 | 80 |
| 90 | 0.5251 | 0.5346 | 0.5441 | 0.5537 | 0.5632 | 0.5728 | 0.5824 | 0.5920 | 0.6016 | 0.6113 | 0.6209 | 90 |
| 100 | 0.6209 | 0.6306 | 0.6402 | 0.6499 | 0.6596 | 0.6694 | 0.6791 | 0.6889 | 0.6986 | 0.7084 | 0.7182 | 100 |
| 110 | 0.7182 | 0.7280 | 0.7378 | 0.7477 | 0.7575 | 0.7674 | 0.7773 | 0.7872 | 0.7971 | 0.8070 | 0.8169 | 110 |
| 120 | 0.8169 | 0.8269 | 0.8368 | 0.8468 | 0.8568 | 0.8668 | 0.8768 | 0.8869 | 0.8969 | 0.9070 | 0.9170 | 120 |
| 130 | 0.9170 | 0.9271 | 0.9372 | 0.9473 | 0.9575 | 0.9676 | 0.9778 | 0.9879 | 0.9981 | 1.0083 | 1.0185 | 130 |
| 140 | 1.0185 | 1.0288 | 1.0390 | 1.0492 | 1.0595 | 1.0698 | 1.0801 | 1.0904 | 1.1007 | 1.1110 | 1.1214 | 140 |
| 150 | 1.1214 | 1.1317 | 1.1421 | 1.1525 | 1.1629 | 1.1733 | 1.1837 | 1.1941 | 1.2046 | 1.2150 | 1.2255 | 150 |
| 160 | 1.2255 | 1.2360 | 1.2465 | 1.2570 | 1.2675 | 1.2780 | 1.2886 | 1.2991 | 1.3097 | 1.3203 | 1.3309 | 160 |
| 170 | 1.3309 | 1.3415 | 1.3521 | 1.3628 | 1.3734 | 1.3841 | 1.3947 | 1.4054 | 1.4161 | 1.4268 | 1.4376 | 170 |
| 180 | 1.4376 | 1.4483 | 1.4590 | 1.4698 | 1.4806 | 1.4913 | 1.5021 | 1.5129 | 1.5238 | 1.5346 | 1.5454 | 180 |
| 190 | 1.5454 | 1.5563 | 1.5671 | 1.5780 | 1.5889 | 1.5998 | 1.6107 | 1.6217 | 1.6326 | 1.6435 | 1.6545 | 190 |
| 200 | 1.6545 | 1.6655 | 1.6764 | 1.6874 | 1.6984 | 1.7095 | 1.7205 | 1.7315 | 1.7426 | 1.7536 | 1.7647 | 200 |
| 210 | 1.7647 | 1.7758 | 1.7869 | 1.7980 | 1.8091 | 1.8203 | 1.8314 | 1.8426 | 1.8537 | 1.8649 | 1.8761 | 210 |
| 220 | 1.8761 | 1.8873 | 1.8985 | 1.9097 | 1.9209 | 1.9322 | 1.9434 | 1.9547 | 1.9660 | 1.9773 | 1.9886 | 220 |
| 230 | 1.9886 | 1.9999 | 2.0112 | 2.0225 | 2.0339 | 2.0452 | 2.0566 | 2.0679 | 2.0793 | 2.0907 | 2.1021 | 230 |
| 240 | 2.1021 | 2.1135 | 2.1250 | 2.1364 | 2.1478 | 2.1593 | 2.1708 | 2.1823 | 2.1937 | 2.2052 | 2.2167 | 240 |
| 250 | 2.2167 | 2.2283 | 2.2398 | 2.2513 | 2.2629 | 2.2744 | 2.2860 | 2.2976 | 2.3092 | 2.3208 | 2.3324 | 250 |
| 260 | 2.3324 | 2.3440 | 2.3557 | 2.3673 | 2.3790 | 2.3906 | 2.4023 | 2.4140 | 2.4257 | 2.4374 | 2.4491 | 260 |
| 270 | 2.4491 | 2.4608 | 2.4725 | 2.4843 | 2.4960 | 2.5078 | 2.5196 | 2.5313 | 2.5431 | 2.5549 | 2.5667 | 270 |
| 280 | 2.5667 | 2.5786 | 2.5904 | 2.6022 | 2.6141 | 2.6259 | 2.6378 | 2.6497 | 2.6616 | 2.6735 | 2.6854 | 280 |
| 290 | 2.6854 | 2.6973 | 2.7092 | 2.7211 | 2.7331 | 2.7450 | 2.7570 | 2.7690 | 2.7809 | 2.7929 | 2.8049 | 290 |
| 300 | 2.8049 | 2.8169 | 2.8290 | 2.8410 | 2.8530 | 2.8651 | 2.8771 | 2.8892 | 2.9013 | 2.9133 | 2.9254 | 300 |
| 310 | 2.9254 | 2.9375 | 2.9496 | 2.9617 | 2.9739 | 2.9860 | 2.9982 | 3.0103 | 3.0225 | 3.0346 | 3.0468 | 310 |
| 320 | 3.0468 | 3.0590 | 3.0712 | 3.0834 | 3.0956 | 3.1078 | 3.1201 | 3.1323 | 3.1446 | 3.1568 | 3.1691 | 320 |
| 330 | 3.1691 | 3.1814 | 3.1937 | 3.2059 | 3.2182 | 3.2306 | 3.2429 | 3.2552 | 3.2675 | 3.2799 | 3.2922 | 330 |
| 340 | 3.2922 | 3.3046 | 3.3170 | 3.3293 | 3.3417 | 3.3541 | 3.3665 | 3.3789 | 3.3913 | 3.4038 | 3.4162 | 340 |
| 350 | 3.4162 | 3.4287 | 3.4411 | 3.4536 | 3.4660 | 3.4785 | 3.4910 | 3.5035 | 3.5160 | 3.5285 | 3.5410 | 350 |
| 360 | 3.5410 | 3.5535 | 3.5661 | 3.5786 | 3.5912 | 3.6037 | 3.6163 | 3.6289 | 3.6414 | 3.6540 | 3.6666 | 360 |
| 370 | 3.6666 | 3.6792 | 3.6918 | 3.7045 | 3.7171 | 3.7297 | 3.7424 | 3.7550 | 3.7677 | 3.7803 | 3.7930 | 370 |
| 380 | 3.7930 | 3.8057 | 3.8184 | 3.8311 | 3.8438 | 3.8565 | 3.8692 | 3.8819 | 3.8947 | 3.9074 | 3.9202 | 380 |
| 390 | 3.9202 | 3.9329 | 3.9457 | 3.9585 | 3.9712 | 3.9840 | 3.9968 | 4.0096 | 4.0224 | 4.0353 | 4.0481 | 390 |
| 400 | 4.0481 | 4.0609 | 4.0738 | 4.0866 | 4.0995 | 4.1123 | 4.1252 | 4.1381 | 4.1509 | 4.1638 | 4.1767 | 400 |
| 410 | 4.1767 | 4.1896 | 4.2025 | 4.2155 | 4.2284 | 4.2413 | 4.2543 | 4.2672 | 4.2802 | 4.2931 | 4.3061 | 410 |
| 420 | 4.3061 | 4.3191 | 4.3320 | 4.3450 | 4.3580 | 4.3710 | 4.3840 | 4.3971 | 4.4101 | 4.4231 | 4.4362 | 420 |
| 430 | 4.4362 | 4.4492 | 4.4622 | 4.4753 | 4.4884 | 4.5014 | 4.5145 | 4.5276 | 4.5407 | 4.5538 | 4.5669 | 430 |
| 440 | 4.5669 | 4.5800 | 4.5931 | 4.6063 | 4.6194 | 4.6325 | 4.6457 | 4.6588 | 4.6720 | 4.6852 | 4.6983 | 440 |
| 450 | 4.6983 | 4.7115 | 4.7247 | 4.7379 | 4.7511 | 4.7643 | 4.7775 | 4.7907 | 4.8039 | 4.8172 | 4.8304 | 450 |
| 460 | 4.8304 | 4.8436 | 4.8569 | 4.8702 | 4.8834 | 4.8967 | 4.9100 | 4.9232 | 4.9365 | 4.9498 | 4.9631 | 460 |
| 470 | 4.9631 | 4.9764 | 4.9897 | 5.0031 | 5.0164 | 5.0297 | 5.0431 | 5.0564 | 5.0698 | 5.0831 | 5.0965 | 470 |
| 480 | 5.0965 | 5.1098 | 5.1232 | 5.1366 | 5.1500 | 5.1634 | 5.1768 | 5.1902 | 5.2036 | 5.2170 | 5.2304 | 480 |
| 490 | 5.2304 | 5.2439 | 5.2573 | 5.2707 | 5.2842 | 5.2976 | 5.3111 | 5.3246 | 5.3380 | 5.3515 | 5.3650 | 490 |
| 500 | 5.3650 | 5.3785 | 5.3920 | 5.4055 | 5.4190 | 5.4325 | 5.4460 | 5.4595 | 5.4731 | 5.4866 | 5.5001 | 500 |
| 510 | 5.5001 | 5.5137 | 5.5272 | 5.5408 | 5.5544 | 5.5679 | 5.5815 | 5.5951 | 5.6087 | 5.6223 | 5.6359 | 510 |
| 520 | 5.6359 | 5.6495 | 5.6631 | 5.6767 | 5.6903 | 5.7039 | 5.7176 | 5.7312 | 5.7448 | 5.7585 | 5.7721 | 520 |
| 530 | 5.7721 | 5.7858 | 5.7995 | 5.8131 | 5.8268 | 5.8405 | 5.8542 | 5.8679 | 5.8816 | 5.8953 | 5.9090 | 530 |
| 540 | 5.9090 | 5.9227 | 5.9364 | 5.9501 | 5.9639 | 5.9776 | 5.9913 | 6.0051 | 6.0188 | 6.0326 | 6.0464 | 540 |
| 550 | 6.0464 | 6.0601 | 6.0739 | 6.0877 | 6.1014 | 6.1152 | 6.1290 | 6.1428 | 6.1566 | 6.1704 | 6.1842 | 550 |
| 560 | 6.1842 | 6.1981 | 6.2119 | 6.2257 | 6.2395 | 6.2534 | 6.2672 | 6.2811 | 6.2949 | 6.3088 | 6.3227 | 560 |
| 570 | 6.3227 | 6.3365 | 6.3504 | 6.3643 | 6.3782 | 6.3920 | 6.4059 | 6.4198 | 6.4337 | 6.4477 | 6.4616 | 570 |
| 580 | 6.4616 | 6.4755 | 6.4894 | 6.5033 | 6.5173 | 6.5312 | 6.5452 | 6.5591 | 6.5731 | 6.5870 | 6.6010 | 580 |
| 590 | 6.6010 | 6.6149 | 6.6289 | 6.6429 | 6.6569 | 6.6709 | 6.6848 | 6.6988 | 6.7128 | 6.7268 | 6.7409 | 590 |
| 600 | 6.7409 | 6.7549 | 6.7689 | 6.7829 | 6.7969 | 6.8110 | 6.8250 | 6.8391 | 6.8531 | 6.8672 | 6.8812 | 600 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

TABLE C5. AWG 28 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS | | | | | | | | | | | |
| 600 | 6.7409 | 6.7549 | 6.7689 | 6.7829 | 6.7969 | 6.8110 | 6.8250 | 6.8391 | 6.8531 | 6.8672 | 6.8812 | 600 |
| 610 | 6.8812 | 6.8953 | 6.9093 | 6.9234 | 6.9375 | 6.9516 | 6.9656 | 6.9797 | 6.9938 | 7.0079 | 7.0220 | 610 |
| 620 | 7.0220 | 7.0361 | 7.0502 | 7.0644 | 7.0785 | 7.0926 | 7.1067 | 7.1209 | 7.1350 | 7.1491 | 7.1633 | 620 |
| 630 | 7.1633 | 7.1774 | 7.1916 | 7.2058 | 7.2199 | 7.2341 | 7.2483 | 7.2624 | 7.2766 | 7.2908 | 7.3050 | 630 |
| 640 | 7.3050 | 7.3192 | 7.3334 | 7.3476 | 7.3618 | 7.3760 | 7.3902 | 7.4044 | 7.4187 | 7.4329 | 7.4471 | 640 |
| 650 | 7.4471 | 7.4614 | 7.4756 | 7.4899 | 7.5041 | 7.5184 | 7.5326 | 7.5469 | 7.5611 | 7.5754 | 7.5897 | 650 |
| 660 | 7.5897 | 7.6040 | 7.6183 | 7.6325 | 7.6468 | 7.6611 | 7.6754 | 7.6897 | 7.7040 | 7.7183 | 7.7327 | 660 |
| 670 | 7.7327 | 7.7470 | 7.7613 | 7.7756 | 7.7900 | 7.8043 | 7.8186 | 7.8330 | 7.8473 | 7.8617 | 7.8760 | 670 |
| 680 | 7.8760 | 7.8904 | 7.9047 | 7.9191 | 7.9335 | 7.9479 | 7.9622 | 7.9766 | 7.9910 | 8.0054 | 8.0198 | 680 |
| 690 | 8.0198 | 8.0342 | 8.0486 | 8.0630 | 8.0774 | 8.0918 | 8.1062 | 8.1207 | 8.1351 | 8.1495 | 8.1639 | 690 |
| 700 | 8.1639 | 8.1784 | 8.1928 | 8.2073 | 8.2217 | 8.2361 | 8.2506 | 8.2651 | 8.2795 | 8.2940 | 8.3085 | 700 |
| 710 | 8.3085 | 8.3229 | 8.3374 | 8.3519 | 8.3664 | 8.3809 | 8.3953 | 8.4098 | 8.4243 | 8.4388 | 8.4533 | 710 |
| 720 | 8.4533 | 8.4679 | 8.4824 | 8.4969 | 8.5114 | 8.5259 | 8.5404 | 8.5550 | 8.5695 | 8.5840 | 8.5986 | 720 |
| 730 | 8.5986 | 8.6131 | 8.6277 | 8.6422 | 8.6568 | 8.6713 | 8.6859 | 8.7005 | 8.7150 | 8.7296 | 8.7442 | 730 |
| 740 | 8.7442 | 8.7588 | 8.7733 | 8.7879 | 8.8025 | 8.8171 | 8.8317 | 8.8463 | 8.8609 | 8.8755 | 8.8901 | 740 |
| 750 | 8.8901 | 8.9047 | 8.9193 | | | | | | | | | 750 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C6.** AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | 0.0000 | 0.0086 | 0.0172 | 0.0258 | 0.0344 | 0.0430 | 0.0517 | 0.0604 | 0.0691 | 30 |
| 40 | 0.0691 | 0.0778 | 0.0865 | 0.0953 | 0.1040 | 0.1128 | 0.1216 | 0.1304 | 0.1392 | 0.1481 | 0.1569 | 40 |
| 50 | 0.1569 | 0.1658 | 0.1747 | 0.1836 | 0.1925 | 0.2015 | 0.2104 | 0.2194 | 0.2284 | 0.2374 | 0.2464 | 50 |
| 60 | 0.2464 | 0.2554 | 0.2645 | 0.2736 | 0.2826 | 0.2917 | 0.3009 | 0.3100 | 0.3191 | 0.3283 | 0.3375 | 60 |
| 70 | 0.3375 | 0.3467 | 0.3559 | 0.3651 | 0.3743 | 0.3836 | 0.3929 | 0.4022 | 0.4115 | 0.4208 | 0.4301 | 70 |
| 80 | 0.4301 | 0.4395 | 0.4488 | 0.4582 | 0.4676 | 0.4770 | 0.4864 | 0.4959 | 0.5053 | 0.5148 | 0.5243 | 80 |
| 90 | 0.5243 | 0.5338 | 0.5433 | 0.5528 | 0.5624 | 0.5719 | 0.5815 | 0.5911 | 0.6007 | 0.6103 | 0.6199 | 90 |
| 100 | 0.6199 | 0.6296 | 0.6392 | 0.6489 | 0.6586 | 0.6683 | 0.6780 | 0.6878 | 0.6975 | 0.7073 | 0.7170 | 100 |
| 110 | 0.7170 | 0.7268 | 0.7366 | 0.7465 | 0.7563 | 0.7661 | 0.7760 | 0.7859 | 0.7958 | 0.8057 | 0.8156 | 110 |
| 120 | 0.8156 | 0.8255 | 0.8355 | 0.8454 | 0.8554 | 0.8654 | 0.8754 | 0.8854 | 0.8954 | 0.9055 | 0.9155 | 120 |
| 130 | 0.9155 | 0.9256 | 0.9357 | 0.9458 | 0.9559 | 0.9660 | 0.9762 | 0.9863 | 0.9965 | 1.0067 | 1.0169 | 130 |
| 140 | 1.0169 | 1.0271 | 1.0373 | 1.0475 | 1.0578 | 1.0680 | 1.0783 | 1.0886 | 1.0989 | 1.1092 | 1.1195 | 140 |
| 150 | 1.1195 | 1.1299 | 1.1402 | 1.1506 | 1.1610 | 1.1713 | 1.1817 | 1.1922 | 1.2026 | 1.2130 | 1.2235 | 150 |
| 160 | 1.2235 | 1.2340 | 1.2444 | 1.2549 | 1.2654 | 1.2760 | 1.2865 | 1.2970 | 1.3076 | 1.3182 | 1.3287 | 160 |
| 170 | 1.3287 | 1.3393 | 1.3499 | 1.3606 | 1.3712 | 1.3818 | 1.3925 | 1.4032 | 1.4138 | 1.4245 | 1.4352 | 170 |
| 180 | 1.4352 | 1.4460 | 1.4567 | 1.4674 | 1.4782 | 1.4890 | 1.4997 | 1.5105 | 1.5213 | 1.5321 | 1.5430 | 180 |
| 190 | 1.5430 | 1.5538 | 1.5647 | 1.5755 | 1.5864 | 1.5973 | 1.6082 | 1.6191 | 1.6300 | 1.6409 | 1.6519 | 190 |
| 200 | 1.6519 | 1.6628 | 1.6738 | 1.6848 | 1.6958 | 1.7068 | 1.7178 | 1.7288 | 1.7399 | 1.7509 | 1.7620 | 200 |
| 210 | 1.7620 | 1.7731 | 1.7841 | 1.7952 | 1.8063 | 1.8175 | 1.8286 | 1.8397 | 1.8509 | 1.8620 | 1.8732 | 210 |
| 220 | 1.8732 | 1.8844 | 1.8956 | 1.9068 | 1.9180 | 1.9293 | 1.9405 | 1.9518 | 1.9630 | 1.9743 | 1.9856 | 220 |
| 230 | 1.9856 | 1.9969 | 2.0082 | 2.0195 | 2.0308 | 2.0422 | 2.0535 | 2.0649 | 2.0763 | 2.0876 | 2.0990 | 230 |
| 240 | 2.0990 | 2.1104 | 2.1218 | 2.1333 | 2.1447 | 2.1562 | 2.1676 | 2.1791 | 2.1906 | 2.2020 | 2.2135 | 240 |
| 250 | 2.2135 | 2.2251 | 2.2366 | 2.2481 | 2.2596 | 2.2712 | 2.2828 | 2.2943 | 2.3059 | 2.3175 | 2.3291 | 250 |
| 260 | 2.3291 | 2.3407 | 2.3523 | 2.3640 | 2.3756 | 2.3873 | 2.3989 | 2.4106 | 2.4223 | 2.4340 | 2.4457 | 260 |
| 270 | 2.4457 | 2.4574 | 2.4691 | 2.4809 | 2.4926 | 2.5044 | 2.5161 | 2.5279 | 2.5397 | 2.5515 | 2.5633 | 270 |
| 280 | 2.5633 | 2.5751 | 2.5869 | 2.5987 | 2.6106 | 2.6224 | 2.6343 | 2.6462 | 2.6581 | 2.6699 | 2.6818 | 280 |
| 290 | 2.6818 | 2.6937 | 2.7057 | 2.7176 | 2.7295 | 2.7415 | 2.7534 | 2.7654 | 2.7774 | 2.7894 | 2.8014 | 290 |
| 300 | 2.8014 | 2.8134 | 2.8254 | 2.8374 | 2.8494 | 2.8615 | 2.8735 | 2.8856 | 2.8976 | 2.9097 | 2.9218 | 300 |
| 310 | 2.9218 | 2.9339 | 2.9460 | 2.9581 | 2.9702 | 2.9824 | 2.9945 | 3.0067 | 3.0188 | 3.0310 | 3.0432 | 310 |
| 320 | 3.0432 | 3.0553 | 3.0675 | 3.0797 | 3.0919 | 3.1042 | 3.1164 | 3.1286 | 3.1409 | 3.1531 | 3.1654 | 320 |
| 330 | 3.1654 | 3.1777 | 3.1900 | 3.2022 | 3.2145 | 3.2268 | 3.2392 | 3.2515 | 3.2638 | 3.2762 | 3.2885 | 330 |
| 340 | 3.2885 | 3.3009 | 3.3132 | 3.3256 | 3.3380 | 3.3504 | 3.3628 | 3.3752 | 3.3876 | 3.4000 | 3.4125 | 340 |
| 350 | 3.4125 | 3.4249 | 3.4374 | 3.4498 | 3.4623 | 3.4748 | 3.4873 | 3.4997 | 3.5122 | 3.5248 | 3.5373 | 350 |
| 360 | 3.5373 | 3.5498 | 3.5623 | 3.5749 | 3.5874 | 3.6000 | 3.6125 | 3.6251 | 3.6377 | 3.6503 | 3.6629 | 360 |
| 370 | 3.6629 | 3.6755 | 3.6881 | 3.7007 | 3.7133 | 3.7260 | 3.7386 | 3.7513 | 3.7639 | 3.7766 | 3.7893 | 370 |
| 380 | 3.7893 | 3.8020 | 3.8146 | 3.8273 | 3.8401 | 3.8528 | 3.8655 | 3.8782 | 3.8910 | 3.9037 | 3.9165 | 380 |
| 390 | 3.9165 | 3.9292 | 3.9420 | 3.9548 | 3.9675 | 3.9803 | 3.9931 | 4.0059 | 4.0187 | 4.0316 | 4.0444 | 390 |
| 400 | 4.0444 | 4.0572 | 4.0701 | 4.0829 | 4.0958 | 4.1086 | 4.1215 | 4.1344 | 4.1473 | 4.1602 | 4.1731 | 400 |
| 410 | 4.1731 | 4.1860 | 4.1989 | 4.2118 | 4.2247 | 4.2377 | 4.2506 | 4.2636 | 4.2765 | 4.2895 | 4.3024 | 410 |
| 420 | 4.3024 | 4.3154 | 4.3284 | 4.3414 | 4.3544 | 4.3674 | 4.3804 | 4.3934 | 4.4065 | 4.4195 | 4.4325 | 420 |
| 430 | 4.4325 | 4.4456 | 4.4586 | 4.4717 | 4.4848 | 4.4979 | 4.5109 | 4.5240 | 4.5371 | 4.5502 | 4.5633 | 430 |
| 440 | 4.5633 | 4.5765 | 4.5896 | 4.6027 | 4.6158 | 4.6290 | 4.6421 | 4.6553 | 4.6685 | 4.6816 | 4.6948 | 440 |
| 450 | 4.6948 | 4.7080 | 4.7212 | 4.7344 | 4.7476 | 4.7608 | 4.7740 | 4.7872 | 4.8004 | 4.8137 | 4.8269 | 450 |
| 460 | 4.8269 | 4.8402 | 4.8534 | 4.8667 | 4.8800 | 4.8932 | 4.9065 | 4.9198 | 4.9331 | 4.9464 | 4.9597 | 460 |
| 470 | 4.9597 | 4.9730 | 4.9863 | 4.9996 | 5.0130 | 5.0263 | 5.0397 | 5.0530 | 5.0664 | 5.0797 | 5.0931 | 470 |
| 480 | 5.0931 | 5.1065 | 5.1198 | 5.1332 | 5.1466 | 5.1600 | 5.1734 | 5.1868 | 5.2003 | 5.2137 | 5.2271 | 480 |
| 490 | 5.2271 | 5.2405 | 5.2540 | 5.2674 | 5.2809 | 5.2943 | 5.3078 | 5.3213 | 5.3347 | 5.3482 | 5.3617 | 490 |
| 500 | 5.3617 | 5.3752 | 5.3887 | 5.4022 | 5.4157 | 5.4292 | 5.4428 | 5.4563 | 5.4698 | 5.4834 | 5.4969 | 500 |
| 510 | 5.4969 | 5.5105 | 5.5240 | 5.5376 | 5.5512 | 5.5647 | 5.5783 | 5.5919 | 5.6055 | 5.6191 | 5.6327 | 510 |
| 520 | 5.6327 | 5.6463 | 5.6599 | 5.6735 | 5.6872 | 5.7008 | 5.7144 | 5.7281 | 5.7417 | 5.7554 | 5.7690 | 520 |
| 530 | 5.7690 | 5.7827 | 5.7964 | 5.8100 | 5.8237 | 5.8374 | 5.8511 | 5.8648 | 5.8785 | 5.8922 | 5.9059 | 530 |
| 540 | 5.9059 | 5.9196 | 5.9334 | 5.9471 | 5.9608 | 5.9746 | 5.9883 | 6.0021 | 6.0158 | 6.0296 | 6.0433 | 540 |
| 550 | 6.0433 | 6.0571 | 6.0709 | 6.0847 | 6.0985 | 6.1123 | 6.1261 | 6.1399 | 6.1537 | 6.1675 | 6.1813 | 550 |
| 560 | 6.1813 | 6.1951 | 6.2089 | 6.2228 | 6.2366 | 6.2505 | 6.2643 | 6.2782 | 6.2920 | 6.3059 | 6.3198 | 560 |
| 570 | 6.3198 | 6.3336 | 6.3475 | 6.3614 | 6.3753 | 6.3892 | 6.4031 | 6.4170 | 6.4309 | 6.4448 | 6.4587 | 570 |
| 580 | 6.4587 | 6.4726 | 6.4866 | 6.5005 | 6.5144 | 6.5284 | 6.5423 | 6.5563 | 6.5703 | 6.5842 | 6.5982 | 580 |
| 590 | 6.5982 | 6.6122 | 6.6261 | 6.6401 | 6.6541 | 6.6681 | 6.6821 | 6.6961 | 6.7101 | 6.7241 | 6.7381 | 590 |
| 600 | 6.7381 | 6.7521 | 6.7662 | 6.7802 | 6.7942 | 6.8083 | 6.8223 | 6.8364 | 6.8504 | 6.8645 | 6.8785 | 600 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**TABLE C6.** AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS | | | | | | | | | | | |
| 600 | 6.7381 | 6.7521 | 6.7662 | 6.7802 | 6.7942 | 6.8083 | 6.8223 | 6.8364 | 6.8504 | 6.8645 | 6.8785 | 600 |
| 610 | 6.8785 | 6.8926 | 6.9067 | 6.9207 | 6.9348 | 6.9489 | 6.9630 | 6.9771 | 6.9912 | 7.0053 | 7.0194 | 610 |
| 620 | 7.0194 | 7.0335 | 7.0476 | 7.0617 | 7.0759 | 7.0900 | 7.1041 | 7.1183 | 7.1324 | 7.1466 | 7.1607 | 620 |
| 630 | 7.1607 | 7.1749 | 7.1890 | 7.2032 | 7.2174 | 7.2315 | 7.2457 | 7.2599 | 7.2741 | 7.2883 | 7.3025 | 630 |
| 640 | 7.3025 | 7.3167 | 7.3309 | 7.3451 | 7.3593 | 7.3735 | 7.3877 | 7.4019 | 7.4162 | 7.4304 | 7.4446 | 640 |
| 650 | 7.4446 | 7.4589 | 7.4731 | 7.4874 | 7.5016 | 7.5159 | 7.5302 | 7.5444 | 7.5587 | 7.5730 | 7.5873 | 650 |
| 660 | 7.5873 | 7.6015 | 7.6158 | 7.6301 | 7.6444 | 7.6587 | 7.6730 | 7.6873 | 7.7016 | 7.7160 | 7.7303 | 660 |
| 670 | 7.7303 | 7.7446 | 7.7589 | 7.7733 | 7.7876 | 7.8019 | 7.8163 | 7.8306 | 7.8450 | 7.8593 | 7.8737 | 670 |
| 680 | 7.8737 | 7.8881 | 7.9024 | 7.9168 | 7.9312 | 7.9456 | 7.9599 | 7.9743 | 7.9887 | 8.0031 | 8.0175 | 680 |
| 690 | 8.0175 | 8.0319 | 8.0463 | 8.0607 | 8.0752 | 8.0896 | 8.1040 | 8.1184 | 8.1329 | 8.1473 | 8.1617 | 690 |
| 700 | 8.1617 | 8.1762 | 8.1906 | 8.2051 | 8.2195 | 8.2340 | 8.2484 | 8.2629 | 8.2774 | 8.2918 | 8.3063 | 700 |
| 710 | 8.3063 | 8.3208 | 8.3353 | 8.3498 | 8.3643 | 8.3788 | 8.3933 | 8.4078 | 8.4223 | 8.4368 | 8.4513 | 710 |
| 720 | 8.4513 | 8.4658 | 8.4803 | 8.4948 | 8.5094 | 8.5239 | 8.5384 | 8.5530 | 8.5675 | 8.5821 | 8.5966 | 720 |
| 730 | 8.5966 | 8.6112 | 8.6257 | 8.6403 | 8.6548 | 8.6694 | 8.6840 | 8.6986 | 8.7131 | 8.7277 | 8.7423 | 730 |
| 740 | 8.7423 | 8.7569 | 8.7715 | 8.7861 | 8.8007 | 8.8153 | 8.8299 | 8.8445 | 8.8591 | 8.8737 | 8.8883 | 740 |
| 750 | 8.8883 | 8.9030 | 8.9176 | 8.9322 | 8.9468 | 8.9615 | 8.9761 | 8.9908 | 9.0054 | 9.0201 | 9.0347 | 750 |
| 760 | 9.0347 | 9.0494 | 9.0640 | 9.0787 | 9.0934 | 9.1080 | 9.1227 | 9.1374 | 9.1521 | 9.1667 | 9.1814 | 760 |
| 770 | 9.1814 | 9.1961 | 9.2108 | 9.2255 | 9.2402 | 9.2549 | 9.2696 | 9.2843 | 9.2991 | 9.3138 | 9.3285 | 770 |
| 780 | 9.3285 | 9.3432 | 9.3579 | 9.3727 | 9.3874 | 9.4021 | 9.4169 | 9.4316 | 9.4464 | 9.4611 | 9.4759 | 780 |
| 790 | 9.4759 | 9.4906 | 9.5054 | 9.5201 | 9.5349 | 9.5497 | 9.5644 | 9.5792 | 9.5940 | 9.6088 | 9.6236 | 790 |
| 800 | 9.6236 | 9.6383 | 9.6531 | 9.6679 | 9.6827 | 9.6975 | 9.7123 | 9.7271 | 9.7419 | 9.7568 | 9.7716 | 800 |
| 810 | 9.7716 | 9.7864 | 9.8012 | 9.8160 | 9.8309 | 9.8457 | 9.8605 | 9.8754 | 9.8902 | 9.9050 | 9.9199 | 810 |
| 820 | 9.9199 | 9.9347 | 9.9496 | 9.9644 | 9.9793 | 9.9942 | 10.0090 | 10.0239 | 10.0388 | 10.0536 | 10.0685 | 820 |
| 830 | 10.0685 | 10.0834 | 10.0983 | 10.1132 | 10.1280 | 10.1429 | 10.1578 | 10.1727 | 10.1876 | 10.2025 | 10.2174 | 830 |
| 840 | 10.2174 | 10.2323 | 10.2473 | 10.2622 | 10.2771 | 10.2920 | 10.3069 | 10.3218 | 10.3368 | 10.3517 | 10.3666 | 840 |
| 850 | 10.3666 | 10.3816 | 10.3965 | 10.4115 | 10.4264 | 10.4414 | 10.4563 | 10.4713 | 10.4862 | 10.5012 | 10.5161 | 850 |
| 860 | 10.5161 | 10.5311 | 10.5461 | 10.5611 | 10.5760 | 10.5910 | 10.6060 | 10.6210 | 10.6359 | 10.6509 | 10.6659 | 860 |
| 870 | 10.6659 | 10.6809 | 10.6959 | 10.7109 | 10.7259 | 10.7409 | 10.7559 | 10.7709 | 10.7860 | 10.8010 | 10.8160 | 870 |
| 880 | 10.8160 | 10.8310 | 10.8460 | 10.8611 | 10.8761 | 10.8911 | 10.9062 | 10.9212 | 10.9362 | 10.9513 | 10.9663 | 880 |
| 890 | 10.9663 | 10.9814 | 10.9964 | 11.0115 | 11.0265 | 11.0416 | 11.0567 | 11.0717 | 11.0868 | 11.1019 | 11.1169 | 890 |
| 900 | 11.1169 | 11.1320 | 11.1471 | 11.1622 | 11.1773 | 11.1923 | 11.2074 | 11.2225 | 11.2376 | 11.2527 | 11.2678 | 900 |
| 910 | 11.2678 | 11.2829 | 11.2980 | 11.3131 | 11.3282 | 11.3433 | 11.3585 | 11.3736 | 11.3887 | 11.4038 | 11.4189 | 910 |
| 920 | 11.4189 | 11.4341 | 11.4492 | 11.4643 | 11.4795 | 11.4946 | 11.5097 | 11.5249 | 11.5400 | 11.5552 | 11.5703 | 920 |
| 930 | 11.5703 | 11.5855 | 11.6006 | 11.6158 | 11.6310 | 11.6461 | 11.6613 | 11.6765 | 11.6916 | 11.7068 | 11.7220 | 930 |
| 940 | 11.7220 | 11.7372 | 11.7523 | 11.7675 | 11.7827 | 11.7979 | 11.8131 | 11.8283 | 11.8435 | 11.8587 | 11.8739 | 940 |
| 950 | 11.8739 | 11.8891 | 11.9043 | 11.9195 | 11.9347 | 11.9499 | 11.9651 | 11.9804 | 11.9956 | 12.0108 | 12.0260 | 950 |
| 960 | 12.0260 | 12.0413 | 12.0565 | 12.0717 | 12.0870 | 12.1022 | 12.1174 | 12.1327 | 12.1479 | 12.1632 | 12.1784 | 960 |
| 970 | 12.1784 | 12.1937 | 12.2089 | 12.2242 | 12.2394 | 12.2547 | 12.2700 | 12.2852 | 12.3005 | 12.3158 | 12.3311 | 970 |
| 980 | 12.3311 | 12.3463 | 12.3616 | 12.3769 | 12.3922 | 12.4075 | 12.4228 | 12.4380 | 12.4533 | 12.4686 | 12.4839 | 980 |
| 990 | 12.4839 | 12.4992 | 12.5145 | 12.5298 | 12.5451 | 12.5605 | 12.5758 | 12.5911 | 12.6064 | 12.6217 | 12.6370 | 990 |
| 1,000 | 12.6370 | 12.6524 | 12.6677 | 12.6830 | 12.6983 | 12.7137 | 12.7290 | 12.7444 | 12.7597 | 12.7750 | 12.7904 | 1,000 |
| 1,010 | 12.7904 | 12.8057 | 12.8211 | 12.8364 | 12.8518 | 12.8671 | 12.8825 | 12.8979 | 12.9132 | 12.9286 | 12.9439 | 1,010 |
| 1,020 | 12.9439 | 12.9593 | 12.9747 | 12.9901 | 13.0054 | 13.0208 | 13.0362 | 13.0516 | 13.0670 | 13.0824 | 13.0977 | 1,020 |
| 1,030 | 13.0977 | 13.1131 | 13.1285 | 13.1439 | 13.1593 | 13.1747 | 13.1901 | 13.2055 | 13.2209 | 13.2364 | 13.2518 | 1,030 |
| 1,040 | 13.2518 | 13.2672 | 13.2826 | 13.2980 | 13.3134 | 13.3289 | 13.3443 | 13.3597 | 13.3751 | 13.3906 | 13.4060 | 1,040 |
| 1,050 | 13.4060 | 13.4214 | 13.4369 | 13.4523 | 13.4678 | 13.4832 | 13.4987 | 13.5141 | 13.5296 | 13.5450 | 13.5605 | 1,050 |
| 1,060 | 13.5605 | 13.5759 | 13.5914 | 13.6069 | 13.6223 | 13.6378 | 13.6533 | 13.6687 | 13.6842 | 13.6997 | 13.7152 | 1,060 |
| 1,070 | 13.7152 | 13.7306 | 13.7461 | 13.7616 | 13.7771 | 13.7926 | 13.8081 | 13.8236 | 13.8391 | 13.8546 | 13.8701 | 1,070 |
| 1,080 | 13.8701 | 13.8856 | 13.9011 | 13.9166 | 13.9321 | 13.9476 | 13.9631 | 13.9786 | 13.9941 | 14.0097 | 14.0252 | 1,080 |
| 1,090 | 14.0252 | 14.0407 | 14.0562 | 14.0717 | 14.0873 | 14.1028 | 14.1183 | 14.1339 | 14.1494 | 14.1650 | 14.1805 | 1,090 |
| 1,100 | 14.1805 | 14.1960 | 14.2116 | 14.2271 | 14.2427 | 14.2582 | 14.2738 | 14.2893 | 14.3049 | 14.3205 | 14.3360 | 1,100 |
| 1,110 | 14.3360 | 14.3516 | 14.3672 | 14.3827 | 14.3983 | 14.4139 | 14.4294 | 14.4450 | 14.4606 | 14.4762 | 14.4918 | 1,110 |
| 1,120 | 14.4918 | 14.5074 | 14.5229 | 14.5385 | 14.5541 | 14.5697 | 14.5853 | 14.6009 | 14.6165 | 14.6321 | 14.6477 | 1,120 |
| 1,130 | 14.6477 | 14.6633 | 14.6789 | 14.6945 | 14.7102 | 14.7258 | 14.7414 | 14.7570 | 14.7726 | 14.7882 | 14.8039 | 1,130 |
| 1,140 | 14.8039 | 14.8195 | 14.8351 | 14.8508 | 14.8664 | 14.8820 | 14.8977 | 14.9133 | 14.9289 | 14.9446 | 14.9602 | 1,140 |
| 1,150 | 14.9602 | 14.9759 | 14.9915 | 15.0072 | 15.0228 | 15.0385 | 15.0541 | 15.0698 | 15.0855 | 15.1011 | 15.1168 | 1,150 |
| 1,160 | 15.1168 | 15.1324 | 15.1481 | 15.1638 | 15.1795 | 15.1951 | 15.2108 | 15.2265 | 15.2422 | 15.2579 | 15.2735 | 1,160 |
| 1,170 | 15.2735 | 15.2892 | 15.3049 | 15.3206 | 15.3363 | 15.3520 | 15.3677 | 15.3834 | 15.3991 | 15.4148 | 15.4305 | 1,170 |
| 1,180 | 15.4305 | 15.4462 | 15.4619 | 15.4776 | 15.4933 | 15.5090 | 15.5248 | 15.5405 | 15.5562 | 15.5719 | 15.5876 | 1,180 |
| 1,190 | 15.5876 | 15.6034 | 15.6191 | 15.6348 | 15.6506 | 15.6663 | 15.6820 | 15.6978 | 15.7135 | 15.7292 | 15.7450 | 1,190 |
| 1,200 | 15.7450 | 15.7607 | 15.7765 | 15.7922 | 15.8080 | 15.8237 | 15.8395 | 15.8552 | 15.8710 | 15.8868 | 15.9025 | 1,200 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

TABLE C6. AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,200 | 15.7450 | 15.7607 | 15.7765 | 15.7922 | 15.8080 | 15.8237 | 15.8395 | 15.8552 | 15.8710 | 15.8868 | 15.9025 | 1,200 |
| 1,210 | 15.9025 | 15.9183 | 15.9341 | 15.9498 | 15.9656 | 15.9814 | 15.9971 | 16.0129 | 16.0287 | 16.0445 | 16.0603 | 1,210 |
| 1,220 | 16.0603 | 16.0760 | 16.0918 | 16.1076 | 16.1234 | 16.1392 | 16.1550 | 16.1708 | 16.1866 | 16.2024 | 16.2182 | 1,220 |
| 1,230 | 16.2182 | 16.2340 | 16.2498 | 16.2656 | 16.2814 | 16.2972 | 16.3130 | 16.3288 | 16.3447 | 16.3605 | 16.3763 | 1,230 |
| 1,240 | 16.3763 | 16.3921 | 16.4080 | 16.4238 | 16.4396 | 16.4554 | 16.4713 | 16.4871 | 16.5029 | 16.5188 | 16.5346 | 1,240 |
| 1,250 | 16.5346 | 16.5505 | 16.5663 | 16.5821 | 16.5980 | 16.6138 | 16.6297 | 16.6455 | 16.6614 | 16.6772 | 16.6931 | 1,250 |
| 1,260 | 16.6931 | 16.7090 | 16.7248 | 16.7407 | 16.7566 | 16.7724 | 16.7883 | 16.8042 | 16.8200 | 16.8359 | 16.8518 | 1,260 |
| 1,270 | 16.8518 | 16.8677 | 16.8835 | 16.8994 | 16.9153 | 16.9312 | 16.9471 | 16.9630 | 16.9789 | 16.9948 | 17.0106 | 1,270 |
| 1,280 | 17.0106 | 17.0265 | 17.0424 | 17.0583 | 17.0742 | 17.0902 | 17.1061 | 17.1220 | 17.1379 | 17.1538 | 17.1697 | 1,280 |
| 1,290 | 17.1697 | 17.1856 | 17.2015 | 17.2175 | 17.2334 | 17.2493 | 17.2652 | 17.2811 | 17.2971 | 17.3130 | 17.3289 | 1,290 |
| 1,300 | 17.3289 | 17.3449 | 17.3608 | 17.3767 | 17.3927 | 17.4086 | 17.4246 | 17.4405 | 17.4565 | 17.4724 | 17.4884 | 1,300 |
| 1,310 | 17.4884 | 17.5043 | 17.5203 | 17.5362 | 17.5522 | 17.5681 | 17.5841 | 17.6001 | 17.6160 | 17.6320 | 17.6480 | 1,310 |
| 1,320 | 17.6480 | 17.6639 | 17.6799 | 17.6959 | 17.7118 | 17.7278 | 17.7438 | 17.7598 | 17.7758 | 17.7917 | 17.8077 | 1,320 |
| 1,330 | 17.8077 | 17.8237 | 17.8397 | 17.8557 | 17.8717 | 17.8877 | 17.9037 | 17.9197 | 17.9357 | 17.9517 | 17.9677 | 1,330 |
| 1,340 | 17.9677 | 17.9837 | 17.9997 | 18.0157 | 18.0317 | 18.0477 | 18.0638 | 18.0798 | 18.0958 | 18.1118 | 18.1278 | 1,340 |
| 1,350 | 18.1278 | 18.1439 | 18.1599 | 18.1759 | 18.1919 | 18.2080 | 18.2240 | 18.2400 | 18.2561 | 18.2721 | 18.2882 | 1,350 |
| 1,360 | 18.2882 | 18.3042 | 18.3202 | 18.3363 | 18.3523 | 18.3684 | 18.3844 | 18.4005 | 18.4165 | 18.4326 | 18.4486 | 1,360 |
| 1,370 | 18.4486 | 18.4647 | 18.4808 | 18.4968 | 18.5129 | 18.5290 | 18.5450 | 18.5611 | 18.5772 | 18.5932 | 18.6093 | 1,370 |
| 1,380 | 18.6093 | 18.6254 | 18.6415 | 18.6576 | 18.6736 | 18.6897 | 18.7058 | 18.7219 | 18.7380 | 18.7541 | 18.7702 | 1,380 |
| 1,390 | 18.7702 | 18.7863 | 18.8024 | 18.8185 | 18.8346 | 18.8507 | 18.8668 | 18.8829 | 18.8990 | 18.9151 | 18.9312 | 1,390 |
| 1,400 | 18.9312 | 18.9473 | 18.9634 | 18.9795 | 18.9956 | 19.0118 | 19.0279 | 19.0440 | 19.0601 | 19.0763 | 19.0924 | 1,400 |
| 1,410 | 19.0924 | 19.1085 | 19.1246 | 19.1408 | 19.1569 | 19.1730 | 19.1892 | 19.2053 | 19.2215 | 19.2376 | 19.2538 | 1,410 |
| 1,420 | 19.2538 | 19.2699 | 19.2860 | 19.3022 | 19.3183 | 19.3345 | 19.3507 | 19.3668 | 19.3830 | 19.3991 | 19.4153 | 1,420 |
| 1,430 | 19.4153 | 19.4315 | 19.4476 | 19.4638 | 19.4800 | 19.4961 | 19.5123 | 19.5285 | 19.5446 | 19.5608 | 19.5770 | 1,430 |
| 1,440 | 19.5770 | 19.5932 | 19.6094 | 19.6256 | 19.6417 | 19.6579 | 19.6741 | 19.6903 | 19.7065 | 19.7227 | 19.7389 | 1,440 |
| 1,450 | 19.7389 | 19.7551 | 19.7713 | 19.7875 | 19.8037 | 19.8199 | 19.8361 | 19.8523 | 19.8685 | 19.8847 | 19.9009 | 1,450 |
| 1,460 | 19.9009 | 19.9172 | 19.9334 | 19.9496 | 19.9658 | 19.9820 | 19.9982 | 20.0145 | 20.0307 | 20.0469 | 20.0632 | 1,460 |
| 1,470 | 20.0632 | 20.0794 | 20.0956 | 20.1119 | 20.1281 | 20.1443 | 20.1606 | 20.1768 | 20.1931 | 20.2093 | 20.2255 | 1,470 |
| 1,480 | 20.2255 | 20.2418 | 20.2580 | 20.2743 | 20.2905 | 20.3068 | 20.3231 | 20.3393 | 20.3556 | 20.3718 | 20.3881 | 1,480 |
| 1,490 | 20.3881 | 20.4044 | 20.4206 | 20.4369 | 20.4532 | 20.4694 | 20.4857 | 20.5020 | 20.5183 | 20.5345 | 20.5508 | 1,490 |
| 1,500 | 20.5508 | 20.5671 | 20.5834 | 20.5997 | 20.6159 | 20.6322 | 20.6485 | 20.6648 | 20.6811 | 20.6974 | 20.7137 | 1,500 |
| 1,510 | 20.7137 | 20.7300 | 20.7463 | 20.7626 | 20.7789 | 20.7952 | 20.8115 | 20.8278 | 20.8441 | 20.8604 | 20.8767 | 1,510 |
| 1,520 | 20.8767 | 20.8931 | 20.9094 | 20.9257 | 20.9420 | 20.9583 | 20.9747 | 20.9910 | 21.0073 | 21.0236 | 21.0400 | 1,520 |
| 1,530 | 21.0400 | 21.0563 | 21.0726 | 21.0890 | 21.1053 | 21.1216 | 21.1380 | 21.1543 | 21.1706 | 21.1870 | 21.2033 | 1,530 |
| 1,540 | 21.2033 | 21.2197 | 21.2360 | 21.2524 | 21.2687 | 21.2851 | 21.3014 | 21.3178 | 21.3341 | 21.3505 | 21.3669 | 1,540 |
| 1,550 | 21.3669 | 21.3832 | 21.3996 | 21.4160 | 21.4323 | 21.4487 | 21.4651 | 21.4814 | 21.4978 | 21.5142 | 21.5306 | 1,550 |
| 1,560 | 21.5306 | 21.5469 | 21.5633 | 21.5797 | 21.5961 | 21.6125 | 21.6288 | 21.6452 | 21.6616 | 21.6780 | 21.6944 | 1,560 |
| 1,570 | 21.6944 | 21.7108 | 21.7272 | 21.7436 | 21.7600 | 21.7764 | 21.7928 | 21.8092 | 21.8256 | 21.8420 | 21.8584 | 1,570 |
| 1,580 | 21.8584 | 21.8748 | 21.8912 | 21.9076 | 21.9241 | 21.9405 | 21.9569 | 21.9733 | 21.9897 | 22.0062 | 22.0226 | 1,580 |
| 1,590 | 22.0226 | 22.0390 | 22.0554 | 22.0719 | 22.0883 | 22.1047 | 22.1212 | 22.1376 | 22.1540 | 22.1705 | 22.1869 | 1,590 |
| 1,600 | 22.1869 | 22.2033 | 22.2198 | 22.2362 | 22.2527 | 22.2691 | 22.2856 | 22.3020 | 22.3185 | 22.3349 | 22.3514 | 1,600 |
| 1,610 | 22.3514 | 22.3678 | 22.3843 | 22.4007 | 22.4172 | 22.4337 | 22.4501 | 22.4666 | 22.4831 | 22.4995 | 22.5160 | 1,610 |
| 1,620 | 22.5160 | 22.5325 | 22.5489 | 22.5654 | 22.5819 | 22.5984 | 22.6149 | 22.6313 | 22.6478 | 22.6643 | 22.6808 | 1,620 |
| 1,630 | 22.6808 | 22.6973 | 22.7138 | 22.7302 | 22.7467 | 22.7632 | 22.7797 | 22.7962 | 22.8127 | 22.8292 | 22.8457 | 1,630 |
| 1,640 | 22.8457 | 22.8622 | 22.8787 | 22.8952 | 22.9117 | 22.9282 | 22.9447 | 22.9613 | 22.9778 | 22.9943 | 23.0108 | 1,640 |
| 1,650 | 23.0108 | 23.0273 | 23.0438 | 23.0603 | 23.0769 | 23.0934 | 23.1099 | 23.1264 | 23.1430 | 23.1595 | 23.1760 | 1,650 |
| 1,660 | 23.1760 | 23.1926 | 23.2091 | 23.2256 | 23.2422 | 23.2587 | 23.2752 | 23.2918 | 23.3083 | 23.3249 | 23.3414 | 1,660 |
| 1,670 | 23.3414 | 23.3579 | 23.3745 | 23.3910 | 23.4076 | 23.4241 | 23.4407 | 23.4572 | 23.4738 | 23.4904 | 23.5069 | 1,670 |
| 1,680 | 23.5069 | 23.5235 | 23.5400 | 23.5566 | 23.5732 | 23.5897 | 23.6063 | 23.6229 | 23.6394 | 23.6560 | 23.6726 | 1,680 |
| 1,690 | 23.6726 | 23.6892 | 23.7057 | 23.7223 | 23.7389 | 23.7555 | 23.7720 | 23.7886 | 23.8052 | 23.8218 | 23.8384 | 1,690 |
| 1,700 | 23.8384 | 23.8550 | 23.8716 | 23.8882 | 23.9048 | 23.9213 | 23.9379 | 23.9545 | 23.9711 | 23.9877 | 24.0043 | 1,700 |
| 1,710 | 24.0043 | 24.0209 | 24.0375 | 24.0542 | 24.0708 | 24.0874 | 24.1040 | 24.1206 | 24.1372 | 24.1538 | 24.1704 | 1,710 |
| 1,720 | 24.1704 | 24.1870 | 24.2037 | 24.2203 | 24.2369 | 24.2535 | 24.2701 | 24.2868 | 24.3034 | 24.3200 | 24.3367 | 1,720 |
| 1,730 | 24.3367 | 24.3533 | 24.3699 | 24.3866 | 24.4032 | 24.4198 | 24.4365 | 24.4531 | 24.4697 | 24.4864 | 24.5030 | 1,730 |
| 1,740 | 24.5030 | 24.5197 | 24.5363 | 24.5530 | 24.5696 | 24.5863 | 24.6029 | 24.6196 | 24.6362 | 24.6529 | 24.6695 | 1,740 |
| 1,750 | 24.6695 | 24.6862 | 24.7028 | 24.7195 | 24.7362 | 24.7528 | 24.7695 | 24.7862 | 24.8028 | 24.8195 | 24.8362 | 1,750 |
| 1,760 | 24.8362 | 24.8528 | 24.8695 | 24.8862 | 24.9028 | 24.9195 | 24.9362 | 24.9529 | 24.9696 | 24.9862 | 25.0029 | 1,760 |
| 1,770 | 25.0029 | 25.0196 | 25.0363 | 25.0530 | 25.0697 | 25.0864 | 25.1030 | 25.1197 | 25.1364 | 25.1531 | 25.1698 | 1,770 |
| 1,780 | 25.1698 | 25.1865 | 25.2032 | 25.2199 | 25.2366 | 25.2533 | 25.2700 | 25.2867 | 25.3034 | 25.3201 | 25.3369 | 1,780 |
| 1,790 | 25.3369 | 25.3536 | 25.3703 | 25.3870 | 25.4037 | 25.4204 | 25.4371 | 25.4538 | 25.4706 | 25.4873 | 25.5040 | 1,790 |
| 1,800 | 25.5040 | 25.5207 | 25.5375 | 25.5542 | 25.5709 | 25.5876 | 25.6044 | 25.6211 | 25.6378 | 25.6546 | 25.6713 | 1,800 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C6.** AWG 14 *Nicrosil thermoelements versus platinum,* Pt–67—*thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,800 | 25.5040 | 25.5207 | 25.5375 | 25.5542 | 25.5709 | 25.5876 | 25.6044 | 25.6211 | 25.6378 | 25.6546 | 25.6713 | 1,800 |
| 1,810 | 25.6713 | 25.6880 | 25.7048 | 25.7215 | 25.7382 | 25.7550 | 25.7717 | 25.7885 | 25.8052 | 25.8219 | 25.8387 | 1,810 |
| 1,820 | 25.8387 | 25.8554 | 25.8722 | 25.8889 | 25.9057 | 25.9224 | 25.9392 | 25.9559 | 25.9727 | 25.9895 | 26.0062 | 1,820 |
| 1,830 | 26.0062 | 26.0230 | 26.0397 | 26.0565 | 26.0733 | 26.0900 | 26.1068 | 26.1236 | 26.1403 | 26.1571 | 26.1739 | 1,830 |
| 1,840 | 26.1739 | 26.1906 | 26.2074 | 26.2242 | 26.2410 | 26.2577 | 26.2745 | 26.2913 | 26.3081 | 26.3249 | 26.3416 | 1,840 |
| 1,850 | 26.3416 | 26.3584 | 26.3752 | 26.3920 | 26.4088 | 26.4256 | 26.4424 | 26.4591 | 26.4759 | 26.4927 | 26.5095 | 1,850 |
| 1,860 | 26.5095 | 26.5263 | 26.5431 | 26.5599 | 26.5767 | 26.5935 | 26.6103 | 26.6271 | 26.6439 | 26.6607 | 26.6775 | 1,860 |
| 1,870 | 26.6775 | 26.6943 | 26.7111 | 26.7279 | 26.7447 | 26.7616 | 26.7784 | 26.7952 | 26.8120 | 26.8288 | 26.8456 | 1,870 |
| 1,880 | 26.8456 | 26.8624 | 26.8793 | 26.8961 | 26.9129 | 26.9297 | 26.9465 | 26.9634 | 26.9802 | 26.9970 | 27.0139 | 1,880 |
| 1,890 | 27.0139 | 27.0307 | 27.0475 | 27.0643 | 27.0812 | 27.0980 | 27.1148 | 27.1317 | 27.1485 | 27.1653 | 27.1822 | 1,890 |
| 1,900 | 27.1822 | 27.1990 | 27.2159 | 27.2327 | 27.2495 | 27.2664 | 27.2832 | 27.3001 | 27.3169 | 27.3338 | 27.3506 | 1,900 |
| 1,910 | 27.3506 | 27.3675 | 27.3843 | 27.4012 | 27.4180 | 27.4349 | 27.4517 | 27.4686 | 27.4855 | 27.5023 | 27.5192 | 1,910 |
| 1,920 | 27.5192 | 27.5360 | 27.5529 | 27.5698 | 27.5866 | 27.6035 | 27.6203 | 27.6372 | 27.6541 | 27.6709 | 27.6878 | 1,920 |
| 1,930 | 27.6878 | 27.7047 | 27.7216 | 27.7384 | 27.7553 | 27.7722 | 27.7891 | 27.8059 | 27.8228 | 27.8397 | 27.8566 | 1,930 |
| 1,940 | 27.8566 | 27.8734 | 27.8903 | 27.9072 | 27.9241 | 27.9410 | 27.9579 | 27.9748 | 27.9916 | 28.0085 | 28.0254 | 1,940 |
| 1,950 | 28.0254 | 28.0423 | 28.0592 | 28.0761 | 28.0930 | 28.1099 | 28.1268 | 28.1437 | 28.1606 | 28.1775 | 28.1944 | 1,950 |
| 1,960 | 28.1944 | 28.2113 | 28.2282 | 28.2451 | 28.2620 | 28.2789 | 28.2958 | 28.3127 | 28.3296 | 28.3465 | 28.3634 | 1,960 |
| 1,970 | 28.3634 | 28.3803 | 28.3972 | 28.4141 | 28.4310 | 28.4480 | 28.4649 | 28.4818 | 28.4987 | 28.5156 | 28.5325 | 1,970 |
| 1,980 | 28.5325 | 28.5495 | 28.5664 | 28.5833 | 28.6002 | 28.6171 | 28.6341 | 28.6510 | 28.6679 | 28.6848 | 28.7018 | 1,980 |
| 1,990 | 28.7018 | 28.7187 | 28.7356 | 28.7525 | 28.7695 | 28.7864 | 28.8033 | 28.8203 | 28.8372 | 28.8541 | 28.8711 | 1,990 |
| 2,000 | 28.8711 | 28.8880 | 28.9049 | 28.9219 | 28.9388 | 28.9558 | 28.9727 | 28.9896 | 29.0066 | 29.0235 | 29.0405 | 2,000 |
| 2,010 | 29.0405 | 29.0574 | 29.0744 | 29.0913 | 29.1083 | 29.1252 | 29.1421 | 29.1591 | 29.1760 | 29.1930 | 29.2100 | 2,010 |
| 2,020 | 29.2100 | 29.2269 | 29.2439 | 29.2608 | 29.2778 | 29.2947 | 29.3117 | 29.3286 | 29.3456 | 29.3626 | 29.3795 | 2,020 |
| 2,030 | 29.3795 | 29.3965 | 29.4134 | 29.4304 | 29.4474 | 29.4643 | 29.4813 | 29.4983 | 29.5152 | 29.5322 | 29.5492 | 2,030 |
| 2,040 | 29.5492 | 29.5661 | 29.5831 | 29.6001 | 29.6170 | 29.6340 | 29.6510 | 29.6680 | 29.6849 | 29.7019 | 29.7189 | 2,040 |
| 2,050 | 29.7189 | 29.7359 | 29.7528 | 29.7698 | 29.7868 | 29.8038 | 29.8207 | 29.8377 | 29.8547 | 29.8717 | 29.8887 | 2,050 |
| 2,060 | 29.8887 | 29.9057 | 29.9226 | 29.9396 | 29.9566 | 29.9736 | 29.9906 | 30.0076 | 30.0246 | 30.0416 | 30.0585 | 2,060 |
| 2,070 | 30.0585 | 30.0755 | 30.0925 | 30.1095 | 30.1265 | 30.1435 | 30.1605 | 30.1775 | 30.1945 | 30.2115 | 30.2285 | 2,070 |
| 2,080 | 30.2285 | 30.2455 | 30.2625 | 30.2795 | 30.2965 | 30.3135 | 30.3305 | 30.3475 | 30.3645 | 30.3815 | 30.3985 | 2,080 |
| 2,090 | 30.3985 | 30.4155 | 30.4325 | 30.4495 | 30.4665 | 30.4835 | 30.5005 | 30.5175 | 30.5345 | 30.5515 | 30.5686 | 2,090 |
| 2,100 | 30.5686 | 30.5856 | 30.6026 | 30.6196 | 30.6366 | 30.6536 | 30.6706 | 30.6876 | 30.7047 | 30.7217 | 30.7387 | 2,100 |
| 2,110 | 30.7387 | 30.7557 | 30.7727 | 30.7897 | 30.8068 | 30.8238 | 30.8408 | 30.8578 | 30.8748 | 30.8919 | 30.9089 | 2,110 |
| 2,120 | 30.9089 | 30.9259 | 30.9429 | 30.9600 | 30.9770 | 30.9940 | 31.0110 | 31.0281 | 31.0451 | 31.0621 | 31.0791 | 2,120 |
| 2,130 | 31.0791 | 31.0962 | 31.1132 | 31.1302 | 31.1473 | 31.1643 | 31.1813 | 31.1984 | 31.2154 | 31.2324 | 31.2495 | 2,130 |
| 2,140 | 31.2495 | 31.2665 | 31.2835 | 31.3006 | 31.3176 | 31.3346 | 31.3517 | 31.3687 | 31.3857 | 31.4028 | 31.4198 | 2,140 |
| 2,150 | 31.4198 | 31.4369 | 31.4539 | 31.4709 | 31.4880 | 31.5050 | 31.5221 | 31.5391 | 31.5561 | 31.5732 | 31.5902 | 2,150 |
| 2,160 | 31.5902 | 31.6073 | 31.6243 | 31.6414 | 31.6584 | 31.6755 | 31.6925 | 31.7096 | 31.7266 | 31.7437 | 31.7607 | 2,160 |
| 2,170 | 31.7607 | 31.7777 | 31.7948 | 31.8118 | 31.8289 | 31.8459 | 31.8630 | 31.8801 | 31.8971 | 31.9142 | 31.9312 | 2,170 |
| 2,180 | 31.9312 | 31.9483 | 31.9653 | 31.9824 | 31.9994 | 32.0165 | 32.0335 | 32.0506 | 32.0677 | 32.0847 | 32.1018 | 2,180 |
| 2,190 | 32.1018 | 32.1188 | 32.1359 | 32.1529 | 32.1700 | 32.1871 | 32.2041 | 32.2212 | 32.2382 | 32.2553 | 32.2724 | 2,190 |
| 2,200 | 32.2724 | 32.2894 | 32.3065 | 32.3236 | 32.3406 | 32.3577 | 32.3747 | 32.3918 | 32.4089 | 32.4259 | 32.4430 | 2,200 |
| 2,210 | 32.4430 | 32.4601 | 32.4771 | 32.4942 | 32.5113 | 32.5283 | 32.5454 | 32.5625 | 32.5795 | 32.5966 | 32.6137 | 2,210 |
| 2,220 | 32.6137 | 32.6308 | 32.6478 | 32.6649 | 32.6820 | 32.6990 | 32.7161 | 32.7332 | 32.7503 | 32.7673 | 32.7844 | 2,220 |
| 2,230 | 32.7844 | 32.8015 | 32.8185 | 32.8356 | 32.8527 | 32.8698 | 32.8868 | 32.9039 | 32.9210 | 32.9381 | 32.9551 | 2,230 |
| 2,240 | 32.9551 | 32.9722 | 32.9893 | 33.0064 | 33.0234 | 33.0405 | 33.0576 | 33.0747 | 33.0918 | 33.1088 | 33.1259 | 2,240 |
| 2,250 | 33.1259 | 33.1430 | 33.1601 | 33.1772 | 33.1942 | 33.2113 | 33.2284 | 33.2455 | 33.2626 | 33.2796 | 33.2967 | 2,250 |
| 2,260 | 33.2967 | 33.3138 | 33.3309 | 33.3480 | 33.3651 | 33.3821 | 33.3992 | 33.4163 | 33.4334 | 33.4505 | 33.4676 | 2,260 |
| 2,270 | 33.4676 | 33.4846 | 33.5017 | 33.5188 | 33.5359 | 33.5530 | 33.5701 | 33.5872 | 33.6042 | 33.6213 | 33.6384 | 2,270 |
| 2,280 | 33.6384 | 33.6555 | 33.6726 | 33.6897 | 33.7068 | 33.7238 | 33.7409 | 33.7580 | 33.7751 | 33.7922 | 33.8093 | 2,280 |
| 2,290 | 33.8093 | 33.8264 | 33.8435 | 33.8606 | 33.8776 | 33.8947 | 33.9118 | 33.9289 | 33.9460 | 33.9631 | 33.9802 | 2,290 |
| 2,300 | 33.9802 | 33.9973 | 34.0144 | 34.0315 | 34.0486 | 34.0656 | 34.0827 | 34.0998 | 34.1169 | 34.1340 | 34.1511 | 2,300 |
| 2,310 | 34.1511 | 34.1682 | 34.1853 | 34.2024 | 34.2195 | 34.2366 | 34.2537 | 34.2708 | 34.2879 | 34.3049 | 34.3220 | 2,310 |
| 2,320 | 34.3220 | 34.3391 | 34.3562 | 34.3733 | 34.3904 | 34.4075 | 34.4246 | 34.4417 | 34.4588 | 34.4759 | 34.4930 | 2,320 |
| 2,330 | 34.4930 | 34.5101 | 34.5272 | 34.5443 | 34.5614 | 34.5785 | 34.5956 | 34.6127 | 34.6298 | 34.6468 | 34.6639 | 2,330 |
| 2,340 | 34.6639 | 34.6810 | 34.6981 | 34.7152 | 34.7323 | 34.7494 | 34.7665 | 34.7836 | 34.8007 | 34.8178 | 34.8349 | 2,340 |
| 2,350 | 34.8349 | 34.8520 | 34.8691 | 34.8862 | 34.9033 | 34.9204 | 34.9375 | 34.9546 | 34.9717 | 34.9888 | 35.0059 | 2,350 |
| 2,360 | 35.0059 | 35.0230 | 35.0401 | 35.0572 | 35.0743 | 35.0914 | 35.1085 | 35.1256 | 35.1427 | 35.1598 | 35.1769 | 2,360 |
| 2,370 | 35.1769 | 35.1940 | 35.2111 |  |  |  |  |  |  |  |  | 2,370 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C7.** *Platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -320 | -2.3549 | -2.3612 | -2.3676 | -2.3739 | -2.3803 | -2.3866 | -2.3929 | -2.3991 | -2.4054 | | | -320 |
| -310 | -2.2905 | -2.2970 | -2.3035 | -2.3099 | -2.3164 | -2.3228 | -2.3293 | -2.3357 | -2.3421 | -2.3485 | -2.3549 | -310 |
| -300 | -2.2251 | -2.2317 | -2.2382 | -2.2448 | -2.2514 | -2.2579 | -2.2644 | -2.2710 | -2.2775 | -2.2840 | -2.2905 | -300 |
| -290 | -2.1588 | -2.1655 | -2.1721 | -2.1788 | -2.1854 | -2.1920 | -2.1987 | -2.2053 | -2.2119 | -2.2185 | -2.2251 | -290 |
| -280 | -2.0919 | -2.0986 | -2.1054 | -2.1121 | -2.1188 | -2.1255 | -2.1321 | -2.1388 | -2.1455 | -2.1522 | -2.1588 | -280 |
| -270 | -2.0245 | -2.0313 | -2.0380 | -2.0448 | -2.0515 | -2.0583 | -2.0650 | -2.0718 | -2.0785 | -2.0852 | -2.0919 | -270 |
| -260 | -1.9567 | -1.9635 | -1.9703 | -1.9771 | -1.9839 | -1.9906 | -1.9974 | -2.0042 | -2.0110 | -2.0177 | -2.0245 | -260 |
| -250 | -1.8885 | -1.8953 | -1.9022 | -1.9090 | -1.9158 | -1.9226 | -1.9294 | -1.9363 | -1.9431 | -1.9499 | -1.9567 | -250 |
| -240 | -1.8201 | -1.8269 | -1.8338 | -1.8406 | -1.8475 | -1.8543 | -1.8612 | -1.8680 | -1.8749 | -1.8817 | -1.8885 | -240 |
| -230 | -1.7515 | -1.7583 | -1.7652 | -1.7721 | -1.7789 | -1.7858 | -1.7927 | -1.7995 | -1.8064 | -1.8132 | -1.8201 | -230 |
| -220 | -1.6826 | -1.6895 | -1.6964 | -1.7033 | -1.7102 | -1.7171 | -1.7240 | -1.7308 | -1.7377 | -1.7446 | -1.7515 | -220 |
| -210 | -1.6137 | -1.6206 | -1.6275 | -1.6344 | -1.6413 | -1.6482 | -1.6551 | -1.6620 | -1.6689 | -1.6758 | -1.6826 | -210 |
| -200 | -1.5446 | -1.5515 | -1.5584 | -1.5654 | -1.5723 | -1.5792 | -1.5861 | -1.5930 | -1.5999 | -1.6068 | -1.6137 | -200 |
| -190 | -1.4755 | -1.4824 | -1.4893 | -1.4962 | -1.5031 | -1.5101 | -1.5170 | -1.5239 | -1.5308 | -1.5377 | -1.5446 | -190 |
| -180 | -1.4063 | -1.4132 | -1.4201 | -1.4270 | -1.4340 | -1.4409 | -1.4478 | -1.4547 | -1.4616 | -1.4686 | -1.4755 | -180 |
| -170 | -1.3370 | -1.3439 | -1.3509 | -1.3578 | -1.3647 | -1.3716 | -1.3786 | -1.3855 | -1.3924 | -1.3993 | -1.4063 | -170 |
| -160 | -1.2678 | -1.2747 | -1.2816 | -1.2885 | -1.2955 | -1.3024 | -1.3093 | -1.3162 | -1.3232 | -1.3301 | -1.3370 | -160 |
| -150 | -1.1986 | -1.2055 | -1.2124 | -1.2193 | -1.2262 | -1.2332 | -1.2401 | -1.2470 | -1.2539 | -1.2608 | -1.2678 | -150 |
| -140 | -1.1294 | -1.1363 | -1.1432 | -1.1501 | -1.1571 | -1.1640 | -1.1709 | -1.1778 | -1.1847 | -1.1916 | -1.1986 | -140 |
| -130 | -1.0604 | -1.0673 | -1.0742 | -1.0811 | -1.0880 | -1.0949 | -1.1018 | -1.1087 | -1.1156 | -1.1225 | -1.1294 | -130 |
| -120 | -0.9915 | -0.9984 | -1.0052 | -1.0121 | -1.0190 | -1.0259 | -1.0328 | -1.0397 | -1.0466 | -1.0535 | -1.0604 | -120 |
| -110 | -0.9228 | -0.9296 | -0.9365 | -0.9434 | -0.9502 | -0.9571 | -0.9640 | -0.9708 | -0.9777 | -0.9846 | -0.9915 | -110 |
| -100 | -0.8543 | -0.8612 | -0.8680 | -0.8748 | -0.8817 | -0.8885 | -0.8954 | -0.9022 | -0.9091 | -0.9159 | -0.9228 | -100 |
| -90 | -0.7862 | -0.7930 | -0.7998 | -0.8066 | -0.8134 | -0.8202 | -0.8270 | -0.8339 | -0.8407 | -0.8475 | -0.8543 | -90 |
| -80 | -0.7184 | -0.7252 | -0.7319 | -0.7387 | -0.7455 | -0.7522 | -0.7590 | -0.7658 | -0.7726 | -0.7794 | -0.7862 | -80 |
| -70 | -0.6510 | -0.6577 | -0.6645 | -0.6712 | -0.6779 | -0.6846 | -0.6914 | -0.6981 | -0.7049 | -0.7116 | -0.7184 | -70 |
| -60 | -0.5841 | -0.5908 | -0.5974 | -0.6041 | -0.6108 | -0.6175 | -0.6242 | -0.6309 | -0.6376 | -0.6443 | -0.6510 | -60 |
| -50 | -0.5177 | -0.5243 | -0.5309 | -0.5376 | -0.5442 | -0.5508 | -0.5575 | -0.5641 | -0.5708 | -0.5774 | -0.5841 | -50 |
| -40 | -0.4519 | -0.4584 | -0.4650 | -0.4715 | -0.4781 | -0.4847 | -0.4913 | -0.4979 | -0.5045 | -0.5111 | -0.5177 | -40 |
| -30 | -0.3867 | -0.3932 | -0.3997 | -0.4062 | -0.4127 | -0.4192 | -0.4257 | -0.4322 | -0.4388 | -0.4453 | -0.4519 | -30 |
| -20 | -0.3222 | -0.3286 | -0.3350 | -0.3414 | -0.3479 | -0.3543 | -0.3608 | -0.3672 | -0.3737 | -0.3802 | -0.3867 | -20 |
| -10 | -0.2584 | -0.2648 | -0.2711 | -0.2775 | -0.2838 | -0.2902 | -0.2966 | -0.3030 | -0.3094 | -0.3158 | -0.3222 | -10 |
| - 0 | -0.1955 | -0.2017 | -0.2080 | -0.2143 | -0.2205 | -0.2268 | -0.2331 | -0.2394 | -0.2458 | -0.2521 | -0.2584 | - 0 |
| + 0 | -0.1955 | -0.1892 | -0.1830 | -0.1767 | -0.1705 | -0.1643 | -0.1581 | -0.1519 | -0.1457 | -0.1395 | -0.1334 | + 0 |
| 10 | -0.1334 | -0.1272 | -0.1210 | -0.1149 | -0.1088 | -0.1026 | -0.0965 | -0.0904 | -0.0843 | -0.0782 | -0.0722 | 10 |
| 20 | -0.0722 | -0.0661 | -0.0600 | -0.0540 | -0.0479 | -0.0419 | -0.0359 | -0.0299 | -0.0239 | -0.0179 | -0.0119 | 20 |
| 30 | -0.0119 | -0.0060 | 0.0000 | | | | | | | | | 30 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C7.** *Platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | | | 0.0000 | 0.0059 | 0.0119 | 0.0178 | 0.0237 | 0.0296 | 0.0355 | 0.0414 | 0.0473 | 30 |
| 40 | 0.0473 | 0.0531 | 0.0590 | 0.0648 | 0.0707 | 0.0765 | 0.0823 | 0.0881 | 0.0939 | 0.0997 | 0.1055 | 40 |
| 50 | 0.1055 | 0.1112 | 0.1170 | 0.1227 | 0.1285 | 0.1342 | 0.1400 | 0.1457 | 0.1514 | 0.1571 | 0.1628 | 50 |
| 60 | 0.1628 | 0.1685 | 0.1742 | 0.1799 | 0.1855 | 0.1912 | 0.1969 | 0.2025 | 0.2082 | 0.2138 | 0.2194 | 60 |
| 70 | 0.2194 | 0.2251 | 0.2307 | 0.2363 | 0.2419 | 0.2475 | 0.2531 | 0.2587 | 0.2643 | 0.2699 | 0.2755 | 70 |
| 80 | 0.2755 | 0.2810 | 0.2866 | 0.2922 | 0.2977 | 0.3033 | 0.3088 | 0.3144 | 0.3199 | 0.3255 | 0.3310 | 80 |
| 90 | 0.3310 | 0.3365 | 0.3421 | 0.3476 | 0.3531 | 0.3586 | 0.3641 | 0.3696 | 0.3752 | 0.3807 | 0.3862 | 90 |
| 100 | 0.3862 | 0.3916 | 0.3971 | 0.4026 | 0.4081 | 0.4136 | 0.4191 | 0.4246 | 0.4300 | 0.4355 | 0.4410 | 100 |
| 110 | 0.4410 | 0.4464 | 0.4519 | 0.4574 | 0.4628 | 0.4683 | 0.4738 | 0.4792 | 0.4847 | 0.4901 | 0.4956 | 110 |
| 120 | 0.4956 | 0.5010 | 0.5065 | 0.5119 | 0.5173 | 0.5228 | 0.5282 | 0.5337 | 0.5391 | 0.5445 | 0.5500 | 120 |
| 130 | 0.5500 | 0.5554 | 0.5608 | 0.5662 | 0.5717 | 0.5771 | 0.5825 | 0.5879 | 0.5934 | 0.5988 | 0.6042 | 130 |
| 140 | 0.6042 | 0.6096 | 0.6150 | 0.6205 | 0.6259 | 0.6313 | 0.6367 | 0.6421 | 0.6475 | 0.6529 | 0.6584 | 140 |
| 150 | 0.6584 | 0.6638 | 0.6692 | 0.6746 | 0.6800 | 0.6854 | 0.6908 | 0.6962 | 0.7016 | 0.7070 | 0.7124 | 150 |
| 160 | 0.7124 | 0.7179 | 0.7233 | 0.7287 | 0.7341 | 0.7395 | 0.7449 | 0.7503 | 0.7557 | 0.7611 | 0.7665 | 160 |
| 170 | 0.7665 | 0.7719 | 0.7773 | 0.7827 | 0.7881 | 0.7935 | 0.7989 | 0.8043 | 0.8097 | 0.8152 | 0.8206 | 170 |
| 180 | 0.8206 | 0.8260 | 0.8314 | 0.8368 | 0.8422 | 0.8476 | 0.8530 | 0.8584 | 0.8638 | 0.8692 | 0.8746 | 180 |
| 190 | 0.8746 | 0.8800 | 0.8854 | 0.8908 | 0.8963 | 0.9017 | 0.9071 | 0.9125 | 0.9179 | 0.9233 | 0.9287 | 190 |
| 200 | 0.9287 | 0.9341 | 0.9395 | 0.9449 | 0.9504 | 0.9558 | 0.9612 | 0.9666 | 0.9720 | 0.9774 | 0.9828 | 200 |
| 210 | 0.9828 | 0.9883 | 0.9937 | 0.9991 | 1.0045 | 1.0099 | 1.0153 | 1.0208 | 1.0262 | 1.0316 | 1.0370 | 210 |
| 220 | 1.0370 | 1.0424 | 1.0479 | 1.0533 | 1.0587 | 1.0641 | 1.0696 | 1.0750 | 1.0804 | 1.0858 | 1.0913 | 220 |
| 230 | 1.0913 | 1.0967 | 1.1021 | 1.1075 | 1.1130 | 1.1184 | 1.1238 | 1.1293 | 1.1347 | 1.1401 | 1.1456 | 230 |
| 240 | 1.1456 | 1.1510 | 1.1564 | 1.1619 | 1.1673 | 1.1727 | 1.1782 | 1.1836 | 1.1890 | 1.1945 | 1.1999 | 240 |
| 250 | 1.1999 | 1.2054 | 1.2108 | 1.2162 | 1.2217 | 1.2271 | 1.2326 | 1.2380 | 1.2435 | 1.2489 | 1.2543 | 250 |
| 260 | 1.2543 | 1.2598 | 1.2652 | 1.2707 | 1.2761 | 1.2816 | 1.2870 | 1.2925 | 1.2979 | 1.3034 | 1.3088 | 260 |
| 270 | 1.3088 | 1.3143 | 1.3198 | 1.3252 | 1.3307 | 1.3361 | 1.3416 | 1.3470 | 1.3525 | 1.3580 | 1.3634 | 270 |
| 280 | 1.3634 | 1.3689 | 1.3743 | 1.3798 | 1.3853 | 1.3907 | 1.3962 | 1.4017 | 1.4071 | 1.4126 | 1.4181 | 280 |
| 290 | 1.4181 | 1.4235 | 1.4290 | 1.4345 | 1.4399 | 1.4454 | 1.4509 | 1.4563 | 1.4618 | 1.4673 | 1.4728 | 290 |
| 300 | 1.4728 | 1.4782 | 1.4837 | 1.4892 | 1.4947 | 1.5002 | 1.5056 | 1.5111 | 1.5166 | 1.5221 | 1.5276 | 300 |
| 310 | 1.5276 | 1.5330 | 1.5385 | 1.5440 | 1.5495 | 1.5550 | 1.5605 | 1.5659 | 1.5714 | 1.5769 | 1.5824 | 310 |
| 320 | 1.5824 | 1.5879 | 1.5934 | 1.5989 | 1.6044 | 1.6099 | 1.6154 | 1.6209 | 1.6264 | 1.6319 | 1.6373 | 320 |
| 330 | 1.6373 | 1.6428 | 1.6483 | 1.6538 | 1.6593 | 1.6648 | 1.6703 | 1.6758 | 1.6814 | 1.6869 | 1.6924 | 330 |
| 340 | 1.6924 | 1.6979 | 1.7034 | 1.7089 | 1.7144 | 1.7199 | 1.7254 | 1.7309 | 1.7364 | 1.7419 | 1.7475 | 340 |
| 350 | 1.7475 | 1.7530 | 1.7585 | 1.7640 | 1.7695 | 1.7750 | 1.7805 | 1.7861 | 1.7916 | 1.7971 | 1.8026 | 350 |
| 360 | 1.8026 | 1.8082 | 1.8137 | 1.8192 | 1.8247 | 1.8302 | 1.8358 | 1.8413 | 1.8468 | 1.8524 | 1.8579 | 360 |
| 370 | 1.8579 | 1.8634 | 1.8690 | 1.8745 | 1.8800 | 1.8856 | 1.8911 | 1.8966 | 1.9022 | 1.9077 | 1.9132 | 370 |
| 380 | 1.9132 | 1.9188 | 1.9243 | 1.9299 | 1.9354 | 1.9409 | 1.9465 | 1.9520 | 1.9576 | 1.9631 | 1.9687 | 380 |
| 390 | 1.9687 | 1.9742 | 1.9798 | 1.9853 | 1.9909 | 1.9964 | 2.0020 | 2.0075 | 2.0131 | 2.0187 | 2.0242 | 390 |
| 400 | 2.0242 | 2.0298 | 2.0353 | 2.0409 | 2.0465 | 2.0520 | 2.0576 | 2.0632 | 2.0687 | 2.0743 | 2.0799 | 400 |
| 410 | 2.0799 | 2.0854 | 2.0910 | 2.0966 | 2.1021 | 2.1077 | 2.1133 | 2.1189 | 2.1244 | 2.1300 | 2.1356 | 410 |
| 420 | 2.1356 | 2.1412 | 2.1468 | 2.1524 | 2.1579 | 2.1635 | 2.1691 | 2.1747 | 2.1803 | 2.1859 | 2.1915 | 420 |
| 430 | 2.1915 | 2.1971 | 2.2027 | 2.2082 | 2.2138 | 2.2194 | 2.2250 | 2.2306 | 2.2362 | 2.2418 | 2.2474 | 430 |
| 440 | 2.2474 | 2.2530 | 2.2587 | 2.2643 | 2.2699 | 2.2755 | 2.2811 | 2.2867 | 2.2923 | 2.2979 | 2.3035 | 440 |
| 450 | 2.3035 | 2.3092 | 2.3148 | 2.3204 | 2.3260 | 2.3316 | 2.3373 | 2.3429 | 2.3485 | 2.3541 | 2.3598 | 450 |
| 460 | 2.3598 | 2.3654 | 2.3710 | 2.3767 | 2.3823 | 2.3879 | 2.3936 | 2.3992 | 2.4048 | 2.4105 | 2.4161 | 460 |
| 470 | 2.4161 | 2.4218 | 2.4274 | 2.4330 | 2.4387 | 2.4443 | 2.4500 | 2.4556 | 2.4613 | 2.4669 | 2.4726 | 470 |
| 480 | 2.4726 | 2.4783 | 2.4839 | 2.4896 | 2.4952 | 2.5009 | 2.5066 | 2.5122 | 2.5179 | 2.5236 | 2.5292 | 480 |
| 490 | 2.5292 | 2.5349 | 2.5406 | 2.5462 | 2.5519 | 2.5576 | 2.5633 | 2.5690 | 2.5746 | 2.5803 | 2.5860 | 490 |
| 500 | 2.5860 | 2.5917 | 2.5974 | 2.6031 | 2.6087 | 2.6144 | 2.6201 | 2.6258 | 2.6315 | 2.6372 | 2.6429 | 500 |
| 510 | 2.6429 | 2.6486 | 2.6543 | 2.6600 | 2.6657 | 2.6714 | 2.6771 | 2.6828 | 2.6885 | 2.6943 | 2.7000 | 510 |
| 520 | 2.7000 | 2.7057 | 2.7114 | 2.7171 | 2.7228 | 2.7285 | 2.7343 | 2.7400 | 2.7457 | 2.7514 | 2.7572 | 520 |
| 530 | 2.7572 | 2.7629 | 2.7686 | 2.7744 | 2.7801 | 2.7858 | 2.7916 | 2.7973 | 2.8030 | 2.8088 | 2.8145 | 530 |
| 540 | 2.8145 | 2.8203 | 2.8260 | 2.8317 | 2.8375 | 2.8432 | 2.8490 | 2.8547 | 2.8605 | 2.8663 | 2.8720 | 540 |
| 550 | 2.8720 | 2.8778 | 2.8835 | 2.8893 | 2.8950 | 2.9008 | 2.9066 | 2.9123 | 2.9181 | 2.9239 | 2.9296 | 550 |
| 560 | 2.9296 | 2.9354 | 2.9412 | 2.9470 | 2.9527 | 2.9585 | 2.9643 | 2.9701 | 2.9759 | 2.9816 | 2.9874 | 560 |
| 570 | 2.9874 | 2.9932 | 2.9990 | 3.0048 | 3.0106 | 3.0164 | 3.0221 | 3.0279 | 3.0337 | 3.0395 | 3.0453 | 570 |
| 580 | 3.0453 | 3.0511 | 3.0569 | 3.0627 | 3.0685 | 3.0743 | 3.0801 | 3.0859 | 3.0918 | 3.0976 | 3.1034 | 580 |
| 590 | 3.1034 | 3.1092 | 3.1150 | 3.1208 | 3.1266 | 3.1324 | 3.1383 | 3.1441 | 3.1499 | 3.1557 | 3.1615 | 590 |
| 600 | 3.1615 | 3.1674 | 3.1732 | 3.1790 | 3.1848 | 3.1907 | 3.1965 | 3.2023 | 3.2082 | 3.2140 | 3.2198 | 600 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C7.** *Platinum,* Pt–67, *versus* AWG 28 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 600 | 3.1615 | 3.1674 | 3.1732 | 3.1790 | 3.1848 | 3.1907 | 3.1965 | 3.2023 | 3.2082 | 3.2140 | 3.2198 | 600 |
| 610 | 3.2198 | 3.2257 | 3.2315 | 3.2373 | 3.2432 | 3.2490 | 3.2548 | 3.2607 | 3.2665 | 3.2724 | 3.2782 | 610 |
| 620 | 3.2782 | 3.2841 | 3.2899 | 3.2958 | 3.3016 | 3.3075 | 3.3133 | 3.3192 | 3.3250 | 3.3309 | 3.3367 | 620 |
| 630 | 3.3367 | 3.3426 | 3.3484 | 3.3543 | 3.3601 | 3.3660 | 3.3719 | 3.3777 | 3.3836 | 3.3894 | 3.3953 | 630 |
| 640 | 3.3953 | 3.4012 | 3.4070 | 3.4129 | 3.4188 | 3.4246 | 3.4305 | 3.4364 | 3.4423 | 3.4481 | 3.4540 | 640 |
| 650 | 3.4540 | 3.4599 | 3.4657 | 3.4716 | 3.4775 | 3.4834 | 3.4892 | 3.4951 | 3.5010 | 3.5069 | 3.5128 | 650 |
| 660 | 3.5128 | 3.5186 | 3.5245 | 3.5304 | 3.5363 | 3.5422 | 3.5480 | 3.5539 | 3.5598 | 3.5657 | 3.5716 | 660 |
| 670 | 3.5716 | 3.5775 | 3.5834 | 3.5892 | 3.5951 | 3.6010 | 3.6069 | 3.6128 | 3.6187 | 3.6246 | 3.6305 | 670 |
| 680 | 3.6305 | 3.6364 | 3.6423 | 3.6482 | 3.6541 | 3.6600 | 3.6658 | 3.6717 | 3.6776 | 3.6835 | 3.6894 | 680 |
| 690 | 3.6894 | 3.6953 | 3.7012 | 3.7071 | 3.7130 | 3.7189 | 3.7248 | 3.7307 | 3.7366 | 3.7425 | 3.7484 | 690 |
| 700 | 3.7484 | 3.7543 | 3.7603 | 3.7662 | 3.7721 | 3.7780 | 3.7839 | 3.7898 | 3.7957 | 3.8016 | 3.8075 | 700 |
| 710 | 3.8075 | 3.8134 | 3.8193 | 3.8252 | 3.8311 | 3.8370 | 3.8430 | 3.8489 | 3.8548 | 3.8607 | 3.8666 | 710 |
| 720 | 3.8666 | 3.8725 | 3.8784 | 3.8844 | 3.8903 | 3.8962 | 3.9021 | 3.9080 | 3.9139 | 3.9199 | 3.9258 | 720 |
| 730 | 3.9258 | 3.9317 | 3.9376 | 3.9435 | 3.9495 | 3.9554 | 3.9613 | 3.9672 | 3.9731 | 3.9791 | 3.9850 | 730 |
| 740 | 3.9850 | 3.9909 | 3.9968 | 4.0028 | 4.0087 | 4.0146 | 4.0206 | 4.0265 | 4.0324 | 4.0384 | 4.0443 | 740 |
| 750 | 4.0443 | 4.0502 | 4.0562 |  |  |  |  |  |  |  |  | 750 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**TABLE C8.** *Platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F. Abbreviated table.*

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 |  |  | 0.0000 | 0.0058 | 0.0116 | 0.0174 | 0.0232 | 0.0290 | 0.0348 | 0.0406 | 0.0464 | 30 |
| 40 | 0.0464 | 0.0521 | 0.0579 | 0.0636 | 0.0694 | 0.0751 | 0.0809 | 0.0866 | 0.0923 | 0.0980 | 0.1038 | 40 |
| 50 | 0.1038 | 0.1095 | 0.1152 | 0.1209 | 0.1266 | 0.1322 | 0.1379 | 0.1436 | 0.1493 | 0.1549 | 0.1606 | 50 |
| 60 | 0.1606 | 0.1663 | 0.1719 | 0.1776 | 0.1832 | 0.1888 | 0.1945 | 0.2001 | 0.2057 | 0.2113 | 0.2169 | 60 |
| 70 | 0.2169 | 0.2226 | 0.2282 | 0.2338 | 0.2394 | 0.2450 | 0.2505 | 0.2561 | 0.2617 | 0.2673 | 0.2729 | 70 |
| 80 | 0.2729 | 0.2784 | 0.2840 | 0.2896 | 0.2951 | 0.3007 | 0.3062 | 0.3118 | 0.3173 | 0.3228 | 0.3284 | 80 |
| 90 | 0.3284 | 0.3339 | 0.3394 | 0.3450 | 0.3505 | 0.3560 | 0.3615 | 0.3670 | 0.3726 | 0.3781 | 0.3836 | 90 |
| 100 | 0.3836 | 0.3891 | 0.3946 | 0.4001 | 0.4056 | 0.4110 | 0.4165 | 0.4220 | 0.4275 | 0.4330 | 0.4385 | 100 |
| 110 | 0.4385 | 0.4439 | 0.4494 | 0.4549 | 0.4603 | 0.4658 | 0.4713 | 0.4767 | 0.4822 | 0.4876 | 0.4931 | 110 |
| 120 | 0.4931 | 0.4985 | 0.5040 | 0.5094 | 0.5149 | 0.5203 | 0.5258 | 0.5312 | 0.5366 | 0.5421 | 0.5475 | 120 |
| 130 | 0.5475 | 0.5529 | 0.5584 | 0.5638 | 0.5692 | 0.5746 | 0.5801 | 0.5855 | 0.5909 | 0.5963 | 0.6017 | 130 |
| 140 | 0.6017 | 0.6072 | 0.6126 | 0.6180 | 0.6234 | 0.6288 | 0.6342 | 0.6396 | 0.6450 | 0.6504 | 0.6558 | 140 |
| 150 | 0.6558 | 0.6612 | 0.6666 | 0.6720 | 0.6774 | 0.6828 | 0.6882 | 0.6936 | 0.6990 | 0.7044 | 0.7098 | 150 |
| 160 | 0.7098 | 0.7152 | 0.7206 | 0.7260 | 0.7313 | 0.7367 | 0.7421 | 0.7475 | 0.7529 | 0.7583 | 0.7637 | 160 |
| 170 | 0.7637 | 0.7690 | 0.7744 | 0.7798 | 0.7852 | 0.7906 | 0.7959 | 0.8013 | 0.8067 | 0.8121 | 0.8175 | 170 |
| 180 | 0.8175 | 0.8228 | 0.8282 | 0.8336 | 0.8390 | 0.8443 | 0.8497 | 0.8551 | 0.8605 | 0.8658 | 0.8712 | 180 |
| 190 | 0.8712 | 0.8766 | 0.8820 | 0.8873 | 0.8927 | 0.8981 | 0.9035 | 0.9088 | 0.9142 | 0.9196 | 0.9249 | 190 |
| 200 | 0.9249 | 0.9303 | 0.9357 | 0.9411 | 0.9464 | 0.9518 | 0.9572 | 0.9626 | 0.9679 | 0.9733 | 0.9787 | 200 |
| 210 | 0.9787 | 0.9841 | 0.9894 | 0.9948 | 1.0002 | 1.0055 | 1.0109 | 1.0163 | 1.0217 | 1.0270 | 1.0324 | 210 |
| 220 | 1.0324 | 1.0378 | 1.0432 | 1.0485 | 1.0539 | 1.0593 | 1.0647 | 1.0701 | 1.0754 | 1.0808 | 1.0862 | 220 |
| 230 | 1.0862 | 1.0916 | 1.0970 | 1.1023 | 1.1077 | 1.1131 | 1.1185 | 1.1239 | 1.1292 | 1.1346 | 1.1400 | 230 |
| 240 | 1.1400 | 1.1454 | 1.1508 | 1.1562 | 1.1616 | 1.1669 | 1.1723 | 1.1777 | 1.1831 | 1.1885 | 1.1939 | 240 |
| 250 | 1.1939 | 1.1993 | 1.2047 | 1.2101 | 1.2155 | 1.2208 | 1.2262 | 1.2316 | 1.2370 | 1.2424 | 1.2478 | 250 |
| 260 | 1.2478 | 1.2532 | 1.2586 | 1.2640 | 1.2694 | 1.2748 | 1.2802 | 1.2856 | 1.2910 | 1.2964 | 1.3018 | 260 |
| 270 | 1.3018 | 1.3073 | 1.3127 | 1.3181 | 1.3235 | 1.3289 | 1.3343 | 1.3397 | 1.3451 | 1.3505 | 1.3560 | 270 |
| 280 | 1.3560 | 1.3614 | 1.3668 | 1.3722 | 1.3776 | 1.3830 | 1.3885 | 1.3939 | 1.3993 | 1.4047 | 1.4102 | 280 |
| 290 | 1.4102 | 1.4156 | 1.4210 | 1.4264 | 1.4319 | 1.4373 | 1.4427 | 1.4482 | 1.4536 | 1.4590 | 1.4645 | 290 |
| 300 | 1.4645 | 1.4699 | 1.4754 | 1.4808 | 1.4862 | 1.4917 | 1.4971 | 1.5026 | 1.5080 | 1.5135 | 1.5189 | 300 |
| 310 | 1.5189 | 1.5244 | 1.5298 | 1.5353 | 1.5407 | 1.5462 | 1.5516 | 1.5571 | 1.5625 | 1.5680 | 1.5734 | 310 |
| 320 | 1.5734 | 1.5789 | 1.5844 | 1.5898 | 1.5953 | 1.6008 | 1.6062 | 1.6117 | 1.6172 | 1.6226 | 1.6281 | 320 |
| 330 | 1.6281 | 1.6336 | 1.6391 | 1.6445 | 1.6500 | 1.6555 | 1.6610 | 1.6664 | 1.6719 | 1.6774 | 1.6829 | 330 |
| 340 | 1.6829 | 1.6884 | 1.6939 | 1.6994 | 1.7048 | 1.7103 | 1.7158 | 1.7213 | 1.7268 | 1.7323 | 1.7378 | 340 |
| 350 | 1.7378 | 1.7433 | 1.7488 | 1.7543 | 1.7598 | 1.7653 | 1.7708 | 1.7763 | 1.7818 | 1.7874 | 1.7929 | 350 |
| 360 | 1.7929 | 1.7984 | 1.8039 | 1.8094 | 1.8149 | 1.8204 | 1.8260 | 1.8315 | 1.8370 | 1.8425 | 1.8481 | 360 |
| 370 | 1.8481 | 1.8536 | 1.8591 | 1.8646 | 1.8702 | 1.8757 | 1.8812 | 1.8868 | 1.8923 | 1.8978 | 1.9034 | 370 |
| 380 | 1.9034 | 1.9089 | 1.9145 | 1.9200 | 1.9255 | 1.9311 | 1.9366 | 1.9422 | 1.9477 | 1.9533 | 1.9588 | 380 |
| 390 | 1.9588 | 1.9644 | 1.9700 | 1.9755 | 1.9811 | 1.9866 | 1.9922 | 1.9977 | 2.0033 | 2.0089 | 2.0144 | 390 |
| 400 | 2.0144 | 2.0200 | 2.0256 | 2.0312 | 2.0367 | 2.0423 | 2.0479 | 2.0535 | 2.0590 | 2.0646 | 2.0702 | 400 |
| 410 | 2.0702 | 2.0758 | 2.0814 | 2.0869 | 2.0925 | 2.0981 | 2.1037 | 2.1093 | 2.1149 | 2.1205 | 2.1261 | 410 |
| 420 | 2.1261 | 2.1317 | 2.1373 | 2.1429 | 2.1485 | 2.1541 | 2.1597 | 2.1653 | 2.1709 | 2.1765 | 2.1821 | 420 |
| 430 | 2.1821 | 2.1877 | 2.1933 | 2.1989 | 2.2046 | 2.2102 | 2.2158 | 2.2214 | 2.2270 | 2.2326 | 2.2383 | 430 |
| 440 | 2.2383 | 2.2439 | 2.2495 | 2.2552 | 2.2608 | 2.2664 | 2.2720 | 2.2777 | 2.2833 | 2.2889 | 2.2946 | 440 |
| 450 | 2.2946 | 2.3002 | 2.3059 | 2.3115 | 2.3171 | 2.3228 | 2.3284 | 2.3341 | 2.3397 | 2.3454 | 2.3510 | 450 |
| 460 | 2.3510 | 2.3567 | 2.3623 | 2.3680 | 2.3737 | 2.3793 | 2.3850 | 2.3906 | 2.3963 | 2.4020 | 2.4076 | 460 |
| 470 | 2.4076 | 2.4133 | 2.4190 | 2.4246 | 2.4303 | 2.4360 | 2.4416 | 2.4473 | 2.4530 | 2.4587 | 2.4644 | 470 |
| 480 | 2.4644 | 2.4700 | 2.4757 | 2.4814 | 2.4871 | 2.4928 | 2.4985 | 2.5041 | 2.5098 | 2.5155 | 2.5212 | 480 |
| 490 | 2.5212 | 2.5269 | 2.5326 | 2.5383 | 2.5440 | 2.5497 | 2.5554 | 2.5611 | 2.5668 | 2.5725 | 2.5782 | 490 |
| 500 | 2.5782 | 2.5839 | 2.5896 | 2.5953 | 2.6011 | 2.6068 | 2.6125 | 2.6182 | 2.6239 | 2.6296 | 2.6354 | 500 |
| 510 | 2.6354 | 2.6411 | 2.6468 | 2.6525 | 2.6582 | 2.6640 | 2.6697 | 2.6754 | 2.6812 | 2.6869 | 2.6926 | 510 |
| 520 | 2.6926 | 2.6984 | 2.7041 | 2.7098 | 2.7156 | 2.7213 | 2.7271 | 2.7328 | 2.7385 | 2.7443 | 2.7500 | 520 |
| 530 | 2.7500 | 2.7558 | 2.7615 | 2.7673 | 2.7730 | 2.7788 | 2.7845 | 2.7903 | 2.7960 | 2.8018 | 2.8076 | 530 |
| 540 | 2.8076 | 2.8133 | 2.8191 | 2.8249 | 2.8306 | 2.8364 | 2.8421 | 2.8479 | 2.8537 | 2.8595 | 2.8652 | 540 |
| 550 | 2.8652 | 2.8710 | 2.8768 | 2.8826 | 2.8883 | 2.8941 | 2.8999 | 2.9057 | 2.9115 | 2.9172 | 2.9230 | 550 |
| 560 | 2.9230 | 2.9288 | 2.9346 | 2.9404 | 2.9462 | 2.9520 | 2.9578 | 2.9635 | 2.9693 | 2.9751 | 2.9809 | 560 |
| 570 | 2.9809 | 2.9867 | 2.9925 | 2.9983 | 3.0041 | 3.0099 | 3.0157 | 3.0215 | 3.0274 | 3.0332 | 3.0390 | 570 |
| 580 | 3.0390 | 3.0448 | 3.0506 | 3.0564 | 3.0622 | 3.0680 | 3.0739 | 3.0797 | 3.0855 | 3.0913 | 3.0971 | 580 |
| 590 | 3.0971 | 3.1030 | 3.1088 | 3.1146 | 3.1204 | 3.1263 | 3.1321 | 3.1379 | 3.1437 | 3.1496 | 3.1554 | 590 |
| 600 | 3.1554 | 3.1612 | 3.1671 | 3.1729 | 3.1788 | 3.1846 | 3.1904 | 3.1963 | 3.2021 | 3.2080 | 3.2138 | 600 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**TABLE C8.** *Platinum, Pt–67, versus* AWG 14 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 600 | 3.1554 | 3.1612 | 3.1671 | 3.1729 | 3.1788 | 3.1846 | 3.1904 | 3.1963 | 3.2021 | 3.2080 | 3.2138 | 600 |
| 610 | 3.2138 | 3.2197 | 3.2255 | 3.2314 | 3.2372 | 3.2431 | 3.2489 | 3.2548 | 3.2606 | 3.2665 | 3.2723 | 610 |
| 620 | 3.2723 | 3.2782 | 3.2840 | 3.2899 | 3.2958 | 3.3016 | 3.3075 | 3.3134 | 3.3192 | 3.3251 | 3.3310 | 620 |
| 630 | 3.3310 | 3.3368 | 3.3427 | 3.3486 | 3.3544 | 3.3603 | 3.3662 | 3.3721 | 3.3779 | 3.3838 | 3.3897 | 630 |
| 640 | 3.3897 | 3.3956 | 3.4015 | 3.4073 | 3.4132 | 3.4191 | 3.4250 | 3.4309 | 3.4368 | 3.4427 | 3.4485 | 640 |
| 650 | 3.4485 | 3.4544 | 3.4603 | 3.4662 | 3.4721 | 3.4780 | 3.4839 | 3.4898 | 3.4957 | 3.5016 | 3.5075 | 650 |
| 660 | 3.5075 | 3.5134 | 3.5193 | 3.5252 | 3.5311 | 3.5370 | 3.5429 | 3.5488 | 3.5547 | 3.5606 | 3.5666 | 660 |
| 670 | 3.5666 | 3.5725 | 3.5784 | 3.5843 | 3.5902 | 3.5961 | 3.6020 | 3.6080 | 3.6139 | 3.6198 | 3.6257 | 670 |
| 680 | 3.6257 | 3.6316 | 3.6376 | 3.6435 | 3.6494 | 3.6553 | 3.6613 | 3.6672 | 3.6731 | 3.6791 | 3.6850 | 680 |
| 690 | 3.6850 | 3.6909 | 3.6969 | 3.7028 | 3.7087 | 3.7147 | 3.7206 | 3.7265 | 3.7325 | 3.7384 | 3.7444 | 690 |
| 700 | 3.7444 | 3.7503 | 3.7562 | 3.7622 | 3.7681 | 3.7741 | 3.7800 | 3.7860 | 3.7919 | 3.7979 | 3.8038 | 700 |
| 710 | 3.8038 | 3.8098 | 3.8157 | 3.8217 | 3.8276 | 3.8336 | 3.8395 | 3.8455 | 3.8515 | 3.8574 | 3.8634 | 710 |
| 720 | 3.8634 | 3.8693 | 3.8753 | 3.8813 | 3.8872 | 3.8932 | 3.8992 | 3.9051 | 3.9111 | 3.9171 | 3.9230 | 720 |
| 730 | 3.9230 | 3.9290 | 3.9350 | 3.9409 | 3.9469 | 3.9529 | 3.9589 | 3.9648 | 3.9708 | 3.9768 | 3.9828 | 730 |
| 740 | 3.9828 | 3.9888 | 3.9947 | 4.0007 | 4.0067 | 4.0127 | 4.0187 | 4.0246 | 4.0306 | 4.0366 | 4.0426 | 740 |
| 750 | 4.0426 | 4.0486 | 4.0546 | 4.0606 | 4.0666 | 4.0726 | 4.0785 | 4.0845 | 4.0905 | 4.0965 | 4.1025 | 750 |
| 760 | 4.1025 | 4.1085 | 4.1145 | 4.1205 | 4.1265 | 4.1325 | 4.1385 | 4.1445 | 4.1505 | 4.1565 | 4.1625 | 760 |
| 770 | 4.1625 | 4.1685 | 4.1745 | 4.1805 | 4.1865 | 4.1925 | 4.1986 | 4.2046 | 4.2106 | 4.2166 | 4.2226 | 770 |
| 780 | 4.2226 | 4.2286 | 4.2346 | 4.2406 | 4.2466 | 4.2527 | 4.2587 | 4.2647 | 4.2707 | 4.2767 | 4.2828 | 780 |
| 790 | 4.2828 | 4.2888 | 4.2948 | 4.3008 | 4.3068 | 4.3129 | 4.3189 | 4.3249 | 4.3309 | 4.3370 | 4.3430 | 790 |
| 800 | 4.3430 | 4.3490 | 4.3550 | 4.3611 | 4.3671 | 4.3731 | 4.3792 | 4.3852 | 4.3912 | 4.3973 | 4.4033 | 800 |
| 810 | 4.4033 | 4.4093 | 4.4154 | 4.4214 | 4.4274 | 4.4335 | 4.4395 | 4.4455 | 4.4516 | 4.4576 | 4.4637 | 810 |
| 820 | 4.4637 | 4.4697 | 4.4757 | 4.4818 | 4.4878 | 4.4939 | 4.4999 | 4.5060 | 4.5120 | 4.5181 | 4.5241 | 820 |
| 830 | 4.5241 | 4.5302 | 4.5362 | 4.5422 | 4.5483 | 4.5543 | 4.5604 | 4.5665 | 4.5725 | 4.5786 | 4.5846 | 830 |
| 840 | 4.5846 | 4.5907 | 4.5967 | 4.6028 | 4.6088 | 4.6149 | 4.6209 | 4.6270 | 4.6331 | 4.6391 | 4.6452 | 840 |
| 850 | 4.6452 | 4.6512 | 4.6573 | 4.6634 | 4.6694 | 4.6755 | 4.6815 | 4.6876 | 4.6937 | 4.6997 | 4.7058 | 850 |
| 860 | 4.7058 | 4.7119 | 4.7179 | 4.7240 | 4.7301 | 4.7361 | 4.7422 | 4.7483 | 4.7543 | 4.7604 | 4.7665 | 860 |
| 870 | 4.7665 | 4.7726 | 4.7786 | 4.7847 | 4.7908 | 4.7968 | 4.8029 | 4.8090 | 4.8151 | 4.8211 | 4.8272 | 870 |
| 880 | 4.8272 | 4.8333 | 4.8394 | 4.8454 | 4.8515 | 4.8576 | 4.8637 | 4.8698 | 4.8758 | 4.8819 | 4.8880 | 880 |
| 890 | 4.8880 | 4.8941 | 4.9002 | 4.9062 | 4.9123 | 4.9184 | 4.9245 | 4.9306 | 4.9367 | 4.9427 | 4.9488 | 890 |
| 900 | 4.9488 | 4.9549 | 4.9610 | 4.9671 | 4.9732 | 4.9793 | 4.9853 | 4.9914 | 4.9975 | 5.0036 | 5.0097 | 900 |
| 910 | 5.0097 | 5.0158 | 5.0219 | 5.0280 | 5.0341 | 5.0402 | 5.0462 | 5.0523 | 5.0584 | 5.0645 | 5.0706 | 910 |
| 920 | 5.0706 | 5.0767 | 5.0828 | 5.0889 | 5.0950 | 5.1011 | 5.1072 | 5.1133 | 5.1194 | 5.1255 | 5.1316 | 920 |
| 930 | 5.1316 | 5.1377 | 5.1438 | 5.1498 | 5.1559 | 5.1620 | 5.1681 | 5.1742 | 5.1803 | 5.1864 | 5.1925 | 930 |
| 940 | 5.1925 | 5.1986 | 5.2047 | 5.2108 | 5.2169 | 5.2230 | 5.2291 | 5.2352 | 5.2413 | 5.2474 | 5.2535 | 940 |
| 950 | 5.2535 | 5.2596 | 5.2657 | 5.2718 | 5.2779 | 5.2841 | 5.2902 | 5.2963 | 5.3024 | 5.3085 | 5.3146 | 950 |
| 960 | 5.3146 | 5.3207 | 5.3268 | 5.3329 | 5.3390 | 5.3451 | 5.3512 | 5.3573 | 5.3634 | 5.3695 | 5.3756 | 960 |
| 970 | 5.3756 | 5.3817 | 5.3878 | 5.3939 | 5.4000 | 5.4061 | 5.4123 | 5.4184 | 5.4245 | 5.4306 | 5.4367 | 970 |
| 980 | 5.4367 | 5.4428 | 5.4489 | 5.4550 | 5.4611 | 5.4672 | 5.4733 | 5.4794 | 5.4855 | 5.4917 | 5.4978 | 980 |
| 990 | 5.4978 | 5.5039 | 5.5100 | 5.5161 | 5.5222 | 5.5283 | 5.5344 | 5.5405 | 5.5466 | 5.5527 | 5.5588 | 990 |
| 1,000 | 5.5588 | 5.5650 | 5.5711 | 5.5772 | 5.5833 | 5.5894 | 5.5955 | 5.6016 | 5.6077 | 5.6138 | 5.6199 | 1,000 |
| 1,010 | 5.6199 | 5.6260 | 5.6321 | 5.6383 | 5.6444 | 5.6505 | 5.6566 | 5.6627 | 5.6688 | 5.6749 | 5.6810 | 1,010 |
| 1,020 | 5.6810 | 5.6871 | 5.6932 | 5.6993 | 5.7055 | 5.7116 | 5.7177 | 5.7238 | 5.7299 | 5.7360 | 5.7421 | 1,020 |
| 1,030 | 5.7421 | 5.7482 | 5.7543 | 5.7604 | 5.7665 | 5.7726 | 5.7787 | 5.7849 | 5.7910 | 5.7971 | 5.8032 | 1,030 |
| 1,040 | 5.8032 | 5.8093 | 5.8154 | 5.8215 | 5.8276 | 5.8337 | 5.8398 | 5.8459 | 5.8520 | 5.8581 | 5.8642 | 1,040 |
| 1,050 | 5.8642 | 5.8703 | 5.8764 | 5.8825 | 5.8886 | 5.8948 | 5.9009 | 5.9070 | 5.9131 | 5.9192 | 5.9253 | 1,050 |
| 1,060 | 5.9253 | 5.9314 | 5.9375 | 5.9436 | 5.9497 | 5.9558 | 5.9619 | 5.9680 | 5.9741 | 5.9802 | 5.9863 | 1,060 |
| 1,070 | 5.9863 | 5.9924 | 5.9985 | 6.0046 | 6.0107 | 6.0168 | 6.0229 | 6.0290 | 6.0351 | 6.0412 | 6.0473 | 1,070 |
| 1,080 | 6.0473 | 6.0534 | 6.0595 | 6.0656 | 6.0717 | 6.0778 | 6.0839 | 6.0899 | 6.0960 | 6.1021 | 6.1082 | 1,080 |
| 1,090 | 6.1082 | 6.1143 | 6.1204 | 6.1265 | 6.1326 | 6.1387 | 6.1448 | 6.1509 | 6.1570 | 6.1631 | 6.1691 | 1,090 |
| 1,100 | 6.1691 | 6.1752 | 6.1813 | 6.1874 | 6.1935 | 6.1996 | 6.2057 | 6.2118 | 6.2178 | 6.2239 | 6.2300 | 1,100 |
| 1,110 | 6.2300 | 6.2361 | 6.2422 | 6.2483 | 6.2544 | 6.2604 | 6.2665 | 6.2726 | 6.2787 | 6.2848 | 6.2908 | 1,110 |
| 1,120 | 6.2908 | 6.2969 | 6.3030 | 6.3091 | 6.3152 | 6.3212 | 6.3273 | 6.3334 | 6.3395 | 6.3455 | 6.3516 | 1,120 |
| 1,130 | 6.3516 | 6.3577 | 6.3638 | 6.3698 | 6.3759 | 6.3820 | 6.3880 | 6.3941 | 6.4002 | 6.4063 | 6.4123 | 1,130 |
| 1,140 | 6.4123 | 6.4184 | 6.4245 | 6.4305 | 6.4366 | 6.4427 | 6.4487 | 6.4548 | 6.4608 | 6.4669 | 6.4730 | 1,140 |
| 1,150 | 6.4730 | 6.4790 | 6.4851 | 6.4912 | 6.4972 | 6.5033 | 6.5093 | 6.5154 | 6.5214 | 6.5275 | 6.5336 | 1,150 |
| 1,160 | 6.5336 | 6.5396 | 6.5457 | 6.5517 | 6.5578 | 6.5638 | 6.5699 | 6.5759 | 6.5820 | 6.5880 | 6.5941 | 1,160 |
| 1,170 | 6.5941 | 6.6001 | 6.6062 | 6.6122 | 6.6182 | 6.6243 | 6.6303 | 6.6364 | 6.6424 | 6.6484 | 6.6545 | 1,170 |
| 1,180 | 6.6545 | 6.6605 | 6.6666 | 6.6726 | 6.6786 | 6.6847 | 6.6907 | 6.6967 | 6.7028 | 6.7088 | 6.7148 | 1,180 |
| 1,190 | 6.7148 | 6.7209 | 6.7269 | 6.7329 | 6.7389 | 6.7450 | 6.7510 | 6.7570 | 6.7630 | 6.7691 | 6.7751 | 1,190 |
| 1,200 | 6.7751 | 6.7811 | 6.7871 | 6.7931 | 6.7992 | 6.8052 | 6.8112 | 6.8172 | 6.8232 | 6.8292 | 6.8352 | 1,200 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

**Table C8.** *Platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,200 | 6.7751 | 6.7811 | 6.7871 | 6.7931 | 6.7992 | 6.8052 | 6.8112 | 6.8172 | 6.8232 | 6.8292 | 6.8352 | 1,200 |
| 1,210 | 6.8352 | 6.8413 | 6.8473 | 6.8533 | 6.8593 | 6.8653 | 6.8713 | 6.8773 | 6.8833 | 6.8893 | 6.8953 | 1,210 |
| 1,220 | 6.8953 | 6.9013 | 6.9073 | 6.9133 | 6.9193 | 6.9253 | 6.9313 | 6.9373 | 6.9433 | 6.9493 | 6.9553 | 1,220 |
| 1,230 | 6.9553 | 6.9612 | 6.9672 | 6.9732 | 6.9792 | 6.9852 | 6.9912 | 6.9972 | 7.0031 | 7.0091 | 7.0151 | 1,230 |
| 1,240 | 7.0151 | 7.0211 | 7.0271 | 7.0330 | 7.0390 | 7.0450 | 7.0509 | 7.0569 | 7.0629 | 7.0689 | 7.0748 | 1,240 |
| 1,250 | 7.0748 | 7.0808 | 7.0868 | 7.0927 | 7.0987 | 7.1046 | 7.1106 | 7.1166 | 7.1225 | 7.1285 | 7.1344 | 1,250 |
| 1,260 | 7.1344 | 7.1404 | 7.1463 | 7.1523 | 7.1582 | 7.1642 | 7.1701 | 7.1761 | 7.1820 | 7.1880 | 7.1939 | 1,260 |
| 1,270 | 7.1939 | 7.1998 | 7.2058 | 7.2117 | 7.2177 | 7.2236 | 7.2295 | 7.2355 | 7.2414 | 7.2473 | 7.2533 | 1,270 |
| 1,280 | 7.2533 | 7.2592 | 7.2651 | 7.2710 | 7.2770 | 7.2829 | 7.2888 | 7.2947 | 7.3006 | 7.3065 | 7.3125 | 1,280 |
| 1,290 | 7.3125 | 7.3184 | 7.3243 | 7.3302 | 7.3361 | 7.3420 | 7.3479 | 7.3538 | 7.3597 | 7.3656 | 7.3715 | 1,290 |
| 1,300 | 7.3715 | 7.3774 | 7.3833 | 7.3892 | 7.3951 | 7.4010 | 7.4069 | 7.4128 | 7.4187 | 7.4246 | 7.4305 | 1,300 |
| 1,310 | 7.4305 | 7.4363 | 7.4422 | 7.4481 | 7.4540 | 7.4599 | 7.4657 | 7.4716 | 7.4775 | 7.4834 | 7.4892 | 1,310 |
| 1,320 | 7.4892 | 7.4951 | 7.5010 | 7.5068 | 7.5127 | 7.5185 | 7.5244 | 7.5303 | 7.5361 | 7.5420 | 7.5478 | 1,320 |
| 1,330 | 7.5478 | 7.5537 | 7.5595 | 7.5654 | 7.5712 | 7.5771 | 7.5829 | 7.5888 | 7.5946 | 7.6004 | 7.6063 | 1,330 |
| 1,340 | 7.6063 | 7.6121 | 7.6180 | 7.6238 | 7.6296 | 7.6354 | 7.6413 | 7.6471 | 7.6529 | 7.6587 | 7.6646 | 1,340 |
| 1,350 | 7.6646 | 7.6704 | 7.6762 | 7.6820 | 7.6878 | 7.6936 | 7.6995 | 7.7053 | 7.7111 | 7.7169 | 7.7227 | 1,350 |
| 1,360 | 7.7227 | 7.7285 | 7.7343 | 7.7401 | 7.7459 | 7.7517 | 7.7575 | 7.7633 | 7.7690 | 7.7748 | 7.7806 | 1,360 |
| 1,370 | 7.7806 | 7.7864 | 7.7922 | 7.7980 | 7.8037 | 7.8095 | 7.8153 | 7.8211 | 7.8268 | 7.8326 | 7.8384 | 1,370 |
| 1,380 | 7.8384 | 7.8441 | 7.8499 | 7.8557 | 7.8614 | 7.8672 | 7.8729 | 7.8787 | 7.8844 | 7.8902 | 7.8959 | 1,380 |
| 1,390 | 7.8959 | 7.9017 | 7.9074 | 7.9132 | 7.9189 | 7.9247 | 7.9304 | 7.9361 | 7.9419 | 7.9476 | 7.9533 | 1,390 |
| 1,400 | 7.9533 | 7.9591 | 7.9648 | 7.9705 | 7.9762 | 7.9820 | 7.9877 | 7.9934 | 7.9991 | 8.0048 | 8.0105 | 1,400 |
| 1,410 | 8.0105 | 8.0162 | 8.0219 | 8.0276 | 8.0333 | 8.0390 | 8.0447 | 8.0504 | 8.0561 | 8.0618 | 8.0675 | 1,410 |
| 1,420 | 8.0675 | 8.0732 | 8.0789 | 8.0846 | 8.0903 | 8.0959 | 8.1016 | 8.1073 | 8.1130 | 8.1186 | 8.1243 | 1,420 |
| 1,430 | 8.1243 | 8.1300 | 8.1356 | 8.1413 | 8.1470 | 8.1526 | 8.1583 | 8.1639 | 8.1696 | 8.1752 | 8.1809 | 1,430 |
| 1,440 | 8.1809 | 8.1865 | 8.1922 | 8.1978 | 8.2035 | 8.2091 | 8.2147 | 8.2204 | 8.2260 | 8.2316 | 8.2373 | 1,440 |
| 1,450 | 8.2373 | 8.2429 | 8.2485 | 8.2541 | 8.2598 | 8.2654 | 8.2710 | 8.2766 | 8.2822 | 8.2878 | 8.2934 | 1,450 |
| 1,460 | 8.2934 | 8.2990 | 8.3046 | 8.3102 | 8.3158 | 8.3214 | 8.3270 | 8.3326 | 8.3382 | 8.3438 | 8.3494 | 1,460 |
| 1,470 | 8.3494 | 8.3550 | 8.3605 | 8.3661 | 8.3717 | 8.3773 | 8.3828 | 8.3884 | 8.3940 | 8.3995 | 8.4051 | 1,470 |
| 1,480 | 8.4051 | 8.4107 | 8.4162 | 8.4218 | 8.4273 | 8.4329 | 8.4384 | 8.4440 | 8.4495 | 8.4551 | 8.4606 | 1,480 |
| 1,490 | 8.4606 | 8.4661 | 8.4717 | 8.4772 | 8.4827 | 8.4883 | 8.4938 | 8.4993 | 8.5048 | 8.5104 | 8.5159 | 1,490 |
| 1,500 | 8.5159 | 8.5214 | 8.5269 | 8.5324 | 8.5379 | 8.5434 | 8.5489 | 8.5544 | 8.5599 | 8.5654 | 8.5709 | 1,500 |
| 1,510 | 8.5709 | 8.5764 | 8.5819 | 8.5874 | 8.5929 | 8.5984 | 8.6038 | 8.6093 | 8.6148 | 8.6203 | 8.6257 | 1,510 |
| 1,520 | 8.6257 | 8.6312 | 8.6367 | 8.6421 | 8.6476 | 8.6531 | 8.6585 | 8.6640 | 8.6694 | 8.6749 | 8.6803 | 1,520 |
| 1,530 | 8.6803 | 8.6858 | 8.6912 | 8.6967 | 8.7021 | 8.7075 | 8.7130 | 8.7184 | 8.7238 | 8.7292 | 8.7347 | 1,530 |
| 1,540 | 8.7347 | 8.7401 | 8.7455 | 8.7509 | 8.7563 | 8.7617 | 8.7672 | 8.7726 | 8.7780 | 8.7834 | 8.7888 | 1,540 |
| 1,550 | 8.7888 | 8.7942 | 8.7996 | 8.8049 | 8.8103 | 8.8157 | 8.8211 | 8.8265 | 8.8319 | 8.8372 | 8.8426 | 1,550 |
| 1,560 | 8.8426 | 8.8480 | 8.8534 | 8.8587 | 8.8641 | 8.8695 | 8.8748 | 8.8802 | 8.8855 | 8.8909 | 8.8962 | 1,560 |
| 1,570 | 8.8962 | 8.9016 | 8.9069 | 8.9123 | 8.9176 | 8.9229 | 8.9283 | 8.9336 | 8.9389 | 8.9443 | 8.9496 | 1,570 |
| 1,580 | 8.9496 | 8.9549 | 8.9602 | 8.9656 | 8.9709 | 8.9762 | 8.9815 | 8.9868 | 8.9921 | 8.9974 | 9.0027 | 1,580 |
| 1,590 | 9.0027 | 9.0080 | 9.0133 | 9.0186 | 9.0239 | 9.0292 | 9.0345 | 9.0397 | 9.0450 | 9.0503 | 9.0556 | 1,590 |
| 1,600 | 9.0556 | 9.0608 | 9.0661 | 9.0714 | 9.0766 | 9.0819 | 9.0872 | 9.0924 | 9.0977 | 9.1029 | 9.1082 | 1,600 |
| 1,610 | 9.1082 | 9.1134 | 9.1187 | 9.1239 | 9.1292 | 9.1344 | 9.1396 | 9.1449 | 9.1501 | 9.1553 | 9.1605 | 1,610 |
| 1,620 | 9.1605 | 9.1658 | 9.1710 | 9.1762 | 9.1814 | 9.1866 | 9.1918 | 9.1970 | 9.2022 | 9.2074 | 9.2126 | 1,620 |
| 1,630 | 9.2126 | 9.2178 | 9.2230 | 9.2282 | 9.2334 | 9.2386 | 9.2438 | 9.2489 | 9.2541 | 9.2593 | 9.2645 | 1,630 |
| 1,640 | 9.2645 | 9.2696 | 9.2748 | 9.2800 | 9.2851 | 9.2903 | 9.2955 | 9.3006 | 9.3058 | 9.3109 | 9.3161 | 1,640 |
| 1,650 | 9.3161 | 9.3212 | 9.3263 | 9.3315 | 9.3366 | 9.3417 | 9.3469 | 9.3520 | 9.3571 | 9.3623 | 9.3674 | 1,650 |
| 1,660 | 9.3674 | 9.3725 | 9.3776 | 9.3827 | 9.3878 | 9.3929 | 9.3980 | 9.4031 | 9.4082 | 9.4133 | 9.4184 | 1,660 |
| 1,670 | 9.4184 | 9.4235 | 9.4286 | 9.4337 | 9.4388 | 9.4439 | 9.4489 | 9.4540 | 9.4591 | 9.4642 | 9.4692 | 1,670 |
| 1,680 | 9.4692 | 9.4743 | 9.4793 | 9.4844 | 9.4895 | 9.4945 | 9.4996 | 9.5046 | 9.5097 | 9.5147 | 9.5198 | 1,680 |
| 1,690 | 9.5198 | 9.5248 | 9.5298 | 9.5349 | 9.5399 | 9.5449 | 9.5499 | 9.5550 | 9.5600 | 9.5650 | 9.5700 | 1,690 |
| 1,700 | 9.5700 | 9.5750 | 9.5800 | 9.5850 | 9.5900 | 9.5950 | 9.6000 | 9.6050 | 9.6100 | 9.6150 | 9.6200 | 1,700 |
| 1,710 | 9.6200 | 9.6250 | 9.6300 | 9.6350 | 9.6399 | 9.6449 | 9.6499 | 9.6549 | 9.6598 | 9.6648 | 9.6697 | 1,710 |
| 1,720 | 9.6697 | 9.6747 | 9.6797 | 9.6846 | 9.6896 | 9.6945 | 9.6995 | 9.7044 | 9.7093 | 9.7143 | 9.7192 | 1,720 |
| 1,730 | 9.7192 | 9.7241 | 9.7291 | 9.7340 | 9.7389 | 9.7438 | 9.7488 | 9.7537 | 9.7586 | 9.7635 | 9.7684 | 1,730 |
| 1,740 | 9.7684 | 9.7733 | 9.7782 | 9.7831 | 9.7880 | 9.7929 | 9.7978 | 9.8027 | 9.8076 | 9.8125 | 9.8173 | 1,740 |
| 1,750 | 9.8173 | 9.8222 | 9.8271 | 9.8320 | 9.8368 | 9.8417 | 9.8466 | 9.8514 | 9.8563 | 9.8612 | 9.8660 | 1,750 |
| 1,760 | 9.8660 | 9.8709 | 9.8757 | 9.8806 | 9.8854 | 9.8902 | 9.8951 | 9.8999 | 9.9047 | 9.9096 | 9.9144 | 1,760 |
| 1,770 | 9.9144 | 9.9192 | 9.9240 | 9.9289 | 9.9337 | 9.9385 | 9.9433 | 9.9481 | 9.9529 | 9.9577 | 9.9625 | 1,770 |
| 1,780 | 9.9625 | 9.9673 | 9.9721 | 9.9769 | 9.9817 | 9.9865 | 9.9913 | 9.9960 | 10.0008 | 10.0056 | 10.0104 | 1,780 |
| 1,790 | 10.0104 | 10.0151 | 10.0199 | 10.0247 | 10.0294 | 10.0342 | 10.0390 | 10.0437 | 10.0485 | 10.0532 | 10.0580 | 1,790 |
| 1,800 | 10.0580 | 10.0627 | 10.0674 | 10.0722 | 10.0769 | 10.0816 | 10.0864 | 10.0911 | 10.0958 | 10.1005 | 10.1053 | 1,800 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

Table C8. *Platinum,* Pt–67, *versus* AWG 14 *Nisil thermoelements—thermoelectric voltage as a function of temperature (°F), reference junctions at 32 °F*—Continued

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1,800 | 10.0580 | 10.0627 | 10.0674 | 10.0722 | 10.0769 | 10.0816 | 10.0864 | 10.0911 | 10.0958 | 10.1005 | 10.1053 | 1,800 |
| 1,810 | 10.1053 | 10.1100 | 10.1147 | 10.1194 | 10.1241 | 10.1288 | 10.1335 | 10.1382 | 10.1429 | 10.1476 | 10.1523 | 1,810 |
| 1,820 | 10.1523 | 10.1570 | 10.1617 | 10.1664 | 10.1710 | 10.1757 | 10.1804 | 10.1851 | 10.1897 | 10.1944 | 10.1991 | 1,820 |
| 1,830 | 10.1991 | 10.2037 | 10.2084 | 10.2131 | 10.2177 | 10.2224 | 10.2270 | 10.2317 | 10.2363 | 10.2409 | 10.2456 | 1,830 |
| 1,840 | 10.2456 | 10.2502 | 10.2548 | 10.2595 | 10.2641 | 10.2687 | 10.2733 | 10.2780 | 10.2826 | 10.2872 | 10.2918 | 1,840 |
| 1,850 | 10.2918 | 10.2964 | 10.3010 | 10.3056 | 10.3102 | 10.3148 | 10.3194 | 10.3240 | 10.3286 | 10.3332 | 10.3377 | 1,850 |
| 1,860 | 10.3377 | 10.3423 | 10.3469 | 10.3515 | 10.3560 | 10.3606 | 10.3652 | 10.3697 | 10.3743 | 10.3789 | 10.3834 | 1,860 |
| 1,870 | 10.3834 | 10.3880 | 10.3925 | 10.3971 | 10.4016 | 10.4062 | 10.4107 | 10.4152 | 10.4198 | 10.4243 | 10.4288 | 1,870 |
| 1,880 | 10.4288 | 10.4333 | 10.4379 | 10.4424 | 10.4469 | 10.4514 | 10.4559 | 10.4604 | 10.4649 | 10.4695 | 10.4740 | 1,880 |
| 1,890 | 10.4740 | 10.4785 | 10.4829 | 10.4874 | 10.4919 | 10.4964 | 10.5009 | 10.5054 | 10.5099 | 10.5143 | 10.5188 | 1,890 |
| 1,900 | 10.5188 | 10.5233 | 10.5277 | 10.5322 | 10.5367 | 10.5411 | 10.5456 | 10.5500 | 10.5545 | 10.5589 | 10.5634 | 1,900 |
| 1,910 | 10.5634 | 10.5678 | 10.5723 | 10.5767 | 10.5811 | 10.5856 | 10.5900 | 10.5944 | 10.5988 | 10.6033 | 10.6077 | 1,910 |
| 1,920 | 10.6077 | 10.6121 | 10.6165 | 10.6209 | 10.6253 | 10.6297 | 10.6341 | 10.6385 | 10.6429 | 10.6473 | 10.6517 | 1,920 |
| 1,930 | 10.6517 | 10.6561 | 10.6605 | 10.6649 | 10.6692 | 10.6736 | 10.6780 | 10.6823 | 10.6867 | 10.6911 | 10.6954 | 1,930 |
| 1,940 | 10.6954 | 10.6998 | 10.7042 | 10.7085 | 10.7129 | 10.7172 | 10.7216 | 10.7259 | 10.7302 | 10.7346 | 10.7389 | 1,940 |
| 1,950 | 10.7389 | 10.7432 | 10.7476 | 10.7519 | 10.7562 | 10.7605 | 10.7648 | 10.7692 | 10.7735 | 10.7778 | 10.7821 | 1,950 |
| 1,960 | 10.7821 | 10.7864 | 10.7907 | 10.7950 | 10.7993 | 10.8036 | 10.8079 | 10.8121 | 10.8164 | 10.8207 | 10.8250 | 1,960 |
| 1,970 | 10.8250 | 10.8293 | 10.8335 | 10.8378 | 10.8421 | 10.8463 | 10.8506 | 10.8548 | 10.8591 | 10.8633 | 10.8676 | 1,970 |
| 1,980 | 10.8676 | 10.8718 | 10.8761 | 10.8803 | 10.8846 | 10.8888 | 10.8930 | 10.8972 | 10.9015 | 10.9057 | 10.9099 | 1,980 |
| 1,990 | 10.9099 | 10.9141 | 10.9183 | 10.9226 | 10.9268 | 10.9310 | 10.9352 | 10.9394 | 10.9436 | 10.9478 | 10.9520 | 1,990 |
| 2,000 | 10.9520 | 10.9561 | 10.9603 | 10.9645 | 10.9687 | 10.9729 | 10.9770 | 10.9812 | 10.9854 | 10.9895 | 10.9937 | 2,000 |
| 2,010 | 10.9937 | 10.9979 | 11.0020 | 11.0062 | 11.0103 | 11.0145 | 11.0186 | 11.0228 | 11.0269 | 11.0310 | 11.0352 | 2,010 |
| 2,020 | 11.0352 | 11.0393 | 11.0434 | 11.0475 | 11.0517 | 11.0558 | 11.0599 | 11.0640 | 11.0681 | 11.0722 | 11.0763 | 2,020 |
| 2,030 | 11.0763 | 11.0804 | 11.0845 | 11.0886 | 11.0927 | 11.0968 | 11.1009 | 11.1050 | 11.1090 | 11.1131 | 11.1172 | 2,030 |
| 2,040 | 11.1172 | 11.1213 | 11.1253 | 11.1294 | 11.1335 | 11.1375 | 11.1416 | 11.1456 | 11.1497 | 11.1537 | 11.1578 | 2,040 |
| 2,050 | 11.1578 | 11.1618 | 11.1658 | 11.1699 | 11.1739 | 11.1779 | 11.1820 | 11.1860 | 11.1900 | 11.1940 | 11.1980 | 2,050 |
| 2,060 | 11.1980 | 11.2021 | 11.2061 | 11.2101 | 11.2141 | 11.2181 | 11.2221 | 11.2261 | 11.2300 | 11.2340 | 11.2380 | 2,060 |
| 2,070 | 11.2380 | 11.2420 | 11.2460 | 11.2499 | 11.2539 | 11.2579 | 11.2618 | 11.2658 | 11.2698 | 11.2737 | 11.2777 | 2,070 |
| 2,080 | 11.2777 | 11.2816 | 11.2856 | 11.2895 | 11.2935 | 11.2974 | 11.3013 | 11.3053 | 11.3092 | 11.3131 | 11.3170 | 2,080 |
| 2,090 | 11.3170 | 11.3209 | 11.3249 | 11.3288 | 11.3327 | 11.3366 | 11.3405 | 11.3444 | 11.3483 | 11.3522 | 11.3561 | 2,090 |
| 2,100 | 11.3561 | 11.3600 | 11.3638 | 11.3677 | 11.3716 | 11.3755 | 11.3794 | 11.3832 | 11.3871 | 11.3909 | 11.3948 | 2,100 |
| 2,110 | 11.3948 | 11.3987 | 11.4025 | 11.4064 | 11.4102 | 11.4141 | 11.4179 | 11.4217 | 11.4256 | 11.4294 | 11.4332 | 2,110 |
| 2,120 | 11.4332 | 11.4370 | 11.4409 | 11.4447 | 11.4485 | 11.4523 | 11.4561 | 11.4599 | 11.4637 | 11.4675 | 11.4713 | 2,120 |
| 2,130 | 11.4713 | 11.4751 | 11.4789 | 11.4827 | 11.4865 | 11.4903 | 11.4940 | 11.4978 | 11.5016 | 11.5053 | 11.5091 | 2,130 |
| 2,140 | 11.5091 | 11.5129 | 11.5166 | 11.5204 | 11.5241 | 11.5279 | 11.5316 | 11.5353 | 11.5391 | 11.5428 | 11.5465 | 2,140 |
| 2,150 | 11.5465 | 11.5503 | 11.5540 | 11.5577 | 11.5614 | 11.5652 | 11.5689 | 11.5726 | 11.5763 | 11.5800 | 11.5837 | 2,150 |
| 2,160 | 11.5837 | 11.5874 | 11.5911 | 11.5947 | 11.5984 | 11.6021 | 11.6058 | 11.6095 | 11.6131 | 11.6168 | 11.6205 | 2,160 |
| 2,170 | 11.6205 | 11.6241 | 11.6278 | 11.6314 | 11.6351 | 11.6387 | 11.6424 | 11.6460 | 11.6497 | 11.6533 | 11.6569 | 2,170 |
| 2,180 | 11.6569 | 11.6606 | 11.6642 | 11.6678 | 11.6714 | 11.6750 | 11.6786 | 11.6823 | 11.6859 | 11.6895 | 11.6931 | 2,180 |
| 2,190 | 11.6931 | 11.6966 | 11.7002 | 11.7038 | 11.7074 | 11.7110 | 11.7146 | 11.7181 | 11.7217 | 11.7253 | 11.7288 | 2,190 |
| 2,200 | 11.7288 | 11.7324 | 11.7360 | 11.7395 | 11.7431 | 11.7466 | 11.7502 | 11.7537 | 11.7572 | 11.7608 | 11.7643 | 2,200 |
| 2,210 | 11.7643 | 11.7678 | 11.7713 | 11.7749 | 11.7784 | 11.7819 | 11.7854 | 11.7889 | 11.7924 | 11.7959 | 11.7994 | 2,210 |
| 2,220 | 11.7994 | 11.8029 | 11.8064 | 11.8099 | 11.8133 | 11.8168 | 11.8203 | 11.8238 | 11.8272 | 11.8307 | 11.8342 | 2,220 |
| 2,230 | 11.8342 | 11.8376 | 11.8411 | 11.8445 | 11.8480 | 11.8514 | 11.8548 | 11.8583 | 11.8617 | 11.8651 | 11.8686 | 2,230 |
| 2,240 | 11.8686 | 11.8720 | 11.8754 | 11.8788 | 11.8822 | 11.8857 | 11.8891 | 11.8925 | 11.8959 | 11.8993 | 11.9026 | 2,240 |
| 2,250 | 11.9026 | 11.9060 | 11.9094 | 11.9128 | 11.9162 | 11.9195 | 11.9229 | 11.9263 | 11.9296 | 11.9330 | 11.9364 | 2,250 |
| 2,260 | 11.9364 | 11.9397 | 11.9431 | 11.9464 | 11.9498 | 11.9531 | 11.9564 | 11.9598 | 11.9631 | 11.9664 | 11.9697 | 2,260 |
| 2,270 | 11.9697 | 11.9731 | 11.9764 | 11.9797 | 11.9830 | 11.9863 | 11.9896 | 11.9929 | 11.9962 | 11.9995 | 12.0028 | 2,270 |
| 2,280 | 12.0028 | 12.0061 | 12.0093 | 12.0126 | 12.0159 | 12.0192 | 12.0224 | 12.0257 | 12.0289 | 12.0322 | 12.0354 | 2,280 |
| 2,290 | 12.0354 | 12.0387 | 12.0419 | 12.0452 | 12.0484 | 12.0517 | 12.0549 | 12.0581 | 12.0613 | 12.0646 | 12.0678 | 2,290 |
| 2,300 | 12.0678 | 12.0710 | 12.0742 | 12.0774 | 12.0806 | 12.0838 | 12.0870 | 12.0902 | 12.0934 | 12.0966 | 12.0998 | 2,300 |
| 2,310 | 12.0998 | 12.1030 | 12.1061 | 12.1093 | 12.1125 | 12.1156 | 12.1188 | 12.1220 | 12.1251 | 12.1283 | 12.1314 | 2,310 |
| 2,320 | 12.1314 | 12.1346 | 12.1377 | 12.1409 | 12.1440 | 12.1471 | 12.1503 | 12.1534 | 12.1565 | 12.1596 | 12.1628 | 2,320 |
| 2,330 | 12.1628 | 12.1659 | 12.1690 | 12.1721 | 12.1752 | 12.1783 | 12.1814 | 12.1845 | 12.1876 | 12.1907 | 12.1937 | 2,330 |
| 2,340 | 12.1937 | 12.1968 | 12.1999 | 12.2030 | 12.2060 | 12.2091 | 12.2122 | 12.2152 | 12.2183 | 12.2214 | 12.2244 | 2,340 |
| 2,350 | 12.2244 | 12.2275 | 12.2305 | 12.2335 | 12.2366 | 12.2396 | 12.2426 | 12.2457 | 12.2487 | 12.2517 | 12.2547 | 2,350 |
| 2,360 | 12.2547 | 12.2578 | 12.2608 | 12.2638 | 12.2668 | 12.2698 | 12.2728 | 12.2758 | 12.2788 | 12.2818 | 12.2848 | 2,360 |
| 2,370 | 12.2848 | 12.2878 | 12.2908 |  |  |  |  |  |  |  |  | 2,370 |
| °F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | °F |

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NBS-114A (REV. 7-73)

| | | | |
|---|---|---|---|
| U.S. DEPT. OF COMM.<br>**BIBLIOGRAPHIC DATA SHEET** | 1. PUBLICATION OR REPORT NO.<br>NBS MN-161 | 2. Gov't Accession No. | 3. Recipient's Accession No. |

4. TITLE AND SUBTITLE

THE NICROSIL VERSUS NISIL THERMOCOUPLE: Properties and Thermoelectric Reference Data

5. Publication Date
April 1978

6. Performing Organization Code

7. AUTHOR(S) Noel A. Burley, Robert L. Powell, George W. Burns, Margaret G. Scroger

8. Performing Organ. Report No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

10. Project/Task/Work Unit No.
2210114

11. Contract/Grant No.

12. Sponsoring Organization Name and Complete Address *(Street, City, State, ZIP)*

Same as 9 above, and Materials Research Laboratories
Australian Department of Defence
Melbourne, Victoria 3032, Australia

13. Type of Report & Period Covered
Final

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

Library of Congress Catalog Card Number: 77-14969

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This monograph deals with the formulation and development of the new highly stable nickel-base thermocouple alloys *Nicrosil* (Ni-14.2Cr-1.4Si) and *Nisil*(Ni-4.4Si-0.1Mg) under the leadership of the Materials Research Laboratories (MRL) of the Australian Government Department of Defence, and their standardization by the National Bureau of Standards (NBS) of the U.S. Department of Commerce.

In the formulation of the new alloys, the main method was to use basic thermodynamic data to predict the conditions of solute concentration, temperature and oxygen pressure under which certain discrete oxide layers could form on the surface as highly efficacious passivating films. This work was the culmination of extensive research in which thermoelectric instability in existing nickel-base thermocouple alloys was correlated with their physical, chemical and metallurgical properties (section 2). The basic thermoelectric properties of Nicrosil and Nisil more recently have been the subject of a joint research project between NBS and MRL. The aim of this project, which was conducted under the terms of an Arrangement under the U.S./Australia Agreement relating to Scientific and Technical Co-operation, was to establish a body of standard reference data on the thermoelectric and other properties of the new thermocouple alloys which could be recognized by various standards authorities around the world.

Cont.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)* Calibration drift; chemical analyses; nickel-base alloys; nickel-chromium alloys; nickel-silicon alloys; oxidation; temperature; thermal electromotive force; thermocouples; thermocouple reference tables; thermoelements; thermometry.

18. AVAILABILITY ☒ Unlimited

☐ For Official Distribution. Do Not Release to NTIS

☒ Order From Sup. of Doc., U.S. Government Printing Office
Washington, D.C. 20402, SD Stock No. SN003-003-01856-2

☐ Order From National Technical Information Service (NTIS)
Springfield, Virginia 22151

| | |
|---|---|
| 19. SECURITY CLASS (THIS REPORT)<br>UNCLASSIFIED | 21. NO. OF PAGES<br>167 |
| 20. SECURITY CLASS (THIS PAGE)<br>UNCLASSIFIED | 22. Price<br>$3.50 |

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Descriptions of the prototype materials and experimental methods used in the joint research are given in sections 3 and 4, while the mathematical methods used to analyze the experimental results are described in section 5. The principal thermoelectric reference data for Nicrosil and Nisil, comprising tabular values of thermoelectric voltages, Seebeck coefficients and derivatives versus temperature, are given in section 7, while other material characteristics, in particular their highly stable thermoelectric properties, are summarized in section 6.

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