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EARTH TERMINAL MEASUREMENT SYSTEM MAINTENANCE MANUAL

John P. Wakefield

Electromagnetic Fields Division
National Engineering Laboratory
National Bureau of Standards
Boulder, Colorado 80303

September 1978

Equipment developed for

Commanding General
U.S. Army Communications Command
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U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, Secretary
Sidney Harman, Under Secretary
Jordan J. Baruch, Assistant Secretary for Science and Technology

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

PREFACE

This manual is organized into ten sections. The first four sections present information related to the overall system. Each of the other sections, 5 through 9, is an instrument instruction manual for a particular unit. Section 10 contains information on the inter-connecting cables.

NOTICE

"Certain commercial equipment, instruments, or matertials are identified in this paper in order to adequately specify the experimental procedure. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the material or equipment identified is necessarily the best available for the purpose."

EARTH TERMINAL MEASUREMENT SYSTEM

MAINTENANCE MANUAL

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EARTH TERMINAL MEASUREMENT SYSTEM
MAINTENANCE MANUAL

By John P. Wakefield

This manual describes the equipment and maintenance procedures to support the earth terminal measurements system (ETMS) developed by the National Bureau of Standards for making measurements of earth terminal and satellite parameters such as figure of merit (G/T), antenna gain relative to a reproducible reference level, ratio of carrier power to the operating noise temperature (C/kT), and satellite effective isotropic radiated power (EIRP). System equipment specifications, site set-up instructions, equipment theory of operation, troubleshooting and maintenance are included. This manual does not include measurement theory nor measurement operating procedures that are described in the Earth Terminal Measurement System Operation Manual.

Key Words: Earth terminal measurement system; effective isotropic radiated power; figure of merit; noise temperature; satellite communication.

Figure 1. ETMS System Equipment.

1. GENERAL INFORMATION

1.1 Introduction

The Earth Terminal Measurement System (ETMS) is a portable automated measurement system (figure 1) developed around the NBS Type IV self-balancing power meter [1]. The system measures pertinent power ratios used in determining various performance parameters of satellite receiving earth terminals.

The ETMS operates through the IF patch panel of the earth terminal. The Power Measurement and Control Console measures the power received from the patch panel and operates the remote rf solid-state noise source attached through a cross-guide coupler to the microwave front-end of the earth terminal as shown in figure 2. All measurements are made in pairs, one measurement with the noise source turned off and one measurement with the noise source turned on, and then the two measurements are normalized by the difference between the two powers to minimize the effects of gain variations of the earth terminal.

The measurement of Gain-Over-Noise Temperature (G/T) of an earth terminal is accomplished by pointing the antenna to a radio-star (essentially a point source) of known flux density, measuring the received power, and then pointing the antenna to "cold sky" and again measuring the power. Normally, the larger portion of the noise power "received" during the cold-sky measurement is generated by the "front-end" of the earth terminal. The G/T of the earth terminal is calculated knowing the cold-sky contribution to the measurement and the expected flux density of the star [2, 3, 4, 5, 6, 7].

1.2 Software

The software for the ETMS system consists of seven cassette tapes, four containing programs for specific tasks: equipment checkout, site-data preparation, data acquisition, and data rework. There are three support tapes, one of tabulated program variables, one of array variables, and one of special functions. The ETMS Operator's Instruction Manual [2], (not part of this manual), contains system operating instructions, including a sample input and printout for each measurement task.

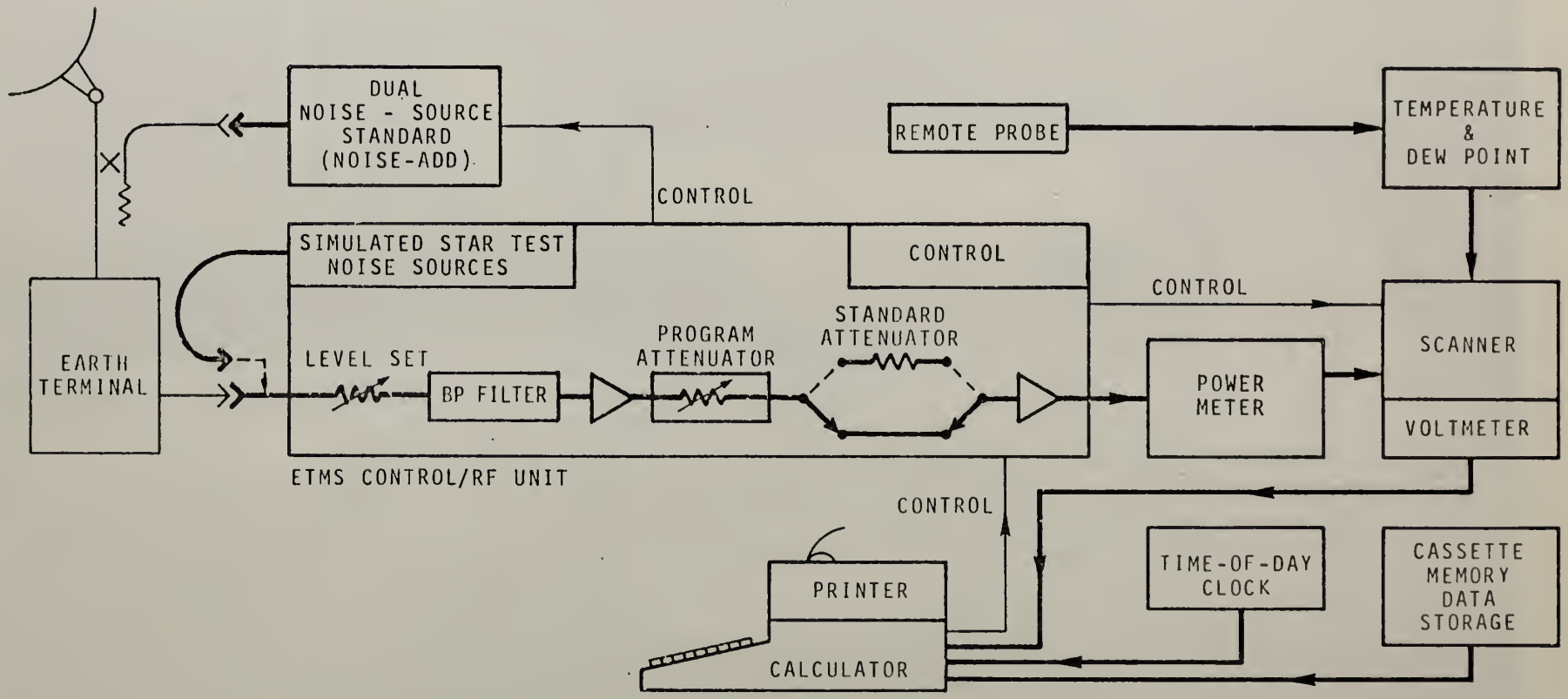

Figure 2. Block Diagram of Earth Terminal and ETMS.

1.3 Hardware

The ETMS unit consists of eight major components (figure 2): (1) The noise-add standard source with its power supply, which is attached to the cross-guide coupler at the antenna low-noise amplifier input; (2) the ETMS control/rf console which plugs into the IF patch panel (this unit also requires two coaxial cables which go up to the antenna rf-plate to remotely control the noise-add source); (3) the power-detector unit which is a thermally-isolated commercial thermistor mount and an NBS type IV power-meter; (4) the multi-channel input digital-voltmeter which measures and digitizes the various measurement parameters and monitor voltages in the system; (5) the clock which provides time information to the calculator for predicting star locations; (6) temperature/dew point monitor for calculating water absorption corrections to the star flux, (the temperature and dew point sensors are attached to 30-meter (100-ft) cables so that they may be located outside to monitor outside ambient conditions); (7) the calculator with its printer which provides the operator control interface, control of the measurement process, and calculations of the measurement data; and (8) a cassette memory for storing measurement data.

1.4 Specifications

Introduction:

The various units of the ETMS systems will operate over different frequency ranges and power levels, so specifications are given for the overall system. The specifications for each individual unit are given in the section pertaining to that particular unit.

1.4.1 System Specifications

General system specification size: The ETMS is transported in six (6) foam-rubber lined fiber glass transit cases each weighing between 25 and 35 Kg (55 and 75 pounds). Total shipping weight of system is approximately 210 Kg (460 pounds). These transit cases provide an easy shipping method by air freight and protect the units against damage.

Power requirements: The ETMS system will operate on either 50 or 60 Hz power line frequency and can be switched to operate from 115 VAC or 230 VAC. The system will operate on a reduced input voltage down to approximately 200 V at either 50 or 60 Hz. System power consumption at 60 Hz is 500 W.

Control/RF Unit: The control/rf unit houses the control and switching circuits to operate the system from calculator commands; the rf circuitry, input attenuator, band-pass filters, programmed attenuators and precision attenuators; rf amplifiers; rf level monitor and alarm; and an internal simulation noise source for verifying system performance.

RF input frequency: The ETMS includes four filters for 30 MHz, 2.5 MHz B.W.; 70 MHz, 5.5 MHz B.W., 2.5 MHz B.W., and 1.3 MHz B.W.; and also permits wideband operation. Wideband operation is useful when an external filter is used for establishing system bandwidth or when measuring a known cw signal.

Actual cw and noise bandwidths are:

Selected Bandwidth	cw Bandwidth	Noise Bandwidth
Wide Band	10-200 Hz	Undefined
30 MHz/2.5	2.5 MHz	2.8 MHz
70 MHz/5.5	5.6 MHz	5.4 MHz
70 MHz/2.5	2.6 MHz	2.65 MHz
70 MHz/1.0	1.4 MHz	1.26 MHz

Input power level: The input rf power is from 0.2 microwatts to 10 milliwatts. The ETMS input is a 0-70 dB attenuator followed by approximately 30 dB of amplification. The optimum power detector level is between 200 and 1000 microwatts for most accurate measurements.

Input impedance: The impedance of the rf input is 50 ohm.

Output impedance: The rf output port impedance is 50 ohms.

RF level meter: The centerscale zero-reading on the rf level meter represents approximately 500 microwatts (-3 dBm) at the detector when operating at 70 MHz. The meter scale is approximately 1 dB per division.

Simulated noise source: The ETMS control/rf unit includes a simulated noise source for testing ETMS system performance without connecting to an earth terminal. The frequency spectrum is approximately 10 to 100 MHz uncalibrated output level. This simulation source incorporates three noise generators, two which simulate the noise-add standard and the third which is manually adjustable over an eleven dB range.

Noise-Add Standard: The dual diode noise-add standard is a solid-state microwave dual noise source with its companion power supply. This unit is attached to the antenna port, through a directional coupler, to inject a known noise signal into the earth terminal receiver under ETMS calculator control.

Dual diode noise-add standard: The 7.0 to 7.4 GHz frequency noise-diode output level is approximately 300,000 K with both diodes on. Diode No. 1 is approximately 3 db less than diode No. 2.

Noise-add current supply: This external module contains a long-term stability voltage reference which is used to determine the constant-current to each noise-add diode.

Input power: 115/230 V 50/60 Hz.
Input control: Two coaxial lines from ETMS control console.

Power Detector Unit: The rf power detector unit is a thermister type rf detector which is in a thermally isolated enclosure, and an NBS type IV power meter. The output of the power meter is a dc voltage which can be measured with a digital-voltmeter.

DVM and Analog Multiplexer Unit: This unit provides eleven (11) input channels to the digital voltmeter for digitizing the various dc voltages involved in the equipment verification and measurement operation of the ETMS. One channel is a spare which can be used as an auxiliary input to the DVM. This module also houses the voltage-offset reference generator used to enhance the rf power measurement.

Time, Temperature and Dew Point Unit: This unit houses the system clock and temperature monitor circuits.

Time: The clock is a commercial module with a crystal time base. The unit has a power-outage, clock-failure signal that is used to initiate a program warning message. (See manufacturer's instruction manual.)

Date: Month and date information to calculator are input on the thumb-wheel switches on the front panel.

Temperature monitor: The temperature monitor is a thermister sensor type meter, with a range of 0 to 100° F [10]. Extended ranging is available on the DVM reading only.

Dew point monitor: The dew point monitor is a heated lithuim-cloride element containing a thermister sensor type meter, range 12° to 96°F [10]. (See manufacturer's instruction manual.)

100-ft extension cables are supplied to remotely locate the temperature and dew point sensors to monitor outside conditions.

Calculator Control Unit: The calculator provides the automatic control and sequencing to operate the ETMS system. The functions are: keyboard input, thermal printer output, cassette tape program, and data storage. The software is in BASIC programming language. Four input/output channels are provided for instrument interfaces (see manufacturer's instruction manual).

1.4.2 Individual Unit Specifications

Refer to each respective equipment section of this manual for particular specifications for each unit.

2. INSTALLATION AND OPERATION

2.1 Introduction

Installation procedures are usually performed on arrival at each site. In short, this amounts to first unpacking the system units; calculator, printer, external cassette unit, control/rf unit, DVM, power detector and clock, then interconnecting the various cables between units, verifying that the power line supply voltage selectors and fuses match the available power, turning on the system, and running the equipment check-out program.

2.2 Unpacking and Inspection

Figure 1 is a photograph of the units of the ETMS system. The system is shipped in six (6) transit cases labeled as follows:

Box No. 1 - Calculator
Box No. 2 - Printer
Box No. 3 - EMTS control/rf unit
Box No. 4 - DVM
Box No. 5 - Clock & power detector
Box No. 6 - Supplies & spare parts

Itemized lists of the contents of each case provide a guide for repacking equipment for transit.

Packing list:

Box No. 1 - Calculator
Calculator with special keys template attached
ac power cord
Tall dust cover for calculator
Box No. 2 - Printer
Thermal printer
Printer I/O cable (interface cable)
ac inter-connect power cord

Box No. 3 - ETMS control/rf unit
control/rf unit
ac power cord
5-short BNC cables
2-type N cables
1-IF patch panel to type "N" adapter cable
2-6 meter (20 ft) BNC cables
2-90 cm (3 ft) BNC cables

Box No. 4 - DVM
DVM with input multiplexer
2-ac power cords
1-I/O cable (rf unit)
1-I/O cable (clock)
1-I/O cable (DVM)
1-I/O cable (cassette unit)
1-control cable (rf to DVM)
3-analog cables
a) rf/control cable
b) power detector cable
c) temp/dew point cable
1-DVM top cover (under foam padding)

Box No. 5 - Clock/Power meter
Clock & temperature-dew point meter
Power detector
External cassette memory
Dual diode noise-add standard
1-SMA/Type "N" simi-rigid line
Noise-add power supply
Hydrometer (temp/humidity)
4-ac power cords
2-SMA noise-add supply cables

Box No. 6 - Supplies & Spare Parts
Temperature/dew point probe enclosure
3 cartons printer paper (6 rolls)
2 cartons cassettes (20 cassettes, program and data tapes)

Spare parts -

1-NBS type IV power meter

1-rf power thermister mount

1-misc components and printed circuit boards

ETMS Accessories:

The manufacturer's accessory packages and instruction manuals for the various equipment are shipped under separate cover to facilitate item check-out upon initial delivery. Some of them will be incorporated into the system transit cases while others probably will not be needed "on the road."

2.3 Initial Installation

After unpacking the system and visually checking for damage, check the position of the 115/230 V selector card in the ac power receptacle for each instrument to make sure it is set to the proper power line voltage. The selected voltage setting is visible beneath the fuse cover.

Connect the calculator, printer, and external cassette unit and proceed through the manufacturer's performance check-outs as directed in the individual manufacturer's instruction manuals. The calculator accessories include a calculator user's training tape, if needed, in addition to the performance test tape.

Clock Check-out:

When satisfied with the calculator's and peripheral's operation, connect the clock I/O cable and set the time and date. Type the following commands on the calculator keyboard:

Type "ENTER (3,*) M,T"

Press "EXECUTE" key

Type "DISP M,T"

Press "EXECUTE" key

The calculator display should show two numbers; the left one should be the left (most significant) digit of the month and the right-hand number should be the least digit of the month, the day of the month (2 digits) followed by the time in hours (00 to 23), minutes, and seconds, all combined together as one long number string. The decimal point should be between the minutes and seconds, e.g., December 14, 12:36:04 = 1 2141236.04.

Voltmeter Checkout:

Connect the digital voltmeter I/0 cable. Turn on the digital voltmeter and the input multiplexer power switch. Perform the instrument checkout listed in the manufacturer's instruction manual. Rotate the DVM rate control knob fully counter-clockwise to the ext. position. Press the "output data" button and release the "program control" button. Turn the mode selector to dc volts and the range selector to auto range.

Type the following commands into the calculator:

Type "ENTER (2,*) M,V"
Press "EXECUTE" key
Type "DISP M, V"
Press "EXECUTE" key

The calculator should display a 9 (dc mode) and the right-hand number should coincide with the voltmeter display reading.

2.3.1 ETMS Control/RF Checkout

2.3.1.1 Manual Control

Connect the I/0 cable from the calculator to the control/rf console, and the interconnecting cable between control/rf console and DVM multiplexer, and turn on ac power to all units.

Set each of the control codes in binary (1,2,4,8,16,32, and 64 code) into the programming switches on the front of the control/rf unit, press the "load" button and check for the conditions listed in the table below.

The complete list of control codes used by the calculator is given in Appendix B.

Control Code	Switches Up	Results On Indicator Lights
48	32+16	15 dB Programmed Attenuation
63	32+16+8+4+2+1	0 dB Programmed Attenuation
62	32+16+8+4+2	1 dB Programmed Attenuation
61	32+16+8+4+1	2 dB Programmed Attenuation
59	32+16+8+2+1	4 dB Programmed Attenuation
55	32+16+4+2+1	8 dB Programmed Attenuation
66	64+2	Standard Attenuator In
67	64+2+1	Standard Attenuator Out
68	64+4	rf Off
69	64+4+1	rf On
82	64+16+2	Noise ADD #1 On
83	64+16+2+1	Noise ADD #1 Off
84	64+16+4	Noise ADD #2 On
85	64+16+4+1	Noise ADD #2 Off

The following codes control digital voltmeter functions. Press in the "program" button on the DVM and execute the control codes via the programming switches on the ETMS control/rf unit.

Control Code	Switches Up	Results On Indicator Lights
Input Channels		
111	64+32+8+4+2+1	Input Channel 0
110	64+32+8+4+2	Input Channel 1
109	64+32+8+4+1	Input Channel 2
107	64+32+8+2+1	Input Channel 4
103	64+32+4+2+1	Input Channel 8
100	64+32+4	Input Channel 11
DVM MODES		
33	32+1	dc Volts/w Filter In
32	32	dc Volts/w Filter Out
DVM Ranges		
27	16+8+2+1	0.1 Volt Range
28	16+8+4	1 Volt Range
29	16+8+4+1	10 Volt Range
30	16+8+4+2	100 Volt Range
31	16+8+4+2+1	1000 Volt Range
24	16+8	Auto Range

2.3.1.2 Calculator Control

After checking the control functions listed in the tables above, output the same commands from the calculator by performing the following sequence:

First, set the output format of the calculator by entering one line of program into the calculator by typing "10 FORMAT B" on the keyboard. Then press the "END OF LINE" key.

Now, each of the control codes in the tables above may be executed from the calculator by typing "WRITE (4,10) WBYTEXX;" Where XX is the control code

listed in the table. Then press the EXECUTE key. Note: The semicolon on the end of the direct command above must be included or the calculator waits for an end-of-message flag signal from the instrument and none is generated by this equipment, only a "command completed" flag is returned.

When the EXECUTE key is pressed, the instrument should respond with the results listed in the table. Check each command in the table by repeating the "WRITE (4,10) WBYTEXX;" and EXECUTE for each of the command codes.

The "RECALL" key can be used to avoid retyping the WRITE statement in repeatedly. Refer to the calculator instruction manual as to the use of the RECALL and editing keys.

This completes the preliminary checkout of the control circuitry.

2.3.1.3 RF Circuitry Checkout

Set up the following conditions on the control panel:

a. Manual attenuator (input) set to 60 dB.
b. Connect the simulated noise output coax cable to the input, if not already connected.
c. Execute the command code 65 either from the front panel program switches or through the calculator keyboard as described in the previous section. Command code number 64 switches the standard attenuator in and turns the rf to the power detector "OFF."
d. Set the programmable attenuator to "zero" dB by executing command code 63 as above.
e. Turn the simulated noise-add "OFF" by executing command code 81.
f. Set the hold-bypass switch to the bypass position.
g. Set the meter range selector to X1.
h. Select the 70 MHz/5.3 MHz bandwidth filter on the filter selector control.
i. Set the simulated STAR level attenuator to 3.5 dB.

Adjust the manual input attenuator to increase the input signal (noise) level until the signal level meter reads approximately -3.0 by reducing the manual input attenuator. This should be around 20 dB input attenuation.

Turn each noise-add source on and off using command codes 83 and 82 (NA#1), respectively, or 85 and 84 (NA#2), noting that the signal level meter indicates an increase or decrease in signal. Noise-add #1 is a smaller signal than noise-add #2.

Verify the operation of the programmable attenuator and the standard attenuator by observing the change in level on the meter when each of the following control codes are executed (either manually or through the calculator keyboard).

Control Code	Action
62	Programmable Attenuator = 1 dB
61	Programmable Attenuator = 2 dB
59	Programmable Attenuator = 4 dB
55	Programmable Attenuator = 8 dB
63	Programmable Attenuator = 0 dB
66	Standard Attenuator "IN" (6 dB)
67	Standard Attenuator "OUT" (0 dB)

Overload trip & warning:

Decrease the input attenuator while observing the signal increase on the level meter. The overload light should turn on and the warning buzzer sound when the meter reads approximately + 8 to + 10 dB.

Adjust the input attenuator to reduce the input signal; then press the overload reset button to reset the overload monitor and silence the buzzer. Readjust the input attenuator for a mid-scale (zero) reading on the meter. Set the meter range selector to X 0.1 and adjust the meter offset knob to return the meter to approximately mid-scale.

Vary the simulated star attenuator noting the signal level change on the meter. The meter scale will be approximately 0.1 dB per small division.

Move the meter range selector to X 0.01 again adjusting the meter offset knob to midscale. Varying the simulated star attenuator should provide a signal level change of approximately 0.01 dB per small division. Return the meter range selector to the X 1 position.

2.3.1.4 Power Detector Checkout

Connect the ac power cord to the power detector unit after selecting the correct line voltage setting and fuse for the power line. Note: Make certain

the ground selector switch on the back panel of the unit is in the ungrounded position, and that the bolometer cable is connected. On the front panel, check that the inter-connect links are not connected and that the 100 Ω/remote/200 Ω switch is in the 200 Ω position (this switch is blocked in the 200 Ω position on some models). Turn "ON" the ac power switch on the front panel of the power detector unit.

The meter should move up to about mid scale. Connect the analog voltage cable (J364) between the power detector and the voltmeter. Connect the type "N" coaxial cable between the control/rf unit and the power detector.

Adjust the input manual attenuator for approximately + 3 reading on the rf LEVEL METER on the control/rf unit. While alternately using control codes 69 and 68 (rf "ON" and rf "OFF"), observe that the reading on the current meter on the power detector changes a definite but very small amount.

Execute control code 103 (64+32+4+2+1) either manually or through the calculator keyboard to select DVM input channel 8 (power detector voltage). Execute control code 68 (rf OFF) last.

Set the DVM range selector to auto-range and the rate knob fully clockwise (free-run). Release the program button on the DVM. The DVM reading should be between 2.2 and 2.6 volts depending on the temperature of the power detector unit.

2.3.2 Temperature/Dew-Point Monitor Checkout

Caution:

The lithium cloride bobbin for the dew-point temperature probe is stored in a sealed test tube containing a drying agent. When in operation, the dew-point instrument heats the moisture absorbing bobbin to establish an equilibrium. When not heated, the bobbin will absorb moisture and in some instances can overheat and burn out when turned back on. For this reason the bobbin is kept dry by storing it in the sealed test tube with the drying compound. Refer to the manufacturer's instruction sheet included with the instruction manual for further information.

Unplug the dew-point probe, carefully remove the lithium-cloride bobbin from the dry test tube being careful not to touch the wicking material, and install the bobbin onto the dew-point probe. Replace the probe shield and plug the probe cable back in. After about thirty minutes the dew-point reading and DVM reading will indicate actual dew-point temperature.

Connect the temperature and dew-point probes to the chrono-met unit and the analog cable J656/J356. Within a few minutes, the temperature meter should indicate the probe temperature in degrees Fahrenheit. Executing control code 110 (DVM input channel 1) should read approximately the same temperature reading in millivolts times 10. The dew point should indicate between 0 and 50° F. depending on the probe temperature. Executing control code 109 (DVM input channel 2) should cause the DVM to read the indicated dew-point temperature in millivolts times 10.

2.3.3 Equipment Performance Checkout

The previous section described individual manual checks on each piece of equipment. In the system performance check, the equipment check program (cassette #1, Equipment Check) is loaded into the calculator and the operation of all the functions and the quality of the performance of the entire system is tested. This program is the equipment check, which is performed first each time a setup is made at a new site. It can also be used as a troubleshooting aid.

Place the tape labeled Equipment Check in the cassette transport on the calculator keyboard. Rewind the tape if necessary. Turn the calculator power switch off for a few seconds and then back on. Press the LOAD key then the EXECUTE key. The calculator will load in the program from the tape. After the calculator has loaded the program (|— showing on the calculator display), press the RUN key and then the EXECUTE key. The program will begin execution and will request location of input data tape after a minute. Type 10 on the keyboard, then press the EXECUTE key; the calculator will load several data files off the cassette and begin execution of the program. Proceed through the equipment check program following the instructions described in the ETMS Operator's Manual.

On completion of these tests the ETMS system is operational in the simulated mode.

2.4 New Site Equipment Setup

2.4.1 Introduction

The ETMS equipment is normally shipped to an Earth Terminal site in the six transit cases. This section of this manual presents assembly of the system, connection to the earth terminal, and performance checkout routines assuming that the ETMS system was fully functional when it was packed for shipping. The normal procedure is to unpack and set up the equipment, execute the equipment check program recognizing that the units are cold, and then allowing the system to warm up and stabilize for at least 24 to 36 hours before attempting to make measurements.

2.4.2 Unpacking and Hookup

2.4.2.1 Unpacking

The ETMS can be set up on a small table adjacent to the IF patch panel and within sight of the antenna control console. Figure 1 shows a convenient arrangement of the ETMS equipment.

Unpack the control/rf console, DVM, power detector and clock units. Be sure that the proper power-line voltage is selected on each unit. Note that the DVM unit has ac line voltage selectors on both the input multiplexer and the DVM. Connect the ac power cords but do not turn the equipment "ON." Unpack the calculator and printer, placing them beside the equipment, and check that the printer has paper in it. Unpack the external cassette unit and check the ac line voltage settings of these three units. Connect the ac power cords to these units. The printer and cassette unit can be powered from the calculator. Leave all ac power off until the interconnecting cables are hooked up.

Connect the printer I/O cables (see figure 41), matching the jack numbers on the equipment and cables. The four I/O cables can be plugged into the calculator in any of the four locations.

Connect the control cable J352/J652 between the control/rf console and the DVM; and the three analog cables between the DVM input channels and the control/rf console, the power detector, and the chrono-met (clock) unit.

Connect the type N cable between control/rf console input and the power detector; and the short BNC cable between the simulated noise output and the signal input. Set the input manual attenuator to 70 dB attenuation. Be sure

that all the BNC connectors on the short cables on the front of the control/rf console are properly connected. An intermittent signal cable can wipe out a set of measurements.

Check that all control cable connectors are properly seated and locked.

2.4.2.2 Power-Up

Turn on all the ac power switches. Press the overload reset button on the control/rf console if the overload alarm is tripped. Set the GMT date (number of month and day) into the thumb-wheel switches on the front of the clock. Switch the run/set switch on the clock to the "set" position and set the clock to the GMT time using the seconds, minutes, and hours buttons. Restart the clock by returning the set switch to the run position. The time should be correct within one second of GMT time in order to track stars accurately.

The power-fail warning on the clock is automatically reset when the set switch is moved to set.

2.4.2.3 Temperature/Dew-Point Probes

Unpack the temperature/dew-point probe enclosure and the probe extension cables. There are three extension cables, two cables 15 meter (50 ft.), and one cable 30 meter (100 ft.) in length, all having the same pin connections. Connect the cables as needed to run from the temperature/dew-point meter to a location outside the building away from building air conditioners or heat reflecting walls. Remove the dew-point sensor bobbin from its "dry" test tube and install the bobbin on the dew-point probe in the enclosure. Replace the bobbin shield over the probe and adjust the lid on the enclosure so that the air can circulate freely unless the weather includes gusty winds.

Hang or support the enclosure as high off the ground as possible after connecting the extension cables.

Connect the respective cables to the temperature/dew-point meters. The temperature meter should stabilize in a few minutes; however, the dew-point meter may cycle for an hour before stabilizing.

The temperature meter display will go out of range if the outside temperature exceeds 100° F., however, the analog data to the DVM will still remain valid. The temperature display can be internally switched to a higher range if desired by opening the clock module. (See the temperature/dew-point instruction manual).

The dew-point meter may go out of its operating range in very severe cold weather. If this happens the temperature and humidity can be manually entered into the calculator by placing the thermometer/hydrometer furnished with the system up on the antenna base and monitoring it periodically.

2.4.3 Installation of Noise-Add Standard

The noise-add standard module is mounted in the antenna rf room near the input to the low-noise amplifier where it can be connected to the input coupler through a short semi-rigid coaxial line, and is controlled from the ETMS rf console located in the earth terminal control room.

2.4.3.1 Positioning the Noise-Add Standard

Locate the noise-add standard on a bracket or waveguide near the directional-coupler at the input of the low-noise amplifier where the standard can be connected to the pilot-inject or noise-add input of the directional coupler with the short 45 cm (18 inch) semi-rigid coaxial line. Tape the noise-add module securely with reinforced tape so that the semi-rigid coaxial line may be connected. The noise-add module must move with the low-noise amplifier as the antenna changes elevation. Be sure that sufficient clearance exists.

Transfer the earth terminal receiver to the low-noise amplifier (PARAMP) which will be tested;* disable the pilot detect warnings by switching to maintenance status and carefully disconnect the pilot-inject line from the directional coupler.

Unpack the short semi-rigid coaxial line and connect the noise-add standard into the directional-coupler where the pilot line was removed. Note: If antenna gain over a period of time is to be measured, an individual semi-rigid coaxial line should be made for each antenna, and this semi-rigid line used only for this particular antenna.

The noise-add standard is referenced through this line to the antenna so that every attempt possible must be made to keep the losses repeatable. This

*If the LNA with the pilot disconnected is switched out, the earth terminal control logic may not switch back to the LNA automatically so that the switches must either be manually switched or the pilot temporarily reconnected while switching.

includes reducing wear and tear on the semi-rigid line and SMA connector by having a line for each antenna; connecting and disconnecting the SMA connectors carefully and as few times as possible; and minimizing bending and reshaping the semi-rigid line. In other words, treat the semi-rigid line with TLC (tender, loving care). Connecting the noise-add standard power-supply and remote cables: Unpack the noise-add power supply and ac power cord, the two miniature coax cables having SMA connectors, and the two, 90 cm (3 ft.) BNC cables.

Locate the noise-add power supply on a bracket where the SMA cables will connect between the noise-add standard and the power supply, and the ac power cord will reach a power outlet. Secure the power supply with tape after checking that all cables and modules have sufficient clearance in all antenna positions. Make sure the power supply has the correct supply voltage setting, turn the switch off and connect the ac power cord and SMA cables. Note that the SMA connectors are labled No. 1 and No. 2 on the respective ends.

Locate two coaxial lines running from the earth terminal control room to the antenna rf room which can be used temporarily. For example, on the AN/FSC-78, the frequency reference lines W103 and W203 for the 1 MHz and 5 MHz.

These are labeled J11 and J23 above the frequency control cabinet in the control room and W7 on J7, W8 on J8 in the antenna rf room. Verify that these are the correct unused cables using an ohm meter. Connect the cables in the rf room to the noise-add power supply control J853 and J854 using the three-ft BNC cables and coaxial adapters as needed.

Turn the ac power switch on.

2.4.3.2 Control Room Cables

Unpack the two, 6-meter (20-ft.) BNC cables and connect them between the temporary lines and the ETMS control/rf console, Jacks J653 and J654. Observe the low-noise amplifier output on the downlink spectrum-analyzer monitor. Switch the noise-add diodes off and on to see that they are properly controlled and that No. 2 is larger than No. 1. Execute program control code No. 81 in the ETMS to turn off both noise-add diodes.

Note the noise level rise as noise diode No. 1 is switched on and off using control codes No. 82 and No. 83. Then turn noise-add diode No. 1 off, control code No. 83, then switch noise-add diode No. 2 on and off by executing control codes No. 84 and No. 85. The rise in noise level from noise-add No. 2 should

be larger than the noise from No. 1. If not, interchange the two BNC cables at J653 and J654 on the back of the ETMS control/rf console.

If neither or only one noise-add diode is working, recheck continuity of the temporary control cables between the ETMS and the antenna rf room. Also, verify that the downlink monitor is looking at the same low-noise amplifier to which the noise-add standard is connected.

2.4.4 ETMS IF Patch Panel Connections

Unpack the IF patch panel to type N adapter cable and four-foot coaxial type N cable. Turn the input attenuator on the ETMS to 70 dB and connect the ETMS input to the selected down-connector IF patch. Switch the hold-bypass switch to bypass. Set up the desired down converter frequency and phase-lock control. Switch the ETMS filter selector to 5.3 MHz and then decrease the input attenuation until the signal level meter reads about mid-scale 0 (-3 dBm).

Watch the signal level meter for each change as the noise-add standard is switched off and on using control codes No. 80 (off), No. 83 (NA No. 1) and 84 (NA No. 2) (on).

2.4.5 Equipment Checkout on Station

Load the equipment check program if it is not already in the calculator and proceed with the equipment/station checkout as described in the ETMS Operator's Manual under equipment check (section 6.1).

3. THEORY OF OPERATION

3.1 Introduction

This section describes the equipment which makes up the ETMS System hardware, the requirements on this equipment and evaluation of particular characteristics of the system. Theory of individual units are contained in later chapters of this manual.

The measurement of the pertinent power ratios along with real-time star location predictions is accomplished using a measurement system developed by NBS and known as the earth terminal measurement system (ETMS). The ETMS is an automated measurement system developed around the most accurate power measurement instrument known--the NBS Type IV self-balancing power meter [1]. This meter as implemented in the ETMS, measures the ratio of stable noise powers to an accuracy of better than ± 0.1%.

3.1.1 Measurement Description

The ETMS system is a noise radiometer, capable of high-resolution rf power measurements, which has been combined with a programmable calculator, a clock, and a temperature/dew-point monitor. The calculator has been programmed to automatically operate the radiometer. The system is used to measure the antenna gain to system noise temperature ratio (G/T) of an earth terminal antenna system. The program reads the time from the clock and calculates the predicted pointing azmuth and elevation for the antenna toward a selected radio-star. Then, as the earth rotates, the system records repeated measurement data of received noise-power when the radio-star drifts through the beam of the antenna. This "drift" routine is repeated five times with a different offset in declination angle each time, forming a set of data which cuts the radio-star into six slices. One pass is offset a couple of degrees away from the star to a quiet area to establish a "sky background" noise-level.

The program then reprocesses these data using curve-fitting routines to calculate the maximum intensity of noise power (star flux) at the center of the star, even if none of the five cuts passed exactly through the center of the star. The G/T ratio of the earth-terminal is evaluated using measured data on the background noise temperature, including the receiver system noise and the

star-flux noise temperature as seen by the antenna. It also applies corrections for atmospheric attenuation based on the temperature, dew point, and various antenna parameters. Refer to the ETMS Operator's Manual for a rigorous analysis of the measurement theory and procedures.

3.2 Description of System Equipment

A simplified block diagram of the ETMS is shown in figure 2. The ETMS contains eight subsystems: (1) the control/rf unit which provides signal conditioning, system test signals, precision programmable attenuators, signal monitoring, alarm circuits, and interface circuits which allow the calculator to control the various measuring instruments; (2) and NBS type IV self-balancing power bridge used to measure noise power; (3) a dual X-band solid-state noise source (noise-add) to provide a stable reference signal needed to eliminate the effects of gain fluctuations in the earth terminal; (4) a programmable voltmeter with an analog multiplexer (scanner) which connects the digital voltmeter to the various measurement points of interest; (5) a temperature and dew-point monitor with remote probes to measure the water content of the atmosphere at ground level; (6) a digital clock to provide time information required to determine current star coordinates; (7) a calculator which provides computation capability, and a means of controlling each of the remaining subsystems under automatic sequence control, a keyboard to control the measurement procedures or to enter program modifications, and a means of storing the measurement results on magnetic cassette tape in order to rework the data at a later time; and (8) an external cassette memory which allows redundant recording of measurement data.

The Dual Standard Noise-Source (noise add) and its power supply are connected at the input to the low noise amplifier through a directional coupler. The noise-add control signals are brought up from the ETMS in the earth terminal control room through two auxiliary coaxial lines. The remote temperature and dew-point probes are suspended out near the base of the antenna and connected to the ETMS with long extension cables. The ETMS input signal is picked off at the 70 MHz IF patch panel in the earth terminal control room. The ETMS calculator displays pointing azmuth and elevation angles which the operator sets on the earth terminal control console. Then the calculator automatically measures and records the received noise power as the star drifts through the antenna beam as the earth rotates.

3.3 General System Theory

3.3.1 Control/RF Unit

The 70 MHz IF signal from the down connecter is applied to the input of the ETMS control/rf unit through a level-set attenuator to adjust the input level and then a band-pass filter to limit the bandwidth of the signal fed to the amplifiers. A 3-dB attenuator (not shown in figure 2) isolates the input of the first amplifier from the impedance variations of the filters. The internal filters, which are selectable by a front panel control knob, are 70 MHz center frequency with 1 MHz, 2.5 MHz and 5.5 MHz bandwidths or at 30 MHz center frequency with 2.5 MHz bandwidth. A non-filtered wideband position is also available. The signal path is brought out to the front panel so that an external filter can also be connected.

The first low noise broadband (10-200 MHz) amplifier has 30-dB gain followed by a 10-dB fixed attenuator (not shown) for a net gain of about 17 dB (including the 3-dB input pad). A 0-15 dB programmable attenuator with high repeatability is controlled by the calculator to maintain the signal at an optimum level. The "6 dB reference attenuator" is switched in and out during the measurements and the attenuation value of this step verified as a check on system linearity and accuracy.

The second low noise broadband amplifier (10-200 MHz), which is padded with 10-dB attenuation in its input (not shown), has a gain of 30 dB so the net gain is 20 dB. The + 20 volt dc supply voltage to the amplifiers is monitored on input channel No. 3 of the DVM so that any significant change in supply voltage (which would effect amplifier gain) will be detected at setup time.

The output of the second amplifier is monitored through a directional-coupler and crystal diode detector so that should a signal be high enough to damage the power detector, the rf off/on coaxial relay (not shown) in the rf output will be switched off, protecting the power detector.

The ETMS control unit provides a simulated star noise source and simulated noise-add sources which can be connected to the signal input to simulate earth terminal conditions, so that, with the exception of the X-Band Noise-Add Standard, the performance of the entire system can be checked out.

3.3.2 Power Detector Module

A commercial rf thermistor mount is used with the NBS Type IV dc substitution, self-balancing power meter to measure the noise power. The thermally isolated thermister mount is a 200 ohm negative temperature coefficient unit which detects rf power levels up to 10 mW over the frequency range of 1 MHz to 1000 MHz.

The NBS Type IV power meter is a dc substitution type self-balancing meter which will measure rf power ratios to better than 0.1% accuracy. The output voltage of the meter is the dc voltage which appears across the thermister element as the self-balancing action varies the dc current through the thermister element (and therefore the heating energy) to maintain the element at 200 ohms. As rf power is absorbed by the thermister, thereby heating it, the self-balancing action decreases the dc power by an equal amount.

See the NBS Type IV Instruction Manual [8] and article [1] by N. T. Larsen for a complete theory and operation for the type IV power detector.

3.3.3 Digital Voltmeter

The digital voltmeter is connected to a twelve-channel input multiplexer (scanner) to measure various voltages of interest. Rf power is measured by switching the rf coaxial relay "off" then measuring the power meter dc output voltage on channel 8, switching to channel 9 and measuring the difference between the coarse offset voltage and the power meter voltage. This sets the programmable digital to analog converter (DAC) to this difference in voltage so that the sum of the coarse offset plus the DAC output (called the corrected offset voltage hereafter) is equal to the bridge voltage within ± 1 mv. The DVM input is then switched to input channel 10 which is the difference between the power meter voltage and the corrected offset voltage; the offset difference (less than 1 mv) is measured; the rf coaxial relay is switched "on"; and the new offset voltage difference (on channel 10) is read. The dc voltage across the thermister will have decreased to compensate for the rf power which has been dissipated in the rf thermistor mount. As the rf heats the thermistor element, its resistance tries to decrease, but the self-balancing action reduces the dc current just enough to maintain the resistance at 200 ohms. The decrease in dc power to the thermistor is equal to the rf power introduced into the thermistor.

$$P_{rf} = P_{dc}(\text{ with no rf}) - P_{dc}\ (\text{with rf})$$

so that

$$P = \frac{E_1^2}{R} - \frac{E_2^2}{R},$$

where E_1 is the dc voltage with no rf and E_2 is the power meter dc voltage with the rf applied to the power detector.

The form of the equation normally used for the type IV is

$$P_{rf} = \frac{1}{1000\ R}\ [\Delta V(2E - \Delta V)],$$

where P is the rf power in milliwatts, E is the power meter dc voltage (across the thermister with no rf applied, and ΔV is the change in power meter voltage ($E_1 - E_2$). R = 200 Ω for the detector mount used in the ETMS.

3.3.4 Analog Multiplexer

The analog multiplexer is controlled from the ETMS control unit to provide twelve input channels into the digital voltmeter. These inputs are connected to the DVM input through two-pole reed relays to provide for floating both the high and low inputs to the DVM.

The channel assignments are:

Channel 0	Shorted DVM inputs
Channel 1	Temperature
Channel 2	Dew point
Channel 3	+ 20 volt supply
Channel 4	+ 12 volt supply
Channel 5	DAC output
Channel 6	Diode detector voltage
Channel 7	DAC reference voltage
Channel 8	Power bridge voltage
Channel 9	Offset voltage
Channel 10	Δ Volts power-measure
Channel 11	Spare or auxillary input

3.3.5 Temperature and Dew-Point Meters

The temperature and dew-point sensors are bridge circuits having a remote composite thermister probe in one leg. The bridge outputs are followed by instrument amplifiers to provide a 10 mV per degree Fahrenheit scaled output. These outputs (temperature and dew point) are connected to DVM input channels No. 1 and No. 2; and to the temperature and dew-point panel displays.

The dew-point probe has a thermister surrounded by a wick bobbin containing (LiCl) lithium chloride. Electrodes are connected to the lithium chloride so that an electric current can be conducted through it, thus heating it.

The LiCl absorbs moisture from the surrounding atmosphere, decreasing its electrical resistance. The electrical current heats the LiCl bobbin until an equilibrium is established between the vapor pressure of the moisture in the LiCl and the ambient humidity. The thermister senses the probe temperature so that the bridge output is proportional to the dew-point temperature.

3.3.6 X-Band Dual Noise-Add Standard

The dual noise-add source injects a reference level noise power into the earth terminal system between the receive-output of the antenna and the input to the low noise amplifier. This noise source acts as a stable reference level which is turned on and off remotely by the ETMS control/rf unit.

Measurements are repeated with the noise-add source both off and on and the calculated results corrected so as to keep the measured noise-added power constant. This effectively removes the effects of receiver gain changes from the measurements.

The two individual sources differ in power output by approximately 3 dB and they can be used singly or together. Software can be implemented to utilize the power step difference between the two as a receiver system linearity verification check.

This is accomplished by using two coaxial noise diodes which are combined through two, 3-dB hybrids resulting in a circuit which attenuates the output of noise diode No. 1 by 3 dB more than the output of diode No. 2. The combined noise output is connected to the insertion directional coupler through a semi-rigid coaxial line.

The noise diodes are biased by two constant current generators whose reference is a very stable, precision, solid-state voltage standard. The noise outputs are adjusted for best temperature stability and 3 dB difference by selected trim resistors in the constant current source circuits.

Each diode is switched off by shunting the diode bias current to ground through a transistor switch. The transistor switch is connected to the input control line through an optical coupler.

3.4 System Control Circuits

The calculator controls the ETMS system via I/O-Select Code #4 through the TTL 8-bit bi-directional interface to the ETMS Control/rf unit. The control signals are the function-select code (MSB 4 bits), data (LSB 4 bits), the control command (CTL 1), and the auxillary interface control signal (I/O). These are processed in the ETMS control/rf unit and distributed to the various sub-systems or to the voltmeter control (refer to figure 3). The system answer-back signal called the return flag (or just flag), is collected in the control/rf unit from the various sub-systems and the voltmeter control and sent back to the calculator via this control/rf unit interface cable.

The voltmeter data, voltmeter read command, and flag signal are connected to the calculator via a BCD input interface cable on I/O-select code #2. The clock, month, and day data are connected to the calculator through a BCD input interface cable on I/O-select code #3.

3.4.1 Control Signals

The signals that control the ETMS are divided into two classifications, the function select lines (data bits) 5,6, and 7 having binary weights 16, 32, and 64 respectively, and the four data bits 1, 2, 3, and 4 having binary weights 1, 2, 4, and 8. The function-select information (lines 5, 6, and 7) are combined with the function data (lines 1, 2, 3, and 4) to form a seven-bit control code to activate or deactivate any function in the ETMS. This control code can be selected on the programming switches on the ETMS control/rf unit and the LOAD button pressed to generate a control pulse or the code can be programmed on the calculator using the WBYTE command, and output to I/O-select code #4.
NOTE: If WBYTE is used, the form must be WBYTE XX; where XX is the control code suffixed by the semicolon. The semicolon tells the calculator not to wait for a second flag or "end of data" signal from the interface.

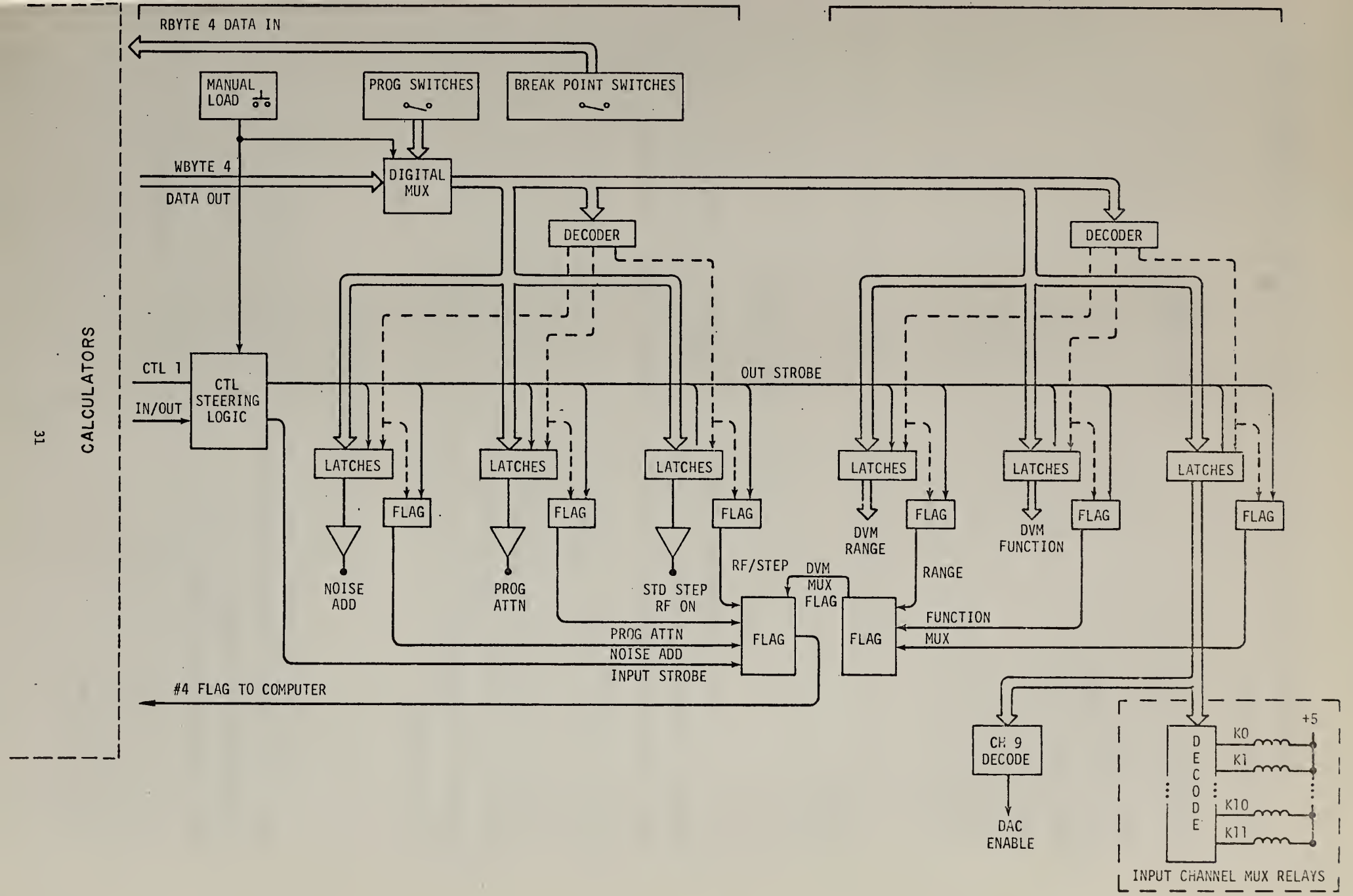

Figure 3. System Control.

The control function select codes (bits 5, 6, and 7) are listed in the following table.

Function	Switch Codes				
	8	7	6	5	Decimal Code
DVM Range	X	0	0	1	16+
DVM Function (DCV)	X	0	1	0	32+
Programmable Attn	X	0	1	1	48+
Step Attn & RF On	X	1	0	0	64+
Noise-add	X	1	0	1	80+
Voltmeter Input Channel	X	1	1	0	96+

(X represents a "don't care" position.)

A complete list of the command codes is given in section 2.3.1.1 of this manual.

3.4.2 Offset Voltage Control

The offset reference voltage is used to increase the digital voltmeter resolution of the power meter measurement. This reference offset voltage from the DAC must be set equal to the bridge voltage (within one MV) while the rf signal is turned off in the ETMS. The output of a DAC is wired in series with a fixed voltage offset. When DVM channel 9 is selected, the DVM low input is connected to the fixed voltage offset and the DVM high input is connected to the power bridge so that the DVM reading is the difference voltage. This DVM reading is the input data to the DAC. The DAC strobe is enabled when the DVM channel 9 is decoded so that the DVM flag pulse strobes the DAC, storing the DVM reading.

3.4.3 Noise-Add Control

The X-Band Solid-State Dual Noise-add Standard is remotely controlled by the ETMS control/rf unit through auxillary coaxial cables already installed between the earth terminal control room and the rf room at the antenna. The ETMS console turns the noise-add source off by effectively shorting the coaxial line with a transistor switch. The control inputs of the noise-add power supply (constant current sources) are coupled to the incoming control lines through optical couplers.

3.5 System Flag Circuits

There are three independent flag circuits; the DVM data-ready flag on I/O select code #2, the time and date data-ready flag on I/O select code #3, and the ETMS control-ready flag on I/O select code #4. Select codes #2 and #3 are input only I/O channels. The control-ready flag on #4 includes control commands to the DVM (range, function, etc.) and the return flag for the break-point switches on select code #4 input. The output or input return flags on the control/rf unit is selected depending on the interface auxiliary control line called I/O signal on select code #4.

3.5.1 ETMS Control/RF Console Flags

The control interface cable, I/O select code #4, is a bidirectional buss. Control data is transferred to the ETMS and the break-point switch input data is transferred from the ETMS control/rf unit to the calculator on this interface. A device ready flag is required for both input and output. On the input command, the auxiliary control line I/O is high, thus directing or steering the control signal to the input ready-flag one-shot, which sends a flag pulse back to the calculator.

The I/O signal remains low on output commands in order to steer the control signal to the various controlled functions.

Each of the particular functions: Programmable attenuator/RF ON, noise-add, and multiplier/DVM control generate a ready-flag in response to the control signal when selected. These flag pulses are combined along with the break-point input flag to generate the interface answer-back flag for I/O select code #4 to the calculator.

3.5.2 DVM Data-Ready Flag

The digital voltmeter generates a data-ready flag in response to the control (read) signal upon completion of the digital conversion. This data-ready flag is sent back to the calculator on I/O select code #2 and to the DAC strobe input if analog input channel #9 has been selected.

3.5.3 Clock Data-Ready Flag

The time clock inhibit circuit locks the clock reading for a one-shot duration of 70 ms in response to a control signal (CTL1) on I/O select code #3. The data-ready flag is returned to the calculator at the beginning of the one-shot pulse allowing time for the calculator to input the time and date before the time data is allowed to update.

3.6 System Data Circuits

Digital data circuits are divided into four separate non-interacting circuits: (1) Control and command data output on I/O select code #4, (2) Breakpoint switch input data input on I/O select code #4, (3) Digital voltmeter data input to the calculator on I/O select code #2, and (4) Month, day and time clock data input on I/O select code #3.

3.6.1 Control Data Paths

Control data is sent from the calculator to the ETMS control/rf unit on eight (8) parallel lines. These signals are distributed to the function-select decoders in the control/rf unit and in the multiplexer/DVM control chassis and to the various data latches throughout the system. The decoded function will enable the control pulse to strobe the selected function latches. All other latches will remain unchanged since their strobe pulse is not selected by the decoders.

3.6.2 Digital Voltmeter Data

The digital voltmeter data is output in parallel BCD data-lines and is connected to the calculator through a BCD interface cable. This DVM BCD data is also connected to the digital inputs of the DAC used to generate the offset reference voltage. When the analog multiplexer channel #9 is selected, the DVM flag strobes this DVM reading into the DAC data latches. The DVM exponent (range) is corrected to a BCD number before being sent to the calculator by adding +13 in base 16 without carry. Then a decimal point is inserted in the BCD data stream to properly position the exponent.

3.6.3 Date and Time Data Path

The month, day, and clock data are parallel BCD lines connected to the calculator through a BCD interface cable.

The month and day are manually set into BCD coded thumb-wheel switches. These four BCD digits are combined with the clock hours, minutes, and seconds BCD data. The exponent is hard wired to minus two (-2) to locate the decimal point between the minutes and seconds.

The power fail flag from the clock converts the exponent to +80 so that the software program can detect erroneous time data.

3.7 Input-Output Interfaces

Two types of calculator interface cables are used in the ETMS system. The TTL interface cable provides eight parallel control output data lines and eight parallel input data lines. The BCD interface cable is an input-only type which accepts up to 10 parallel BCD digits, a polarity line, exponent digit and sign, and an over-range line. Refer to the manufacturer's instruction manuals for information related to the interface cables.

The signal assignments for the ETMS control/rf unit interface TTL cable and the BCD cables for the DVM and clock are shown in figure 4. The programming format for each type of interface is listed on the lower portion of the figure.

8 Bits Into Computer

BREAK-POINT SWITCHES data

128 64 32 16 8 4 2 1

Operator data input to computer

8 Bits Out From Computer Control To ETMS

FUNCTION selector		LATCH data
128 64 32 16		8 4 2 1
	DVM Range	24-31
	DVM Function	32-33
	Prog Attnr	48-63
	RF On and Step Attnr	64-69
	Noise-Add	80-85
	DVM Inp Chl	100-111

16 BCD Digits Into Computer

BCD Digit	I/O #2 DVM	BCD Digit	I/O #3 Clock
1.	Mode 9=DC Volts	1.	Month MSD
2.	Comma	2.	Comma
3.	Sign(Polarity)	3.	Zero - Not Used
4.	Zero - Not Used	4.	Month LSD
5.	Zero - Not Used	5.	Date MSD
6.	Volts -- MSD D6	6.	Date LSD
7.	Volts -- D5	7.	Hours MSD
8.	Volts -- D4	8.	Hours LSD
9.	Decimal Point	9.	Minutes MSD
10.	Volts -- D3	10.	Minutes LSD
11.	Volts -- D2	11.	Seconds MSD
12.	Volts LSD D1	12.	Seconds LSD
13.	Exp Sign	13.	Dec Pt (Negative)
14.	Exp MSD & Overrange	14.	Exp MSD (Powr Fail)
15.	Exp LSD	15.	Exp(LSD)=2
16.	Line Feed(End)	16.	Line Feed(End)

PROGRAMMING

X = RBYTE 4

I/O Select Code

Control Code

ZZZ Format B

I/O Select Code

Write(4,ZZZ) WBYTE XX;

A must-or computer stops!

NOTE: Skip LF Handshake Flag

PROGRAMMING

First Digit

ENTER(I/O #,*) X1, X2

All the Rest

Free Field Format

I/O#= I/O Select Code
2=DVM
COMMAND 3=Clock

Figure 4. Interface Signal Assignments.

4. SYSTEM TROUBLESHOOTING

This section of this instruction manual addresses troubleshooting from the complete system viewpoint, attempting to present guidelines which will lead to identifying the malfunctioning unit. Troubleshooting for each individual unit is included in the section on that particular unit.

4.1 Systematic Approach

Normally a system malfunction will be suspected when operating in a complete system mode, either during an equipment check or during a measurement sequence.

4.1.1 Preliminary Evaluation

FIRST--STOP, LOOK, and THINK.
Note where the program failed or halted, then proceed carefully.

a. Write down the values of all ETMS, and DVM/MUX controller LED lights, the ETMS meter reading, and the DVM reading, mode and range.
b. Look over the printed output and try to deduce where the measurement went wrong.
c. If program is hung up, press stop button once or twice to recover a display character on the calculator. If a line number is displayed instead of stop, write down the line number. If the line number is in a subroutine, press the "step" button to advance the program one line at a time. Note: "step" will hang up on input/output commands and the "stop" must be pressed again to recover. Repeat the "step" process until the line numbers return to the main part of the program. This should identify where in the program the system is in trouble.
d. Now, again look over the results in the printed output and attempt to isolate the problem by looking for bad answers. Check the current values of any pertinent program variables in use at the time of the malfunctions.
e. Attempt to analyze the clues and deduce whether the problem is an rf signal level failure, a control command failure, or a flag failure.
f. Manually execute a few of the program codes (programmable attenuator, step attenuator, noise-add, DVM input channel, function and range) and observe if the instrument responds to the command and that the ETMS control/rf unit signal level meter or DVM respond as expected.

g. Manually program any condition which looks questionable and then measure the power level using the FNP3 command or FND0 + FND1 + FNP3 (assuming that these subroutines are loaded into the computer memory) if the ETMS needs initializing.

h. When appropriate, check the manual attenuator and filter selector control settings and that the correct rf input coaxial cable and noise-add control cables are properly connected. Make sure that all coaxial connectors on the ETMS system are tight.

i. In case of control and flag problems, carefully inspect all I/O and control cables to be sure they are fully connected in the proper jacks AND THAT ALL CONNECTOR LOCKS ARE PROPERLY LOCKED.

j. If the trouble still has not been isolated to a particular unit, load the equipment check program into the calculator, change the rf input back to the Simulated Star output if connected to the earth terminal, and proceed through the systematic check provided. If the calculator seems to act unpredictably, turn the calculator and printer ac power switches off and back on, then load and run the equipment check program again.

k. The various instruments can be checked from the calculator keyboard without relying on program software.

1) Voltmeter - Enter the command ENTER (2,*) Q, Q1 on the calculator keyboard and press execute. The voltmeter should take a reading and the "|-" return to the calculator display. Then type Q, Q1 and press execute. Two numbers should appear on the display. The first is the DVM mode code and the second the DVM voltage reading. If the calculator did not return an "|-" when the enter command was executed* and the voltmeter did read, then no data-ready flag was received back at the calculator.

2) Repeat the enter test on the clock using ENTER (3,*) Q, Q1.

3) Command control can be checked without program software by entering a format line, 9700 Format B, and pressing the end of line key. Then type the direct command: WRITE (4,9700) WBYTE XX; where XX is the desired control code to actuate a particular function. Note: The semicolon must be included. Then press the execute key. The ETMS should respond with the prescribed command. If the ETMS does respond properly, but the lazy T does not return to the calculator display, no ready flag is being returned. Figure 5 shows the hand-shaking timing interaction of the control signal and the return flag in the calculator input or output interface. Figure 3 shows the distribution of the control signals, data signals and latches and the return flags in the ETMS system.

COMPUTER/DEVICE HANDSHAKE SIGNALS

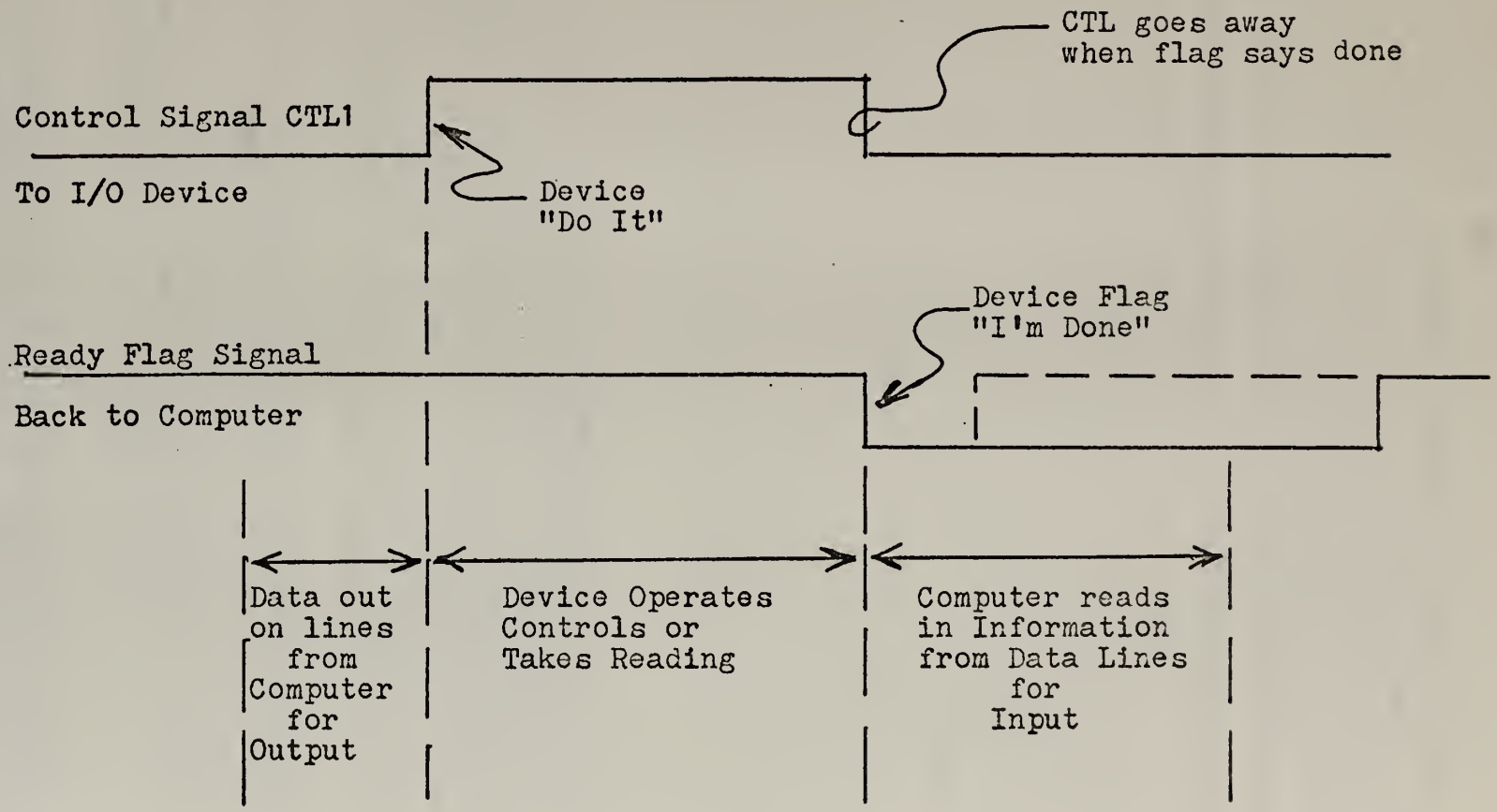

FIGURE 5 Flag Handshake Timing

l. When the problem has been isolated to a particular unit, refer to the trouble-shooting section of the equipment manual for the particular unit.

m. If the calculator, printer or cassette units are suspect, turn the ac power off on these three units and then back on again. Load the System Test Tape furnished with the calculator accessories and run the test programs as described in the instruction booklet, "System Test Instructions," furnished with the calculator.

---

*One unexpected result can be that the calculator appears hung-up for a short time (5 seconds to 2 minutes) and then gives an ERROR 2 (out of memory). The internal BCD I/O software attempts to input BCD digits until a line-feed is received. When the ERROR 2 occurs, the calculator did not recognize the 16th and last character (LF) transmitted by the BCD interface card. The BCD I/O card is programmed for either high-true or low-true logic input signals by grounding one of two lines in the interface cable. The ETMS uses high-true logic, requiring that line 917 in the interface cable be connected to ground. Without this ground connection the ERROR 2 occurs.

To check, read the 16 characters (see pages 1-5 of 12203-A BCD Interface Installation and Service Manual) using the following program:

```
9600   FOR I= 1 TO 16
9610   PRINT I, RBYTE 2 (or 3 for clock)
9620   NEXT I
9630   STOP
```

The sixteenth character should be 10 (line feed). If not, wire 917 on pin 49 of J352 is not grounded. Use RBYTE 3 in above program to check the clock. If the sixteenth digit is not 10, check wire 917 on pin 47 of J400 of clock for ground connection.

5. ETMS CONTROL/RF: INSTRUCTION MANUAL

5.1 Introduction

The ETMS control/rf unit (fig. 6) serves as a system controller as well as the rf signal precessor to amplify and control the level and establish the bandwidth for optimum rf power detector measurements.

The ETMS control/rf unit is the controller for the entire ETMS system. All control signals from the calculator are distributed to the various units through this unit. Manual programming switches are provided on the front panel to exercise the various functions. The rf level monitor protects the power dectector unit by switching the rf power off if 5 mW (+7 dBm) is exceeded.

Simulated star and sky noise and noise-add sources are built into this unit to permit self-checks of the system without connecting to an earth terminal.

Remote controls for the X-Band noise-add sources allow injection of a known added-noise at the throat of the antenna so that the gain of the earth terminal receiver can be monitored and the measurements corrected to compensate for gain changes.

5.2 Specifications

The input frequency range is limited to 10 to 200 MHz, by the internal amplifiers

Input impedance: The input impedance is 50 ohms.

Power level: The maximum output power into 50 ohms is limited to 1.2 milliwatts to prevent amplifier compression and nonlinearity. The internal programmable attenuators, 0-15 dB, and an internal check-standard attenuator, approximately 6 dB, are controlled by the calculator.

Simulated noise source: These noise sources have a frequency output of 10 to 100 MHz, bandwidth limited by an rf combining amplifier. There are three programmed noise-add generators, two controlled by the calculator which are approximately 3 dB apart, and one manually controlled through an 11 dB manual attenuator.

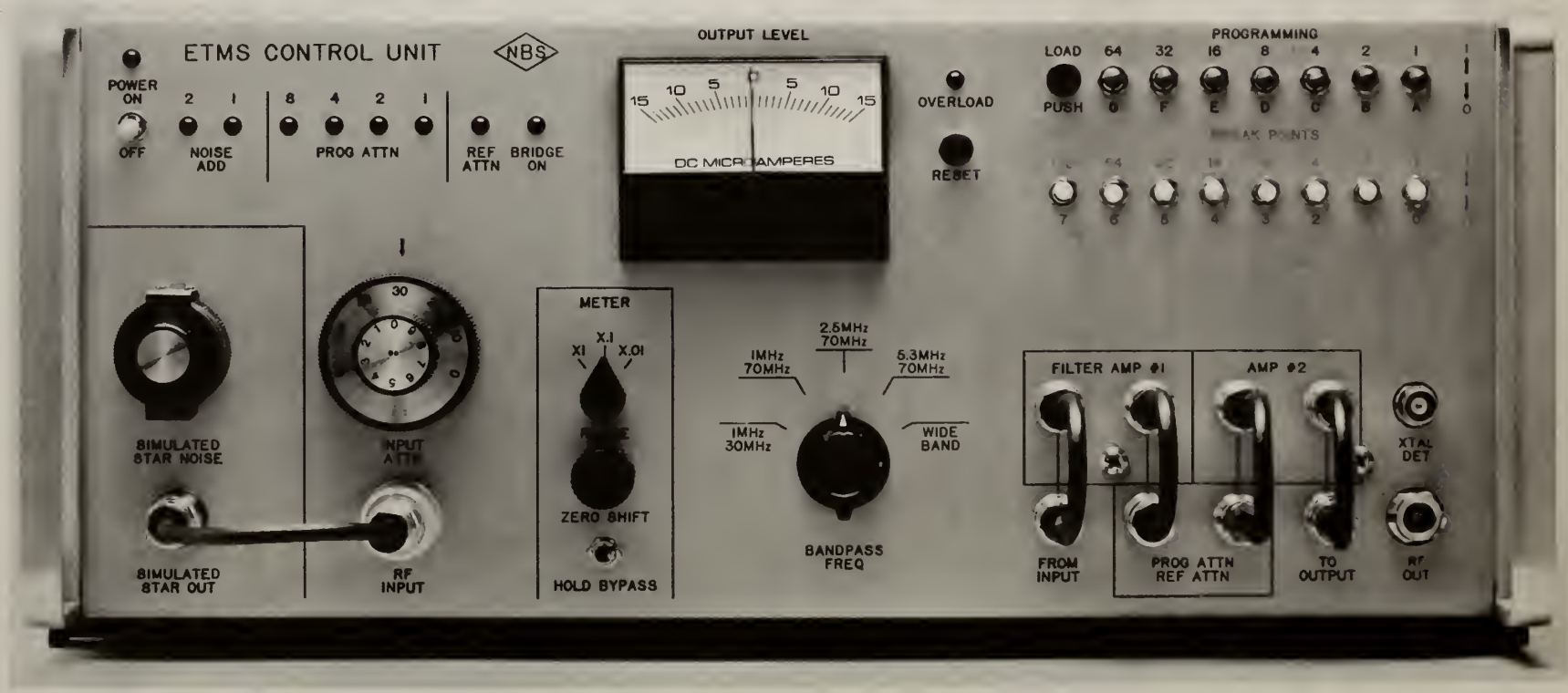

Figure 6. ETMS Control/RF Unit.

5.3 RF Circuits

5.3.1 Input Circuits

The rf input of the ETMS system is connected to the IF patch panel (down-converter output) which is normally 30 or 70 MHz. For self-checks, this input can be connected to the built-in star simulator output via a short coaxial cable (see block diagram in figure 7).

A high quality manual attenuator (zero to 70 dB) adjusts the level of the incoming signal (or noise).

The output of the attenuator is connected through a bandpass filter selector switch permitting selection of wideband (through connection) or 2.5 MHz bandpass at 30 MHz center frequency, or 5.3 MHz, 2.5 MHz or 1 MHz bandpass at 70 MHz center frequency.

The noise-bandwidth of each of these filters has been measured in the system so that measurements requiring known bandwidths such as C/kT can be performed. The quantity referred to as the noise bandwidth and measured in situ for the four bandpass filters in the ETMS is given by the area under the power-gain curve normalized by the power gain of the filter at the defined center frequency (e.g., 30 MHz or 70 MHz). This definition differs from the standard definition of noise bandwidth which is the area under the power-gain curve normalized by the maximum power gain of the filter. If B is the noise bandwidth, and g(f) is the power-gain function of the filter with g as the center frequency gain of the filter. Then

$$B = \frac{\int_0^\infty g(f)df}{g} .$$

Measuring the power gain $g(f_i)$ at each step frequency f_i, and stepping the frequency across the bandpass in uniform steps Df,

$$B = \frac{Df}{g} \sum_{i=1}^{N} g(f_i) .$$

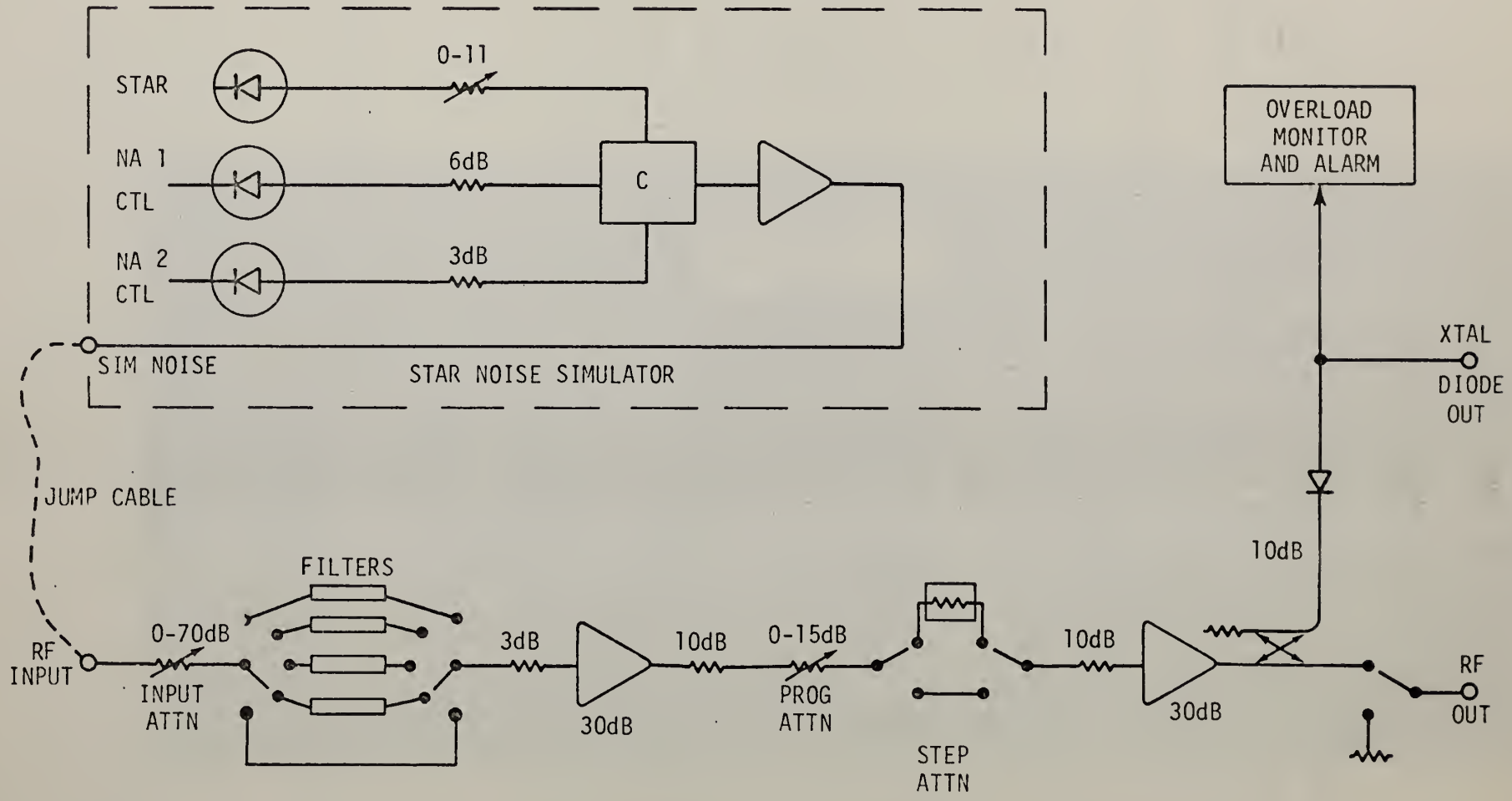

Figure 7. ETMS Control/RF Unit RF Section.

This process is repeated for each filter in the ETMS.

5.3.2 First Amplifier

The output from the bandpass filter selector module is padded with a 3-dB attenuator to stabilize the impedance seen by the first amplifier. This prevents the amplifier from oscillating when the rf input is open circuited. This low noise amplifier has a gain of approximately 30 dB and is padded with 10 dB of attenuation in its output.

5.3.3 Attenuator Module

A highly repeatable programmable attenuator having 0 to 15 dB attenuation is used to optimize the measurement power level under calculator control. Immediately following is a step attenuator which is used as a reference or standard check which is inserted and removed automatically during each measurement. The attenuation value of this attenuator is checked in the program to verify that the second amplifier and power detector are working linearly.

5.3.4 Second Amplifier

The input of the second amplifier is padded by 10 dB to minimize effects of small impedance changes in the attenuator switching. This amplifier has a gain of 30 dB. There is no padding in the output of this amplifier. In addition, the output power is kept below two milliwatts to avoid any detectable compression or clipping in the amplifier response.

5.3.5 Monitor and Output Circuits

A directional coupler samples the amplifier output and a diode detector and comparator monitors the signal (or noise) level and switches a coaxial relay off in the rf output line, avoiding possible damage to the thermistor mount in the power detector unit. Normal power to the power detector is under one milliwatt. Overload threshold is adjusted to 5 milliwatts (+7 dBm).

5.3.6 Star Simulator Circuits

The simulator is three identical solid state noise sources (two of which are switched simultaneously with the remote noise-add controls). The three outputs are combined, amplified, and made available at the front panel.

The background and star noise source is connected through a 0 to 11 dB attenuator so that its level may be manually adjusted over this range, but cannot be turned off. The other two noise sources NA#1 and NA#2 are attenuated 6 dB and 3 dB, respectively, so that their output levels are similar to the noise-add received through the earth terminal. NA#1 and NA#2 simulated sources are controlled simultaneously with the earth terminal noise-add standard, however, only one set of noise sources is connected ETMS input at any one time.

5.4 Control and Flag Circuits

5.4.1 Control

The distribution of the control signals is shown in figure 3. The calculator command data (8 bits parallel) and Manual program data are connected to two, 4-bit digital input multiplexers. When the "LOAD" button is pressed,the multiplexer changes to the programming switches and the program switch data is placed on the data lines. The least significant four bits are distributed to the inputs of the various data latches. The next three bits (5, 6, and 7) are used as inputs to the function--select decoders. The decoded function is used to enable the desired latches so that the low four bits of data are strobed into the latch by the CTL pulse.

The CTL pulse is generated by a one-shot, triggered by the "LOAD" button or by the calculator interface. In normal operation the data from the calculator is fed through the digital multiplexers and to the data and function buss. The control pulse strobes the data into the selected function latches. These data busses are connected to the DVM/multiplexer control via an interconnecting cable so that the program switches can also control the DVM functions.

5.4.2 Ready Flags

After the calculator sends out data on the buss lines and the control pulse (CTL), it waits for a ready-flag signal to be answered back from the device, or when the calculator requests input data by switching the I/O signal to input and sending a CTL pulse, it waits for a data-ready flag to be returned (from the break-point switches, for example). This is the flag hand-shaking between devices and the calculator. Each command function generates its own flag pulse and they are combined in the ETMS control/rf unit to return to the calculator.

When the front panel break-point switches are read, the CTL pulse triggers a one-shot pulse which is sent back as the flag.

5.5 Power Distribution

The ac primary power circuits are dual-voltage circuits capable of operation on either 120 or 230 volts, either 50 or 60 Hz. The small printed circuit card below the fuse holder connects the power leads for the correct voltage. The selected voltage label is visible in the fuse holder. The two fans are operated in parallel for 120 volts and in series for 230 volts.

5.6 Digital Circuit Description

This unit contains three printed circuit boards: the control board (Z 700), the switching board (Z 400), and the rf processor board (Z 500).

5.6.1 Z 700 Control Card (Schematic, Figure 12)

The control card has an eight-bit digital multiplexer (IC's 6 and 7) which selects the input signals either from the calculator I/O cable or from the front panel programming switches when the load push button is pressed. The output signals from these multiplexers are distributed to data latches on this board, the Z 400 driver, and the Y 100 voltmeter/scanner control board. For manual operation, a code set in the programming switches is transferred into various data latches when the "load" push button is pressed. When the normally closed

contacts of the load switch are open, the multiplexer is switched from calculator input to the manual programming switches. The "load" switch is debounced by F/F gates in IC-1 and initiates a one-shot pulse in IC-3. The length of the pulse is determined by the RC combination of C1 and R13. This pulse is the manual entry control signal ($\overline{CTL}$).

Data from the calculator is entered through the I/O cable and multiplexer. The calculator control signal ($\overline{CTL}$) is coupled through steering gates IC-1 and IC-2 into a CTL one-shot (IC-4) or into the "input flag" one shot IC-5 depending on the state of the I/O signal from the calculator. When this I/O signal is high, the calculator interface is in the input mode and is inputting the status of the break point switches on the instrument panel. When the I/O signal is low the calculator is outputting control data to the system.

The manual load pulse is "ORed" with the calculator "$\overline{CTL}$" signal in gate IC-8 to provide a load strobe to the system central logic.

The eight bits of the control data word are divided into two functions, while the most significant bit (MSB), bit eight (H), is not used. The lower four bits, one, two, three, and four (A, B, C, & D), program the function, and bits five, six, and seven (E, F, & G) select the device to be controlled, such as the programmable attenuator or the DVM range or the noise-add generators. The noise-add data are selected by the steering logic gates IC-2, IC-9 and IC-8 so that the function data on the lower four bits are enabled and strobed into the noise-add data latches IC-10. The steering logic combines the device select bits with the $\overline{CTL}$ signal to produce the strobe for these data latches. IC-8 and IC-1 provide a noise-add flag for the calculator.

The noise-add control circuitry is also on this card. Noise-add switching signals are connected to jacks on the rear panel to remotely switch the noise-add standards placed at the antenna feed. In addition, two TTL logic level noise-add control signals are provided on the rear panel. These are switch selectable for high true or low true logic.

The remote cables to the noise-add generators at the antenna are driven by transistors Q_1 and Q_2 which are driven by open collector gates in IC-12. The transistors switch +24 VDC through 2 kilohms load resistance to ground potential in order to drive the capacitance of the remote cable lines and control the remote noise-add generators. The noise-add generators are turned on when the remote cable is at +24 V or open circuited. All the noise-add signals are controlled by the state of the noise-add #1 and noise-add #2 data latches. The front panel LED indicators showing the state of these signals are driven by gates in IC-12.

Simulated noise-add constant current generators

This card also contains three constant-current power-supplies which drive internal noise sources. The output of these simulation noise sources is brought out to a front panel jack and can be connected to the input jack for a simulated test run. One of these noise sources represents the ambient noise while the other two are switched off and on by the noise-add control signals.

The three constant-current power-supplies are operational amplifer (IC-13, 14, and 15) connected as a Howland voltage to the current converter circuit [9].

The simulated noise-add noise sources are controlled by shunting each constant-current power-supply output to ground through an open-collector gate (IC-12), thus turning the noise generator off.

Table I. Test codes for noise-add circuits.

Test Codes	Expected Results	
Manual or WYBTE	NA #1	NA #2
	Front Panel	Front Panel
80_{10}	ON J_1 J_{10}	ON J_2 J_{20}
81_{10}	OFF	OFF
82_{10}	ON	NC
83_{10}	OFF	NC
84_{10}	NC	ON
85_{10}	NC	OFF
86_{10}	NC	NC
87_{10}	NC	NC
88_{10}	Same as 80	
89	Same as 81	
90	Same as 82	
91	Same as 83	
92	Same as 84	
93	Same as 85	
94	NC	NC
95	NC	NC

Table II. Trouble-shooting noise-add.
Test program codes for noise-add.

Test Code	Noise-Add #1				Noise-Add #2			
Program Switch and WBYTE	Front Panel	J_1	J_{10}*	Simulated Noise #1	Front Panel	J_2	J_{20}*	Simulated Noise #2
80_{10}	ON	+24V	+4V	ON	ON	+24V	+4V	ON
81_{10}	OFF	+.5V	+.7V	OFF	OFF	+.5V	+.7V	OFF
82_{10}	ON	+24V	+4V	ON	NC	--	--	NC
83_{10}	OFF	+.5V	+.7V	OFF	NC	--	--	NC
84_{10}	NC	--	--	NC	ON	+24V	+4V	ON
85_{10}	NC	--	--	NC	OFF	+.5V	+.7V	OFF
86_{10}	NC	--	--	NC	NC	--	--	NC
87_{10}	NC	--	--	NC	NC	--	--	NC

NC represents no change (unaffected).

*Signals on J_{10} and J_{20} may be inverted from that shown on table depending on on the position setting of the "0/1" switches S10 and S20.

When the noise-add signals are connected to the system (actual or simulated), the level meter on the front panel should show an increased reading if the meter hold switch is in "bypass" when either or both noise-add signals are turned on.

5.6.2 Z 400 Switch Driver Card (Schematic, Figure 8)

The Z 400 printed circuit board contains the control and switch-drive circuitry for the programmable attenuator and step attenuator. In addition, the flags from the various functions are recombined on this card so they are available for the calculator on the I/O flag line.

Circuit description

The digital control data from the manual/auto multiplexer on the Z 700 card is connected to decoding circuits to decode the desired device code. Control bits five, six, and seven (E, F, and G) are decoded in IC-401 to enable the $\overline{\text{CTL}}$ signal to strobe the data latches IC-404 and IC-408 for the selected device. Control bits one, two, three, and four (A, B, C, and D) select the particular function to be programmed in the device; i.e., 1, 2, or 5 dB in the programmable attenuator or bridge rf ON. Control bit A supplies the true/false or off/on information while the decoded $\overline{\text{CTL}}$ signal is conditioned with bits B, C, and D

in steering gates IC-402 and IC-403 to enable the "load" strobe to the selected data latches in IC-408. Programmable attenuator control bits are latched in IC-404.

Flag circuits

The selected $\overline{CTL}$ signal for the various devices are combined in the NOR gate IC-406 to control the flag one-shot IC-409 to generate the flag pulse. The device flag pulse is combined with the input-command flag signal from the Z 700 card in IC-419 and is returned to the calculator I/O on pin #55 as the $\overline{FLG}$ signal.

Switch drivers

The programmable attenuator and coaxial relays are latching relays so that the switching circuitry provides a pulse to one of the two terminals to actuate the device. The programmable attenuator is strobed by a one-shot, IC-405, and the switches are driven through open-collector gates IC-413, 414, 415, and 416. These gates energize switching transistors Q-1 through Q-8 in a bipolar, mutually exclusive cross-coupled circuit. The coaxial relays are strobed by one-shots IC-407 and IC-410 and gates IC-417 and IC-418. Transistor drive circuits are formed by Q409 and Q410 and Q411 and Q412 to switch the relays. Overload pulse signals from the Z 500 rf level-processor board are connected to pin 15 and pin 33 to pulse the bridge rf driver off when overload occurs. The overload indicator signal on pin 45 from the Z 500 board drives the front panel indicator light through IC-420. The overload signal is combined with the power meter rf ON signal to drive the rf ON front-panel indicator LED so that the rf ON indicator goes out when an overload occurs and the rf is switched off via the overload circuits. The step attenuator LED is driven by IC-411.

The front panel programmable attenuator LED indicators are driven through auxiliary contacts on the attenuator body.

The attenuator action can be monitored by observing the rf level meter on the front panel and the power detector milliamp meter. If the unit is not connected to a source, patch the simulated noise-add to the input connector and turn the noise-add generator on with programming code 80_{10}. Note: When the noise-add is turned on, the meter is inhibited unless the meter hold switch is in bypass.

Table I and Table II list the control codes and expected results when troubleshooting the switch driver circuits.

Table I. Test codes for Z 400 board.

Programmable attenuator.

Manual or WYBTE	Result
63_{10}	0 dB attenuation
62_{10}	1 dB attenuation
61_{10}	3 dB attenuation
60_{10}	3 dB attenuation
59_{10}	4 dB attenuation
58	5 dB attenuation
57	6 dB attenuation
56	7 dB attenuation
55	8 dB attenuation
54	9 dB attenuation
53	10 dB attenuation
52	11 dB attenuation
51	12 dB attenuation
50	13 dB attenuation
49	14 dB attenuation
48_{10}	15 dB attenuation

Table II.

Step attenuator and rf on.

Manual or WYBTE	Step Attenuator	RF
64_{10}	IN	OFF
65_{10}	OUT	ON
66_{10}	IN	NC
67_{10}	OUT	NC
68_{10}	NC	OFF
69_{10}	NC	ON

5.6.3 Z 500 RF Level Processor Board (Schematic Figure 10)

The rf level processor printed circuit card monitors the output of the diode detector. The input on pin 13 is amplified by IC-501 and fed to the overload level comparator, IC-506, through the overload-adjust potentiometer "H" (R5). If the rf power exceeds 5 milliwatts, the overload comparator triggers and latches. This forces the rf off/on switch on the Z 400 board "off" via IC-509 and also energizes the sonalert alarm and overload LED via Pin 47.

The comparator cannot be reset by pressing the reset button until the power level has been reduced to a safe level. When the comparator is reset, a one-shot, IC-508 pulses the rf-on latch (Z 400 board) to the reset (off) state so that the latch (and LED) coincide with the off position of the coaxial latching relay.

The incoming signal level is also processed through a log-amplifier to the front panel rf level meter. The output of the level amplifier passes through a sample and hold circuit, IC-502, which, when enabled by the front panel "Hold" switch, latches the meter to prevent meter surge while the noise-add sources are turned on. Delay timer IC-507 smoothes meter action during noise-add switching.

The output of the sample and hold circuit drives a log-amplifier, IC-504, to convert the meter reading to a dB scale. IC-503 forms a constant current source to set the zero reference of the log amplifier. The output of the log-amplifier drives the meter driver amplifier. The gain of the meter amplifier is switched for gains of x10, x1 and x0.1 to obtain meter scales of 1 dB, 0.1 dB, and 0.01 dB. Potentiometer "D" (R14) adjust the x1 scale zero reference.

5.6.3.1 Adjustments on RF Level Processor

The adjustments on the rf level processor establish the logarithmic amplifier gain for the decibel scale on the front panel signal level meter and sets the overload alarm threshold. Complete alignment requires two, 1-milliamp constant current sources. The sequence for complete alignment follows:

Referring to figure 10,

1. (a) Mount the Z 500 printed circuit card on the pc extension card.
   (b) Remove signal input cable from RF INPUT on front panel.
   (c) Set FILTER switch to 5.3 MHz B.W., 70 MHz on front panel.

2. Put a BNC 50 ohm termination on the "TO OUTPUT" jack on front panel.

3. Connect external voltmeter between TP#1 and ground. Adjust "A" (R7) dc offset on first amplifier for zero on the voltmeter.

4. Switch "HOLD" switch to bypass on front panel. Connect the external voltmeter to TP-V and adjust offset "C" (R9) for a zero reading on the Voltmeter.

5. Remove jumper TP-V to TP-W. Connect temporary jumper TP-X to TP-Y. Connect external voltmeter to TP-Y. Adjust "E" (R19) dc offset first stage of log-amplifier for zero voltmeter reading.

6. Remove temporary jumper TP-X to TP-Y. Remove jumper Z-Z1. Then connect a +1 milliamp constant current source into TP-Z1 and ground; connect the other +1 milliamp constant current source into TP-W and ground. Set both current supplies to 1 milliamp*. Connect the external voltmeter to TP-2 and ground. Adjust "F" (R20) dc offset of second stage of log-amplifier for zero volts on the voltmeter.

7. Remove both constant current sources. Replace jumper TP-V to TP-W. Replace jumper TP-Z to TP-Z1. Remove the BNC termination from the "TO OUTPUT" jack on the front panel.

8. Connect coaxial cable between SIMULATED STAR OUTPUT and RF INPUT on front panel. Connect external rf power meter to RF OUTPUT jack on front panel. Turn bridge "on" with control code 67. Adjust input ATTN and SIMULATED STAR NOISE for 1 mW reading on the power meter.

9. Connect an external voltmeter to TP#1. Adjust first amplifier gain "B" R6 for 1 volt on voltmeter.

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*Connect two milliampre meters in series connection and establish a current reference point on both meters at approximately 1 ma of current. Use the reference points for adjusting the two constant current sources for equal currents.

10. Reduce power to 500 microwatts on power meter. Switch meter range selector on front panel to the X1 position. Adjust "D" (R14) log reference zero offset for a zero reading on the front panel signal level meter.

11. Increase input attenuation by 5 dB. Adjust log-amplifier gain "G" (R21) for a front panel meter reading of -5 divisions. Decrease the input attenuation 10 dB and note front panel meter reading. Touch up "G" if necessary to obtain approximately +5 reading on the meter scale. Recheck -5 reading.

12. Set input attenuator for 1 milliwatt power reading on the power meter. Readjust "D" for +3 division reading on the front panel meter.

13. Adjust front panel attenuators for 5 mW (+7 dBM) power on the power meter. Adjust overload threshold "H" (R5) clockwise until alarm sounds. Back off counter-clockwise 1/2 turn. Reduce input power, reset alarm and turn bridge back on with control code 67. Slowly increase power to test alarm threshold at approximately 5 mW power level.

This completes alignment of the rf level processor monitor circuits. These adjustments do not affect the operation or accuracy of the measurements.

5.7 Simulated Star Noise Sources

The three solid-state noise sources used for simulating earth terminal reception are mounted on the Z 600 sub-assembly. The constant current bias supplies to power these noise sources and their control switches are on the Z 700 printed circuit board through Z 700 - J2. Refer to figure 14 for a block diagram of the Z 600 sub-assembly and the schematic of the solid state noise sources.

5.8 Troubleshooting the ETMS Control/RF Unit

When a problem has been identified as being in this chassis, the nature of the problem (1) no rf signal, (2) rf signal loss during a particular function, (3) improper response or no response to control commands or (4) calculator hangs

up on I/O select code #4 command due to loss of return Ready-Flag, will already be known or at least suspected.

5.8.1 RF Signal Diagnostics

When the problem is a loss of signal, the most straight forward approach is to trace the input rf or noise signal through the ETMS unit using a sensitive detector. The various parts of the circuit can be isolated at the short BNC cables on the front panel. Use caution not to overdrive the amplifier inputs. An alternative would be to use a signal generator and inject a signal at the power detector and then trace the circuit backward until the signal is lost.

Evaluation of a coaxial relay performance can be made by measuring the repeatability of the dc contact resistance. The resistance should be less than 0.2 Ω plus the adapter and lead resistance and should be repeatable within ± 0.1 Ω.

5.8.2 Control Circuitry Diagnostics

The control circuitry can be examined by following the check-out tests given in section 2.3 of this manual, first check out the manual programming command codes and then commands via the calculator. NOTE: The DVM multiplexer control cable must be connected, otherwise the ETMS rf unit ready-flag back to the calculator is inhibited.

Attempt to isolate the clues as to the particular malfunction. Note whether the LED lites coincide with the command. If more than one malfunction is present try to deduce which data signals are common to both. This helps to determine whether the problem is in the data and decoder busses or in the latches and drivers.

Follow through the circuit description and schematics in section 5 for a particular circuit once the problem has been localized.

5.8.3 Ready-Flag Diagnostics

Follow the same procedures given in section 5.8.2 while monitoring the Ready-Flag line with a logic probe or oscilloscope or simply use the calculator response as an indicator. The Ready-Flag can be monitored on pin 55 of the Z 400 printed circuit card.

L.D.D. 1 DEC 77 PARTS LIST- RF UNIT (Z) DATA 9

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-R1	1	RES VAR 10 TURN	10K OHM	DUNC	3253-103

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-C1	1	CAP ELECTRLC 50V	500 UF	CD	WBR-500-50
2	Z-C2	1	CAP ELECTLC 50V	50 UF	SPRG	TE-1304

CATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-D1	10	LED INDICATOR LIGHT	5 VOLT	DIAL	550-0506
2	Z-D2		SAME AS D1	5 VOLT		
3	Z-D3		SAME AS D1	5 VOLT		
4	Z-D4		SAME AS D1	5 VOLT		
5	Z-D5		SAME AS D1	5 VOLT		
6	Z-D6		SAME AS D1	5 VOLT		
7	Z-D7		SAME AS D1	5 VOLT		
8	Z-D8		SAME AS D1	5 VOLT		
9	Z-D9		SAME AS D1	5 VOLT		
10	Z-D10		SAME AS D1	5 VOLT		
11	Z-D11	1	DIODE SILICON 400V	1 AMP	RCA	1N4004

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-IC1	1	INT CRKT REGULATOR 24V	1 AMP	TI	uF7824C

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	J1-J9	9	CONN PANEL BNC-RG58U	COAX	AMPH	31-3206
2	Z-J10	1	CONN PANEL BNC-BNC	COAX	AMPH	UG-492/u
3	Z-J11	1	CONN PANEL N-N	COAX	AMPH	UG-30D/u
4	Z-J12	1	CONN PANEL N-RG58U	COAX	AMPH	UG-566B/u
5	J13-J30	18	CONN SMA ELBOW-RG58U	COAX	EFJ	142-0262-001
6	J31-J36	6	CONN SMA EL-.141 COAX	COAX	AMER	26805
7	Z-J37	1	CONN N-.141 SEMI RIGID	COAX	OSM	402-1
8	J38-J41	4	CONN SMA-.141 SEMI RIG	COAX	OSM	201-1
9	Z-J42		J42-J645 NOT USED			
10	Z-J646	1	CONN PC EDGE (Z400)	60 PIN	AMPH	261-10030-2
11	Z-J647	1	CONN PC EDGE (Z500)	60 PIN	AMPH	261-10030-2
12	Z-J648		NOT USED			
13	Z-J649	1	CONN PC EDGE (Z700)	60 PIN	AMPH	261-10030-2
14	Z-J650	1	CONN BLUE RIBBON I/O	24 PIN	AMPH	57-40240
15	Z-J651	1	CONN BLUE RIBBON I/O	14 PIN	AMPH	57-40140
16	Z-J652		NOT USED			
17	Z-J653	4	CONN PANEL BNC	COAX	AMPH	UG-1094/u
18	Z-J654		SAME AS J653	COAX		
19	Z-J655	1	CONN RECEPTACLE	5 PIN	VIKG	VR5/4AB13
20	Z-J656		SAME AS J653	COAX		
21	Z-J657		SAME AS J653	COAX		
22	P1-P16	16	CONN PLUG SMA-RG58U	COAX	EFJ	142-0261-001
23	P17-P27	11	CONN PLUG BNC-RG58U	COAX	TROM	PL-20-5
24	Z-P28	3	CONN PLUG BNC-RG174/U	COAX	TROM	PL-20-5
25	Z-P29		SAME AS P28	COAX		
26	Z-P30		SAME AS P28	COAX		
27	Z-P31	3	CONN PLUG SMA EL-RG174	COAX	EFJ	221
28	Z-P32		SAME AS P31	COAX		
29	Z-P33		SAME AS P31	COAX		
30	Z-P34	2	PLUG (FOR IC SOCKET)	14 PIN	3M	3406
31	Z-P35		SAME AS P35	14 PIN		

CATEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-T1	1	TERMINAL STRIP DOUBLE	5 LUG	CNCH	5-141

CATEGORY NO. 8----------SWITCHES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-S1	1	SWITCH AC POWER (TOGL)	DPDT	ALCO	MSTL-206N
2	Z-S2	2	SWITCH PUSH BUTTON	SPDT	ALCO	MSP-105F
3	Z-S3		SAME AS S2	SPDT		
4	Z-S4	1	SWITCH ROTARY 3 POLE	3P3T	ALCO	MRB-3-3
5	Z-S5	1	SWITCH COAX TANDM ROT	2P5T	TELC	8401
6	Z-S6	3	SWITCH RF COAX LATCHG	SPDT	TELD	CS-33S60
7	Z-S7		SAME AS S6	SPDT		
8	Z-S8		SAME AS S6	SPDT		
9	Z-S9	16	SWITCH TOGGLE	SPDT	ALCO	MST-105D
10	Z-S10		SAME AS S9	SPDT		
11	Z-S11		SAME AS S9	SPDT		
12	Z-S12		SAME AS S9	SPDT		
13	Z-S13		SAME AS S9	SPDT		
14	Z-S14		SAME AS S9	SPDT		
15	Z-S15		SAME AS S9	SPDT		
16	Z-S16		SAME AS S9	SPDT		
17	Z-S17		SAME AS S9	SPDT		
18	Z-S18		SAME AS S9	SPDT		
19	Z-S19		SAME AS S9	SPDT		
20	Z-S20		SAME AS S9	SPDT		
21	Z-S21		SAME AS S9	SPDT		
22	Z-S22		SAME AS S9	SPDT		
23	Z-S23		SAME AS S9	SPDT		
24	Z-S24		SAME AS S9	SPDT		
25	Z-S25		S25-S655 NOT USED			
26	Z-S656	2	SWITCH TOGGLE	SPDT	ALCO	MST-105D
27	Z-S657		SAME AS S656	SPDT		

CATEGORY NO. 9----------METERS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-I1	1	METER PANEL 0-CENTER	1.5 MA	MODT	25DMA1.5U1.5

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-H1	2	HOUSING FRAME ASSEMBLY	7X16	HP	5060-0734
2	Z-H2		SAME AS H1	7X16		
3	Z-H3	1	HOUSING FRONT PANEL	7H	HP	5000-0120
4	Z-H4	1	HOUSING REAR PANEL	7X16	HP	5000-0121

5	Z-H5	2	HOUSING SIDE COVER	7X16	HP	5000-0743
6	Z-H6		SAME AS H5	7X16		
7	Z-H7	1	HOUSING TOP COVER	16L	HP	5060-0740
8	Z-H8	1	HOUSING BOTTOM COVER	16L	HP	5060-0752
9	Z-H9	2	HOUSING HANDLE		HP	5060-0222
10	Z-H10		SAME AS H9			
11	Z-H11	2	HANDLE RETAINER ASS'Y		HP	5060-0765
12	Z-H12		SAME AS H11			
13	Z-H13	4	HOUSING FOOT ASS'Y		HP	5060-0767
14	Z-H14		SAME AS H13			
15	Z-H15		SAME AS H13			
16	Z-H16		SAME AS H13			
17	Z-H17	1	HOUSING PLATE ASS'Y		HP	5000-0052
18	Z-H18	1	PC CARD CAGE	ALUM	NBS	
19	Z-H19	1	HEAT SINK (HP8472B)	ALUM	NBS	1.75 X 1 X 1
20	Z-H20	1	PLATE MAIN MOUNTING	.125 ALUM	NBS	14D X 15.5W
21	Z-H21	1	PLATE MOUNTING (FANS)	.125 ALUM	NBS	3.75 X 7.5
22	Z-H22	1	PLATE (POWER SUPPYS)	.125 ALUM	NBS	4.75 X 10.5
23	Z-H23	1	BRACKET	.125 ALUM	NBS	12 X 1.5
24	Z-H24	1	BRACKET	.125 ALUM	NBS	9 X .375
25	Z-H25	1	HEAT SINK (AMPLIFIERS)	11L	WAKE	A-1527

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-A1	1	ATTEN STEP PROGRAMBL	BINARY	WEIN	AB134-15-6-1
2	Z-A2	1	ATTEN STEP ROTARY		WEIN	AD9003693101
3	Z-A3	1	ATTEN STEP TANDM ROT		TELC	8140S-108
4	Z-A4	1	ATTENUATOR FXD MIN	3 dB	MIDW	MMT 333
5	Z-A5	1	ATTENUATOR FXD MIN	6 dB	MIDW	MMT 333
6	Z-A6	2	ATTENUATOR FXD MIN	10 dB	MIDW	MMT 333
7	Z-A7		SAME AS A6	10 dB		
8	Z-A8	2	AMPLIFIER 10-200MHZ		AERT	A1517
9	Z-A9		SAME AS A8			
10	Z-F1	1	FILTER BAND PASS	70 MHZ	CIRQ	FBT/20-70/1-
11	Z-F2	1	FILTER BAND PASS	70 MHZ	CIRQ	FBT/2-70/2.5
12	Z-F3	1	FILTER BAND PASS	70 MHZ	CIRQ	FBT/2-70/5.5
13	Z-F4	1	FILTER BAND PASS	30 MHZ	CIRQ	FBT/21-30/2.
14	Z-M1	1	POWER SUPPLY MODULAR	20V	LAMB	LOS-Y-20
15	Z-M2	1	POWER SUPPLY MODULAR	5V	SEMI	ES51000-K2
16	Z-M3	1	POWER SUPPLY MODULAR	+-12V	SEMI	P2.12.100-K2
17	Z-M4	1	POWER SUPPLY MODULAR	+-15V	BB	527
18	Z-M5	1	COUPLER COAXIAL MIN	10 dB	MERR	CRM-10-500
19	Z-M6	1	DETERCTOR DIODE		HP	HP8472B
20	Z-M7	1	TERMINATION COAX MIN	50 OHM	OSM	20020P
21	Z-Z1	1	SWITCHING PC CARD		NBS	Z400
22	Z-Z2	1	RF LEVEL PROC PC CARD		NBS	Z500
23	Z-Z3	1	NOISE ADD BOARD		NBS	Z600
24	Z-Z4	1	INPUT CONTRL PC CARD		NBS	Z700

ATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z-B1	1	FUSE/FILTER/AC SOCKET		CORM	6J4
2	Z-B2	1	AUDIO WARNING DEVICE		MALL	SC628P
3	Z-B3	2	FAN PANCAKE		PANM	8500C
4	Z-B4		SAME AS B3			
5	Z-B5	1	CABLE RIBBON (Z3-Z4)	12	ALPH	3580/14
6	Z-B6	3	CABLE .141 SEMI RIG CX	6	INIF	
7	Z-B7		SAME AS B6	6		
8	Z-B8		SAME AS B6	6		
9	Z-B9	1	CABLE .141 SEMI RIG CX	2	UNIF	
10	Z-B10	8	CABLE COAX RG58AU	20	BELD	RG58AU
11	Z-B11		SAME AS B10	20		
12	Z-B12		SAME AS B10	20		
13	Z-B13		SAME AS B10	20		
14	Z-B14		SAME AS B10	20		
15	Z-B15		SAME AS B10	20		
16	Z-B16		SAME AS B10	20		
17	Z-B17		SAME AS B10	20		
18	Z-B18	4	CABLE COAX RG58AU	7	BELD	RG58AU
19	Z-B19		SAME AS B18	7		
20	Z-B20		SAME AS B18	7		
21	Z-B21		SAME AS B18	7		
22	Z-B22	2	CABLE COAX RG58AU	20	BELD	RG58AU
23	Z-B23		SAME AS B22	22		
24	Z-B24	2	CABLE COAX RG58AU	17	BELD	RG58AU
25	Z-B25	6	CABLE COAX RG58AU	6	BELD	RG58AU
26	Z-B26		SAME AS B25	6		
27	Z-B27		SAME AS B25	6		
28	Z-B28		SAME AS B25	6		
29	Z-B29		SAME AS B25	6		
30	Z-B30		SAME AS B25	6		
31	Z-B31	1	CABLE COAX RG58AU	6.5	BELD	RG58AU
32	Z-B32	1	CABLE COAX RG58AU	13	BELD	RG58AU
33	Z-B33	1	CABLE COAX RG58AU	14.75	BELD	RG58AU
34	Z-B34		SAME AS B24	17		
35	Z-B35	1	CABLE COAX RG58AU	31	BELD	RG58AU
36	Z-B36	1	CABLE COAX RG58AU	32	BELD	RG58AU

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4-R1	3	RES FXD CARB 5% 1/4W	27.0K OHM	AB	CB
2	Z4-R2	1	RES FXD CARB 5% 1/4W	33.0K OHM	AB	CB
3	Z4-R3		SAME AS R1	27.0K OHM		
4	Z4-R4		SAME AS R1	27.0K OHM		
5	Z4-R5	3	RES FXD CARB 5% 1/4W	1.0K OHM	AB	CB
6	Z4-R6		SAME AS R5	1.0K OHM		
7	Z4-R7	8	RES FXD CARB 5% 1/2W	82 OHM	AB	EB
8	Z4-R8		SAME AS R7	82 OHM		
9	Z4-R9		SAME AS R7	82 OHM		
10	Z4-R10		SAME AS R7	82 OHM		
11	Z4-R11		SAME AS R7	82 OHM		
12	Z4-R12		SAME AS R7	82 OHM		
13	Z4-R13		SAME AS R7	82 OHM		
14	Z4-R14		SAME AS R7	82 OHM		
15	Z4-R15	4	RES FXD CARB 5% 1/4W	4.7K OHM	AB	CB
16	Z4-R16		SAME AS R15	4.7K OHM		
17	Z4-R17	4	RES FXD CARB 5% 1/4W	10.0K OHM	AB	CB
18	Z4-R18		SAME AS R17	10.0K OHM		
19	Z4-R19		SAME AS R15	4.7K OHM		
20	Z4-R20		SAME AS R15	4.7K OHM		
21	Z4-R21		SAME AS R17	10.0K OHM		
22	Z4-R22		SAME AS R17	10.0K OHM		
23	Z4-R23		SAME AS R5	1.0K OHM		

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4-C1	4	CAP HI-K MONO 50V	1.0 UF	SPRG	5C023105X025
2	Z4-C2		SAME AS C1	1.0 UF		
3	Z4-C3		SAME AS C1	1.0 UF		
4	Z4-C4		SAME AS C1	1.0 UF		
5	Z4-C5	4	CAP CERAMIC	0.1 UF		
6	Z4-C6	1	CAP TANT 35V	1.0 UF		
7	Z4-C7		SAME AS C5	0.1 UF		
8	Z4-C8		SAME AS C5	0.1 UF		
9	Z4-C9		SAME AS C5	0.1 UF		
10	Z4-C10	1	CAP TANT 25V	10 UF		

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ATEGORY NO. 3----------TRANSISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4-Q1	8	TRANSISTOR SILICON PNP	2N4919	MOT	2N4919
2	Z4-Q2		SAME AS Q1	2N4919		
3	Z4-Q3		SAME AS Q1	2N4919		
4	Z4-Q4		SAME AS Q1	2N4919		
5	Z4-Q5		SAME AS Q1	2N4919		
6	Z4-Q6		SAME AS Q1	2N4919		
7	Z4-Q7		SAME AS Q1	2N4919		
8	Z4-Q8		SAME AS Q1	2N4919		
9	Z4-Q9	4	TRANSISTOR SILICON PNP	2N3906	MOT	2N3906
10	Z4-Q10		SAME AS Q9	2N3906		
11	Z4-Q11		SAME AS Q9	2N3906		
12	Z4-Q12		SAME AS Q9	2N3906		

ATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4-CR1	20	DIODE SILICON 1A 400V	1N4004	RCA	1N4004
2	Z4-CR2		SAME AS CR1	1N4004		
3	Z4-CR3		SAME AS CR1	1N4004		
4	Z4-CR4		SAME AS CR1	1N4004		
5	Z4-CR5	8	DIODE ZENER SI 24V	1N5252	MOT	1N5252A
6	Z4-CR6		SAME AS CR5	1N5252		
7	Z4-CR7		SAME AS CR1	1N4004		
8	Z4-CR8		SAME AS CR1	1N4004		
9	Z4-CR9		SAME AS CR1	1N4004		
10	Z4-CR10		SAME AS CR1	1N4004		
11	Z4-CR11		SAME AS CR5	1N5252		
12	Z4-CR12		SAME AS CR5	1N5252		
13	Z4-CR13		SAME AS CR1	1N4004		
14	Z4-CR14		SAME AS CR1	1N4004		
15	Z4-CR15		SAME AS CR1	1N4004		
16	Z4-CR16		SAME AS CR1	1N4004		
17	Z4-CR17		SAME AS CR5	1N5252		
18	Z4-CR18		SAME AS CR5	1N5252		
19	Z4-CR19		SAME AS CR1	1N4004		
20	Z4-CR20		SAME AS CR1	1N4004		
21	Z4-CR21		SAME AS CR1	1N4004		
22	Z4-CR22		SAME AS CR1	1N4004		
23	Z4-CR23		SAME AS CR5	1N5252		
24	Z4-CR24		SAME AS CR5	1N5252		
25	Z4-CR25		SAME AS CR1	1N4004		
26	Z4-CR26		SAME AS CR1	1N4004		
27	Z4-CR27		SAME AS CR1	1N4004		
28	Z4-CR28		SAME AS CR1	1N4004		

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4-IC1	1	INT. CRKT. BCD DECODER	7442N	TI	SN7442N
2	Z4-IC2	3	INT. CRKT. QUAD NOR	74LS02N	TI	SN74LS02N
3	Z4-IC3	1	INT. CRKT. QUAD NAND	74LS00N	TI	SN74LS00N
4	Z4-IC4	1	INT. CRKT. QUAD LATCH	74LS175N	TI	SN74LS175N
5	Z4-IC5	4	INT. CRKT. ONE SHOT	74121N	TI	SN74121N
6	Z4-IC6		SAME AS IC2	74LS02N		
7	Z4-IC7		SAME AS IC5	74121N		
8	Z4-IC8	1	INT. CRKT. DUAL FF (D)	74LS74N	TI	SN74LS74N
9	Z4-IC9		SAME AS IC5	74121N		
10	Z4-IC10		SAME AS IC5	74121N		
11	Z4-IC11	2	INT. CRKT. HEX INVERT	74LS04N	TI	SN74LS04N
12	Z4-IC12		SAME AS IC11	74LS04N		
13	Z4-IC13	6	IC DUAL NAND OC DRIVE	75452B	TI	SN75452BP
14	Z4-IC14		SAME AS IC13	75452B		
15	Z4-IC15		SAME AS IC13	75452B		
16	Z4-IC16		SAME AS IC13	75452B		
17	Z4-IC17		SAME AS IC13	75452B		
18	Z4-IC18		SAME AS IC13	75452B		
19	Z4-IC19		SAME AS IC2	74LS02N		
20	Z4-IC20	1	IC DUAL NAND BUFFER	74LS38N	TI	SN74LS38N

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4-B1	1	PC BRD FOR SWTCHG CRKT		NBS	PC-400
2	Z4-H1	8	SCREW NYLON 4-40	1/2		
3	Z4-H2	8	NUT NYLON 4-40			
4	Z4-H3	8	WASHER MICA INSULATOR			

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z4	1	RF SWITCHING PC CARD		NBS	Z400

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5-R1	1	RES FXD CARB 5% 1/4W	15K OHM	AB	CB
2	Z5-R2	2	RES FXD MF 1% 1/4W	100 OHM	CORG	NC5
3	Z5-R3	4	RES FXD MF 1% 1/4W	10K OHM	CORG	NC5
4	Z5-R4	1	RES FXD MF 1% 1/4W	1000K OHM	CORG	NC5
5	Z5-R5	1	RES FXD MF 1% 1/4W	5.1K OHM	CORG	NC5
6	Z5-R6	3	RES VAR TRIM CERMET	10K OHM	BRNS	3006W-1-103
7	Z5-R7	1	RES VAR TRIM CERMET	20K OHM	BRNS	3006W-1-203
8	Z5-R8		SAME AS R6	10K OHM		
9	Z5-R9	2	RES VAR TRIM CERMET	1K OHM	BRNS	3006W-1-102
10	Z5-R10	4	RES FXD MF 1% 1/4W	200K OHM	CORG	NC5
11	Z5-R11		SAME AS R10	200K OHM		
12	Z5-R12		SAME AS R10	200K OHM		
13	Z5-R13		SAME AS R10	200K OHM		
14	Z5-R14		SAME AS R6	10K OHM		
15	Z5-R15	1	RES FXD MF 1% 1/4W	2K OHM	CORG	NC5
16	Z5-R16		SAME AS R3	10K OHM		
17	Z5-R17		SAME AS R3	10K OHM		
18	Z5-R18	1	RES FXD MF 1% 1/4W	20K OHM	CORG	NC5
19	Z5-R19	2	RES VAR TRIM CERMET	2K OHM	BRNS	3006W-1-202
20	Z5-R20		SAME AS R19	2K OHM		
21	Z5-R21		SAME AS R9	1K OHM		
22	Z5-R22	1	RES FXD MF 1% 1/4W	511 OHM	CORG	NC5
23	Z5-R23	1	RES FXD MF 1% 1/4W	1K OHM	CORG	NC5
24	Z5-R24		SAME AS R2	100 OHM		
25	Z5-R25	1	RES FXD MF 1% 1/4W	10 OHM	CORG	NC5
26	Z5-R26	1	RES FXD CARB 5% 1/4W	100 OHM	AB	CB
27	Z5-R27	1	RES FXD CARB 5% 1/4W	2.7K OHM	AB	CB
28	Z5-R28		SAME AS R3	10K OHM		
29	Z5-R29	1	RES FXD CARB 5% 1/4W	4.7K OHM	AB	CB
30	Z5-R30	2	RES FXD CARB 5% 1/4W	39K OHM	AB	CB
31	Z5-R31		SAME AS R30	39K OHM		
32	Z5-R32	1	RES FXD CARB 5% 1/4W	27K OHM	AB	CB
33	Z5-R33	1	RES FXD CARB 5% 1/4W	10K OHM	AB	CB
34	Z5-R34	1	RES FXD CARB 5% 1/4W	1K OHM	AB	CB
35	Z5-R35	1	RES FXD MF 1% 1/4W	24.3K OHM	CORG	NC5

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5-C1	2	CAP DISK	.001 UF		
2	Z5-C2	1	CAP CERAMIC	.1 UF		
3	Z5-C3	1	CAP POLYCARBONATE	.1 UF	SEAC	CMK
4	Z5-C4	2	CAP DISK	.01 UF		
5	Z5-C5		SAME AS C4	.01 UF		
6	Z5-C6	4	CAP TANT 35V	22 UF		
7	Z5-C7	1	CAP DIP MICA	150 PF		
8	Z5-C8	2	CAP TANT 20V	47 UF		
9	Z5-C9		SAME AS C8	47 UF		
10	Z5-C10		SAME AS C6	22 UF		
11	Z5-C11		SAME AS C6	22 UF		
12	Z5-C12		SAME AS C6	22 UF		
13	Z5-C13	1	CAP DIP MICA	100 PF		
14	Z5-C14	3	CAP HI-K MONO 50V	1.0 UF	SPRG	5C023105X0250
15	Z5-C15		SAME AS C14	1.0 UF		
16	Z5-C16		SAME AS C1	.001 UF		
17	Z5-C17		SAME AS C14	1.0 UF		

CATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5-D1	1	DIODE SILICON 100V	1N4153	MOT	1N4153

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5-IC1	1	INT. CRKT. OP AMP	OP-05C	MONO	OP-05C
2	Z5-IC2	1	IC SAMPLE & HOLD	SHM-LM-2	DATL	SHM-LM-2
3	Z5-IC3	1	INT. CRKT. FET OP AMP	LH0042C	NATL	LH0042C
4	Z5-IC4	1	INT. CRKT. LOG AMP	8048	ITSL	ICL 8048 ECPI
5	Z5-IC5	1	INT. CRKT. OP AMP	LM741C	NATL	LM741C
6	Z5-IC6	2	INT. CRKT. TIMER	LM555	NATL	LM555
7	Z5-IC7		SAME AS IC6	LM555		
8	Z5-IC8	2	INT. CRKT. ONE SHOT	74121N	TI	SN74121N
9	Z5-IC9	1	INT. CRKT. NAND DRIVE	75452B	TI	SN75452B
10	Z5-IC10		DELETED	74121N		
11	Z5-IC11	1	INT. CRKT. HEX INVERT	74LS04N	TI	SN74LS04N

ATEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5-K1	2	SOCKET ROUND DIP	8 PIN	SAMT	
2	Z5-K2	1	SOCKET DUAL IN-LINE DP	16 PIN	SAMT	IC-316-SGG
3	Z5-K3		SAME AS K1	8 PIN		
4	Z5-J1	2	JACK JUMPER IC PIN	1 PIN	GARY	AA-C
5	Z5-J2		SAME AS J1	1 PIN		
6	Z5-T1	1	TERM TEST POINT	1 PIN	GARY	AA-C

ATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5-B1	1	PC BRD-RF PROCESS CRKT		NBS	PC-500

ATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z5	1	RF PROCLSS PC CARD		NBS	Z500

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z6-R11	6	RES FXD MF 1% 1/4W	10 OHM	CORG	NC5
2	Z6-R12		SAME AS R11	10 OHM		
3	Z6-R13	3	RES FXD MF 1% 1/4W	150 OHM	CORG	NC5
4	Z6-R14	3	RES FXD MF 1% 1/4W	27 OHM	CORG	NC5
5	Z6-R15	3	RES FXD MF 1% 1/4W	30 OHM	CORG	NC5
6	Z6-R21		SAME AS R11	10 OHM		
7	Z6-R22		SAME AS R11	10 OHM		
8	Z6-R23		SAME AS R13	150 OHM		
9	Z6-R24		SAME AS R14	27 OHM		
10	Z6-R25		SAME AS R15	30 OHM		
11	Z6-R31		SAME AS R11	10 OHM		
12	Z6-R32		SAME AS R11	10 OHM		
13	Z6-R33		SAME AS R13	150 OHM		
14	Z6-R34		SAME AS R14	27 OHM		
15	Z6-R35		SAME AS R15	30 OHM		

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z6-C11	6	CAP CERAMIC	10 PF		
2	Z6-C12		SAME AS C11	10 PF		
3	Z6-C21		SAME AS C11	10 PF		
4	Z6-C22		SAME AS C11	10 PF		
5	Z6-C31		SAME AS C11	10 PF		
6	Z6-C32		SAME AS C11	10 PF		

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z6-J1	5	JACK PANEL RECEPTACLE		EFJ	142-0296-001
2	Z6-J2		SAME AS J1			
3	Z6-J3		SAME AS J1			

4	Z6-J4		SAME AS J1		
5	Z6-J5		SAME AS J1		
6	Z6-P1	2	PLUG RIGHT ANGLE CLAMP	EFJ	142-0222-001
7	Z6-P2		SAME AS P1		
8	Z6-P3	3	PLUG RT ANGLE TO .141	OSM	OSM 221-1
9	Z6-P4		SAME AS P3		
10	Z6-P5		SAME AS P3		
11	Z6-P6	1	PLUG SMA TO .141	OSM	OSM 201-1A

ATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z6-H1	1	PLATE ALUM 4.25 X 5.5	1/16	NBS	
2	Z6-H2	2	BRAKET RIGHT ANGLE	1/16	NBS	
3	Z6-H3		SAME AS H2	1/16		
4	Z6-H4	4	MINI BOXES (MODIFIED)		POMA	
5	Z6-H5		SAME AS H4			
6	Z6-H6		SAME AS H4			
7	Z6-H7		SAME AS H4			

ATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z6	1	NOISE ADD CARD		NBS	Z600
2	Z6-S1	1	3 WAY POWER DIVIDER		MERR	PDM-30-55
3	Z6-A1	1	AMP 10-500 MHZ		AVNT	UDP-531
4	Z6-T1	1	ATTENUATOR MINIPAD	5 dB	MID	MTT-333-5
5	Z6-T2	1	ATTENUATOR MINIPAD	10 dB	MID	MTT-333-10

ATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z6-L11	3	INDUCTOR	.15 UH	DLVN	1537-00
2	Z6-L21		SAME AS L11	.15 UH		
3	Z6-L31		SAME AS L11	.15 UH		
4	Z6-X1	1	COAX MINI (RG-174)	3	BELD	174/UG
5	Z6-X2	1	COAX SEMI-RIGID (.141)	4	UNIF	
6	Z6-X3	1	COAX SEMI-RIGID (.141)	1.25	UNIF	

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7-R1	13	RES FXD CARB 5% 1/4W	1.5K OHM	AB	CB
2	Z7-R2		SAME AS R1	1.5K OHM		
3	Z7-R3		SAME AS R1	1.5K OHM		
4	Z7-R4		SAME AS R1	1.5K OHM		
5	Z7-R5		SAME AS R1	1.5K OHM		
6	Z7-R6		SAME AS R1	1.5K OHM		
7	Z7-R7		SAME AS R1	1.5K OHM		
8	Z7-R8		SAME AS R1	1.5K OHM		
9	Z7-R9		SAME AS R1	1.5K OHM		
10	Z7-R10		SAME AS R1	1.5K OHM		
11	Z7-R11		SAME AS R1	1.5K OHM		
12	Z7-R12		SAME AS R1	1.5K OHM		
13	Z7-R13	2	RES FXD CARB 5% 1/4W	12.0K OHM	AB	CB
14	Z7-R14		SAME AS R13	12.0K OHM		
15	Z7-R15	1	RES FXD CARB 5% 1/4W	1.2K OHM	AB	CB
16	Z7-R16		SAME AS R1	1.5K OHM		
17	Z7-R17	4	RES FXD CARB 5% 1/4W	2.2K OHM	AB	CB
18	Z7-R18		NOT USED			
19	Z7-R19	2	RES FXD WW 5% 3W	2.2K OHM		
20	Z7-R20		SAME AS R17	2.2K OHM		
21	Z7-R21		NOT USED			
22	Z7-R22		SAME AS R19	2.2K OHM		
23	Z7-R23	12	RES FXD MF 1% 1/4W	30.1K OHM	CRNG	NC5
24	Z7-R24		SAME AS R23	30.1K OHM		
25	Z7-R25		SAME AS R23	30.1K OHM		
26	Z7-R26		SAME AS R23	30.1K OHM		
27	Z7-R27		SAME AS R23	30.1K OHM		
28	Z7-R28		SAME AS R23	30.1K OHM		
29	Z7-R29		SAME AS R23	30.1K OHM		
30	Z7-R30		SAME AS R23	30.1K OHM		
31	Z7-R31		SAME AS R23	30.1K OHM		
32	Z7-R32		SAME AS R23	30.1K OHM		
33	Z7-R33		SAME AS R23	30.1K OHM		
34	Z7-R34		SAME AS R23	30.1K OHM		

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7-C1	3	CAP HI-K MONO 50V	1.0 UF	SPRG	5C023105X025053
2	Z7-C2		SAME AS C1	1.0 UF		
3	Z7-C3		SAME AS C1	1.0 UF		
4	Z7-C4	1	CAP TANT 35V	1.0 UF		
5	Z7-C5	2	CAP DISK	.01 UF		
6	Z7-C6	1	CAP TANT 25V	10.0 UF		
7	Z7-C7		SAME AS C5	.01 UF		

CATEGORY NO. 3----------TRANSISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7-Q1	2	TRANSISTOR SILICON NPN	2N4922	RCA	2N4922
2	Z7-Q2		SAME AS Q1	2N4922		

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7-IC1	2	INT. CRKT. QUAD NAND	74LS00N	TI	SN74LS00N
2	Z7-IC2	1	INT. CRKT. HEX INVERT	74LS04N	TI	SN74LS04N
3	Z7-IC3	3	INT. CRKT. ONE SHOT	74121N	TI	SN74121N
4	Z7-IC4		SAME AS IC3	74121N		
5	Z7-IC5		SAME AS IC3	74121N		
6	Z7-IC6	2	IC 4 BIT DATA MULTPLX	74LS157N	TI	SN74LS157N
7	Z7-IC7		SAME AS IC6	74LS157N		
8	Z7-IC8	1	INT. CRKT. QUAD NOR	74LS02N	TI	SN74LS02N
9	Z7-IC9		SAME AS IC1	74LS00N		
10	Z7-IC10	1	INT. CRKT. QUAD LATCH	74LS74N	TI	SN74LS74N
11	Z7-IC11	1	IC HEX INVERT (NOT LS)	7404N	TI	SN7404N
12	Z7-IC12	1	IC HEX INVERTER (OC)	7406N	TI	SN7406N
13	Z7-IC13	3	INT. CRKT. OP AMP	OP-05	MONO	OP-05
14	Z7-IC14		SAME AS IC13	OP-05		
15	Z7-IC15		SAME AS IC13	OP-05		

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7-J1		NOT USED			
2	Z7-J2	1	JACK IC DUAL IN-LINE	14 PIN	SAMT	IC-314-SGG

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7-B1	1	PC BRD FOR CNTROL CRKT		NBS	PC-700
2	Z7-H1	2	SCREW NYLON 4-40	1/2		
3	Z7-H2	2	NUT NYLON 4-40			
4	Z7-H3	2	WASHER MICA INSULATOR			

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Z7	1	INPUT CONTROL PC CARD		NBS	Z700

5.10 WIRING LIST

CONTROL/RF UNIT

FRONT PANEL CONNECTIONS *

1 ▷	Z700-20 NA1 LED
2	Z700-28 PGM 64
3	Z700-18 NA2 LED
4	Z700-40 PGM 32
5	
6	Z700-34 PGM 16
7	
8	Z700-33 PGM 8
9	
10	Z700-27 PGM 4
11	
12	Z700-39 PGM 2
13	
14	Z700-43 PGM 1
15	Z700-49 LOAD
16	Z700-51 LOAD
17	SIMUL. STAR OUT
18	GND (PWR SUPPLY)
19	Z700-48 HOLD/Bypass
20	PGM ATN S-8 (LED)
21	PGM ATN S-4 (LED)
22	PGM ATN S-2 (LED)
23	PGM ATN S-1 (LED)
24	Z400-43 REF ATN LED
25	Z400-48 RF ON LED
26	
27	AC LINE FILTER
28	AC LINE FILTER
29	FUSE BLOCK -B
30	FUSE BLOCK -F

31 ▷	Z500-26 METER X.01
32	+5V (POWER SUPPLY) AC ON LED
33	FILTER BAND SWITCH IN
34	R.F. AMP 1 OUT
35	REF ATN OUT
36	TO PGM ATNR
37	R.F. AMP 2 IN
38	R.F. AMP 2 OUT
39	XTAL DET. OUT
40	Z500-28 METER X.1
41	Z500-30 METER X1
42	Z500-23 METER RANGE
43	Z500-43 OFFSET POT
44	Z500-39 OFFSET POT
45	Z500-41 METER X1
46	Z500-27 METER RANGE
47	Z500-32 METER-
48	Z500-34 METER+
49	Z400-44 "1" BUSS
50	Z500-49 RESET
51	Z400-47 OVERLOAD LED
52	J650-8
53	J650-7
54	J650-6
55	J650-5
56	J650-4
57	J650-3
58	J650-2
59	J650-1
60	TO DIRECTIONAL-COUPLER IN
61	R.F. OUTPUT

* Front Panel connections listed above are designated on other diagrams by a Triangular Flag ▷ . See also Figure 15.

WIRING LIST

J-400

ANALOG GND	1	2	ANALOG GND
+36V	3	4	+36V
+24V	5	6	+24V
	7	8	PGM ATN 8+
	9	10	PGM ATN 8-
REF ATN -2	11	12	PGM ATN 4+
REF ATN -1	13	14	PGM ATN 4-
Z500 -50	15	16	PGM ATN 2+
R.F. ON -2	17	18	PGM ATN 2-
Z500 -52	19	20	PGM ATN 1+
R.F. ON -1	21	22	PGM ATN 1-
	23	24	
	25	26	
	27	28	
	29	30	
	31	32	
Z500 -55	33	34	
	35	36	
	37	38	Z700 -31
	39	40	Z700 -25
FP 49	41	42	Z700 -37
FP 29	43	44	Z700 -41
Z500 -47	45	46	Z700 -46
FP 51	47	48	FP 25
Z700 -42	49	50	Z700 -50
Z700 -36	51	52	Z700 -30
Z700 -56	53	54	Z700 -54
J650 -20	55	56	J651 -13
+5V	57	58	+5V
GND	59	60	GND

WIRING LIST

J-500

ANALOG GND	1	2	ANALOG GND
	3	4	
	5	6	
	7	8	
	9	10	
SHIELD XTAL DET.	11	12	
XTAL DET.	13	14	
	15	16	
	17	18	
	19	20	
	21	22	
FP 48	23	24	
	25	26	FP 31
FP 46	27	28	FP 40
	29	30	FP 41
	31	32	FP 47 +METER
	33	34	FP 48 -METER
-15V	35	36	-15V
+15V	37	38	+15V
FP 44	39	40	
FP 45	41	42	
FP 43	43	44	
Z700 -52	45	46	
Z400 -45 FP 51	47	48	
FP 50	49	50	Z400 -15
	51	52	Z400 -19
	53	54	
Z400 -33	55	56	
+5V	57	58	+5V
GND	59	60	GND

WIRING LIST

J-700

ANALOG GND	1	2	ANALOG GND
	3	4	
+24V	5	6	+24V
+12V	7	8	+12V
	9	10	
	11	12	J654 NOISE-ADD #2
	13	14	J653 NOISE-ADD #1
S656 NC TTL NA1	15	16	
S656 NO TTL NA1	17	18	FP 3
S657 NC TTL NA2	19	20	FP 1
S657 NO TTL NA2	21	22	
J650 -16	23	24	
Z400 -16 J651 -3	25	26	J650 -15
FP 10	27	28	FP 2
J650 -11	29	30	Z400 -52 J651 -8
Z400 -38 J651 -4	31	32	J650 -13
FP 8	33	34	FP 6
J650 -12	35	36	Z400 -51 J651 -5
Z400 -42 J651 -2	37	38	J650 -14
FP 12	39	40	FP 14
Z400 -44 J651 -1	41	42	Z400 -49 J651 -6
FP 14	43	44	
J650 -9	45	46	Z400 -46 J651 -12
J650 -10	47	48	FP 19
FP 15	49	50	Z400 -50
FP 16	51	52	Z400 -45
J650 -19	53	54	Z400 -54
J650 -17	55	56	Z400 -53
+5V	57	58	+5V
GND	59	60	GND

ETMS CONNECTOR WIRING LIST

J-650

1	FP	59	BREAK POINT	1
2	FP	58	BREAK POINT	2
3	FP	57	BREAK POINT	4
4	FP	56	BREAK POINT	8
5	FP	55	BREAK POINT	16
6	FP	54	BREAK POINT	32
7	FP	53	BREAK POINT	64
8	FP	52	BREAK POINT	128
9	Z700-45	DATA OUT		1
10	Z700-47	DATA OUT		2
11	Z700-29	DATA OUT		4
12	Z700-35	DATA OUT		8
13	Z700-32	DATA OUT		16
14	Z700-38	DATA OUT		32
15	Z700-26	DATA OUT		64
16	Z700-23	DATA OUT		128
17	Z700-55	$\overline{\text{CTL}}$		
18				
19	Z700-53	I/O		
20	Z400-55	$\overline{\text{FLAG}}$		
21				
22	GND			
23	GND			
24				

J-651

1	Z700-41	DATA	1
2	Z700-37	DATA	2
3	Z700-25	DATA	4
4	Z700-31	DATA	8
5	Z700-36	DATA	16
6	Z700-42	DATA	32
7	GND		
8	Z700-30		
9			
10			
11			
12	Z700-46	$\overline{\text{CONTROL}}$	
13	Z400-56	MUX FLAG	
14	+5V		

J-655

A	GROUND
B	+20V SUPPLY
C	+12V SUPPLY
D	SHIELD-XTAL DET.
E	XTAL DET.

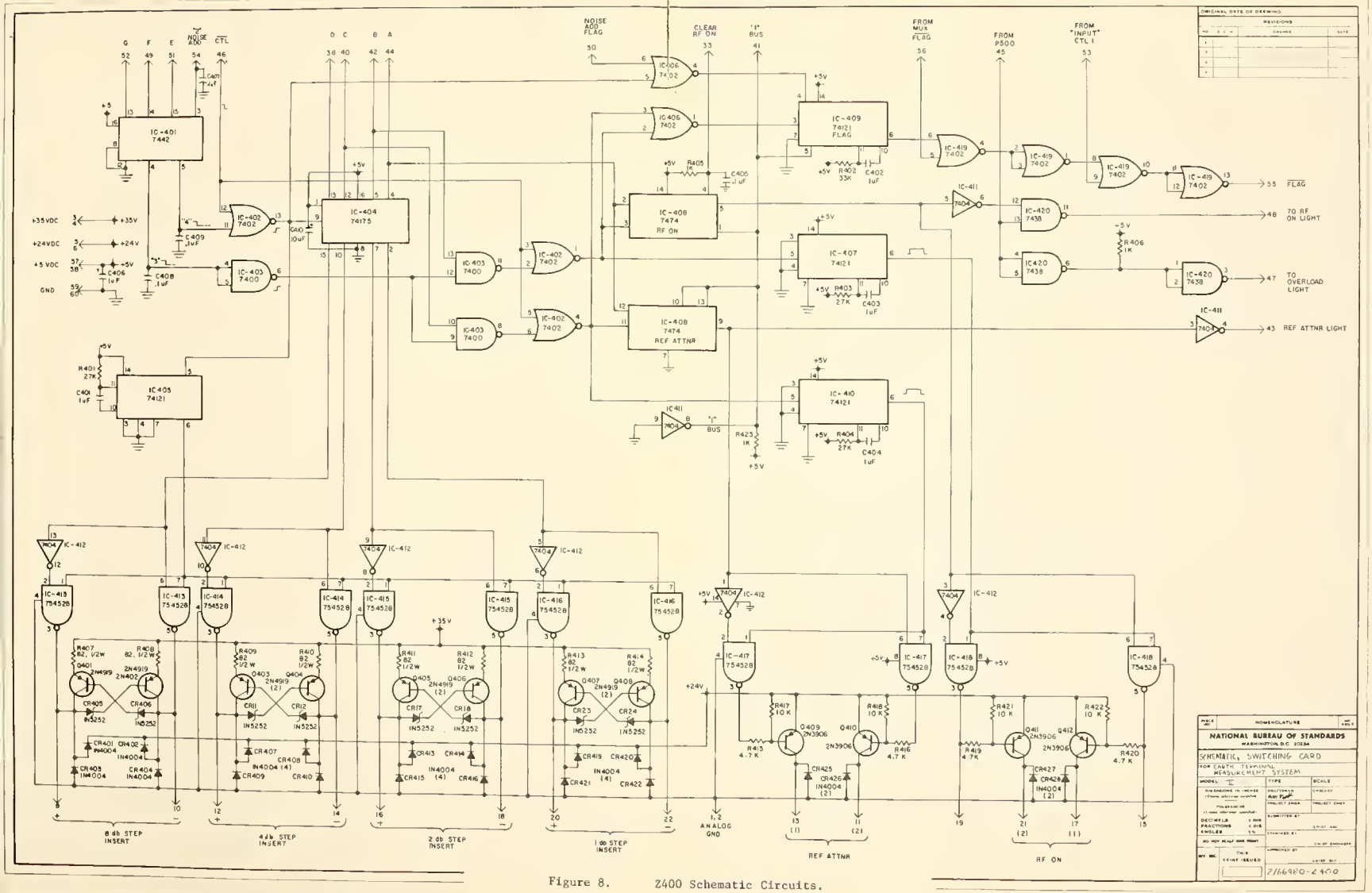
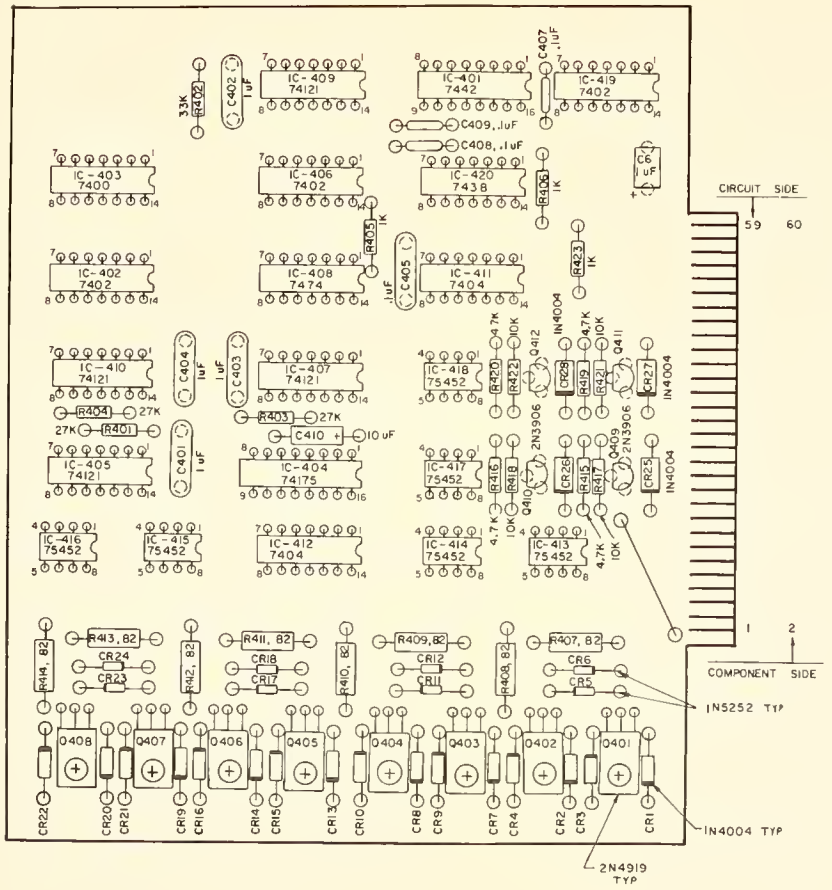


Figure 8. Z400 Schematic Circuits.



ORIGINAL DATE OF DRAWING

REVISIONS

NO	E C N	CHANGE	DATE
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PIECE NO	NOMENCLATURE	NO 450 D
	NATIONAL BUREAU OF STANDARDS WASHINGTON, D.C. 20234	
	ASSY, SWITCHING CARD	
	FOR EARTH TERMINAL MEASUREMENT SYSTEM	
MODEL II	TYPE	SCALE 7/1
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ± .000 FRACTIONS ± .010 ANGLES ± 1°	SUBMITTED BY	CHIEF SEC
DO NOT SCALE THIS PRINT	EXAMINED BY	CHIEF ENGINEER
DIV SEC THIS PRINT ISSUED	APPROVED BY	CHIEF DIV
	2766480 -Z400	

Figure 9. Z400 PC Assembly Drawing.

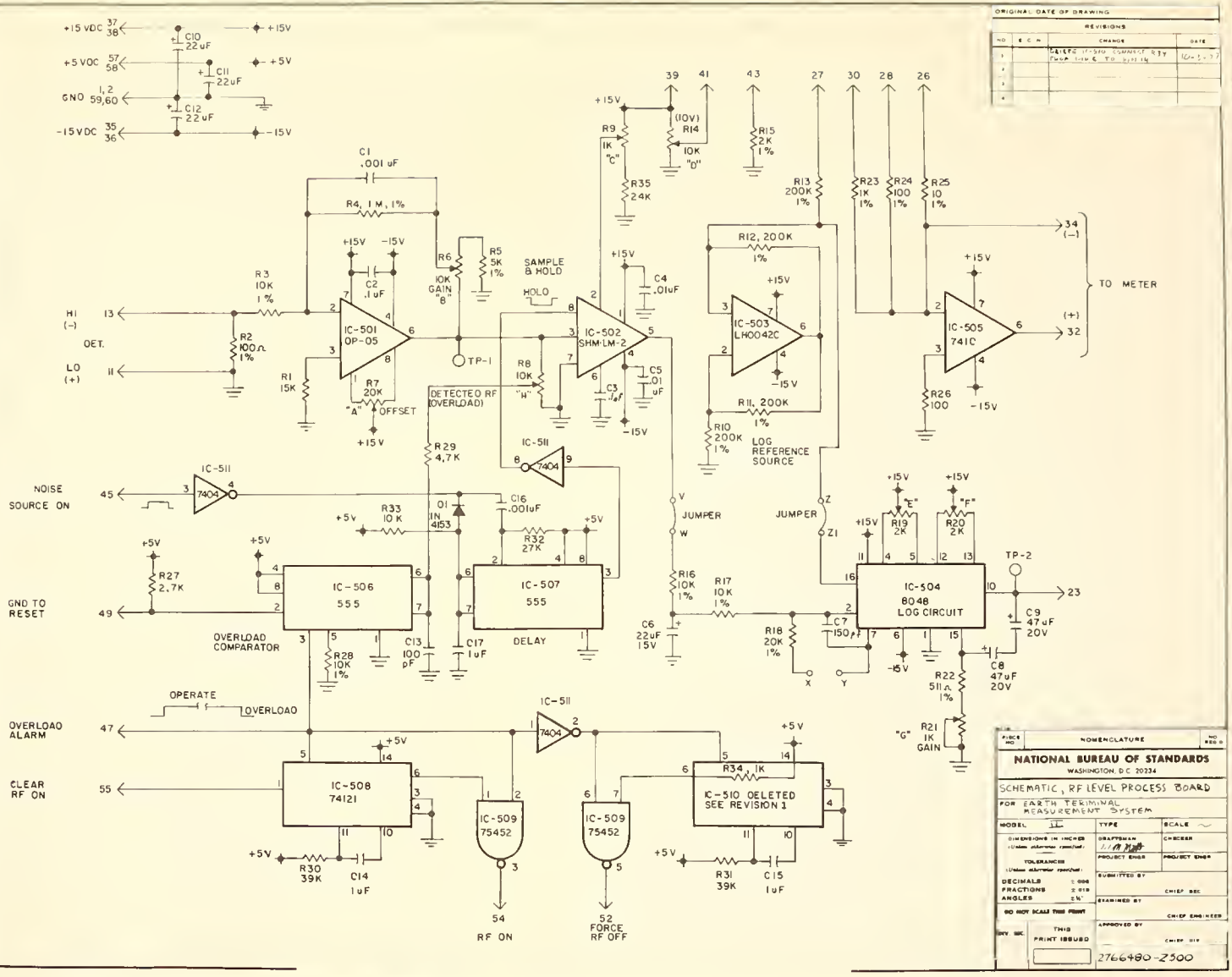


Figure 10. 2500 Schematic Circuits.

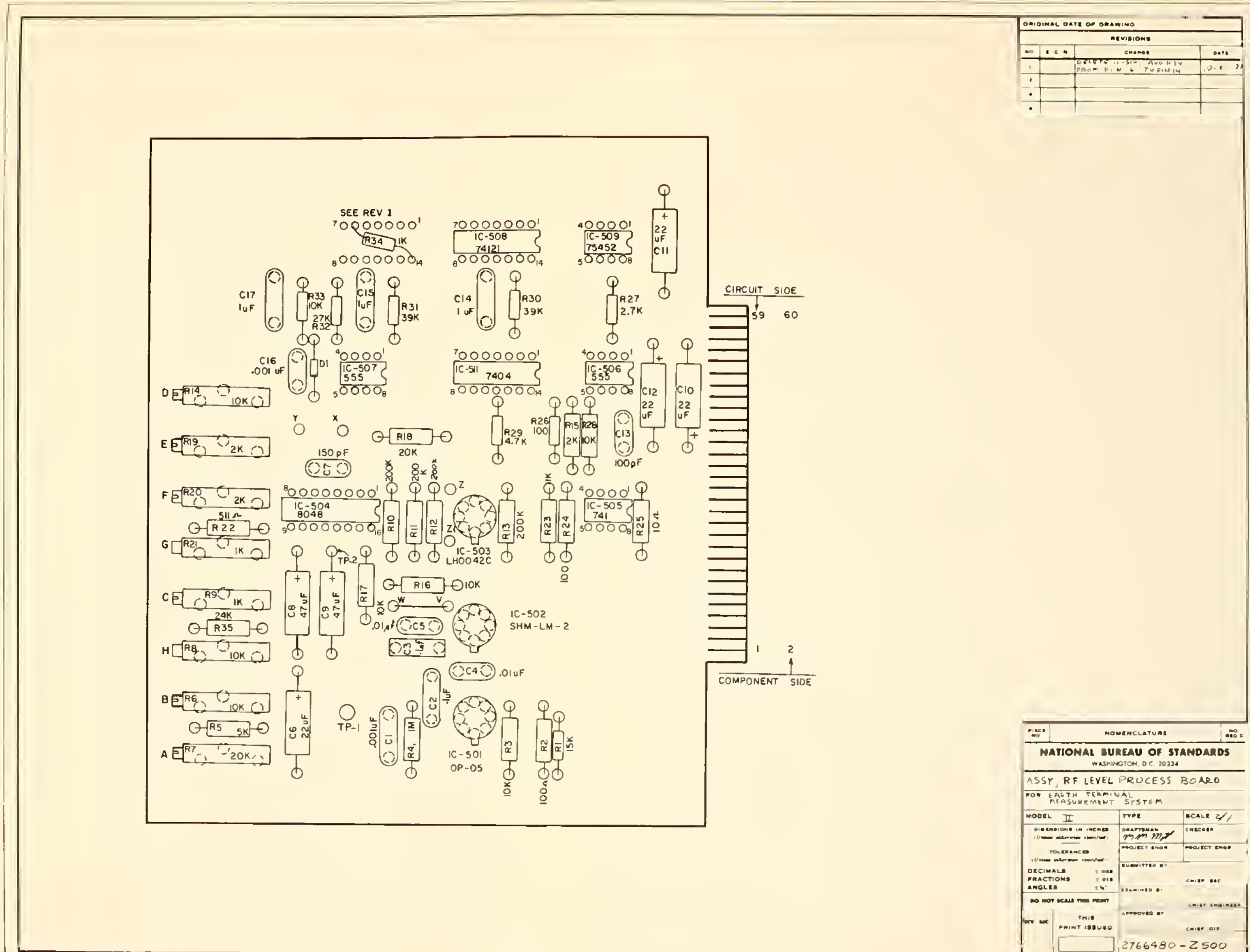


Figure 11. Z500 PC Assembly Drawing.

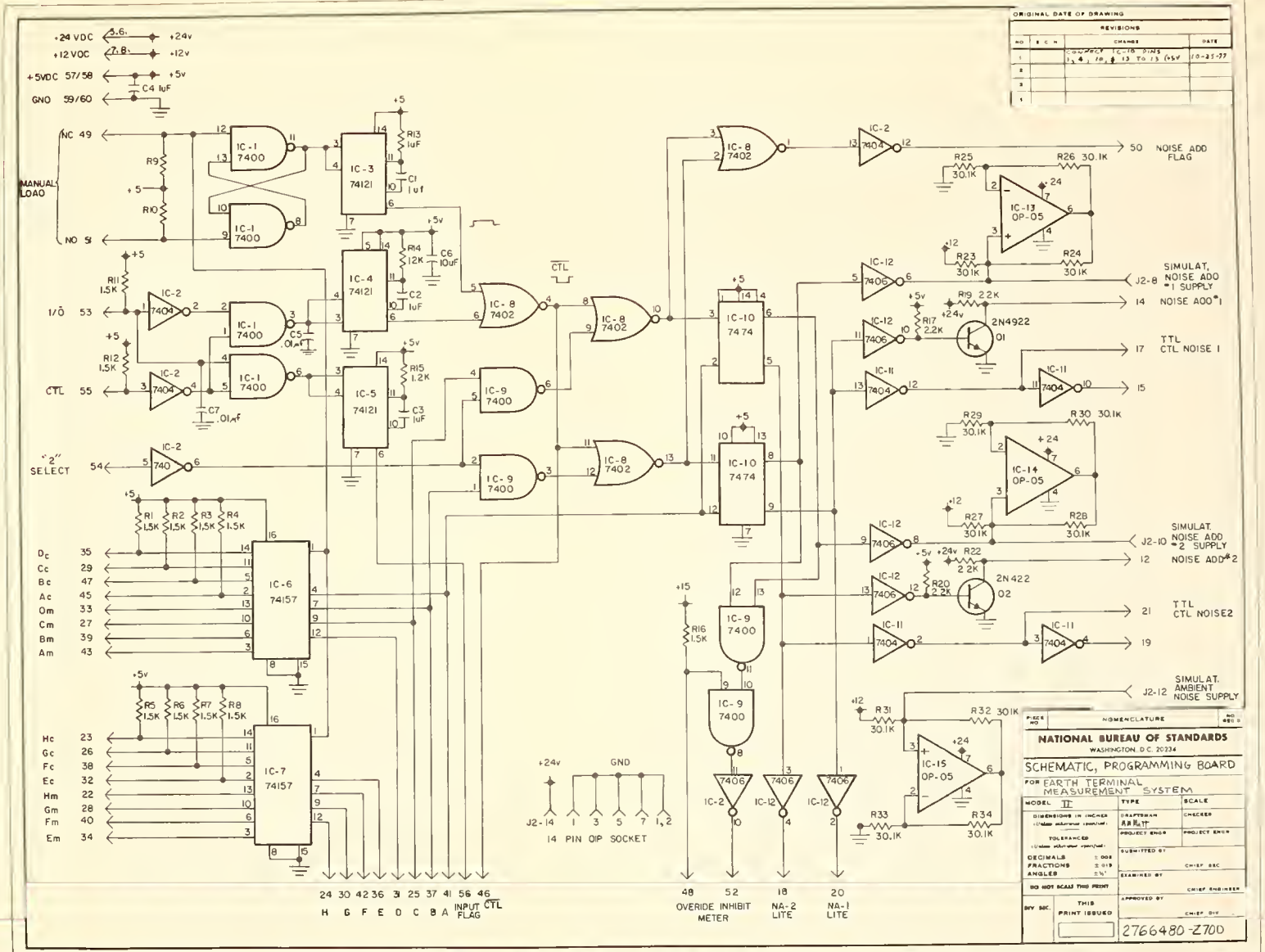
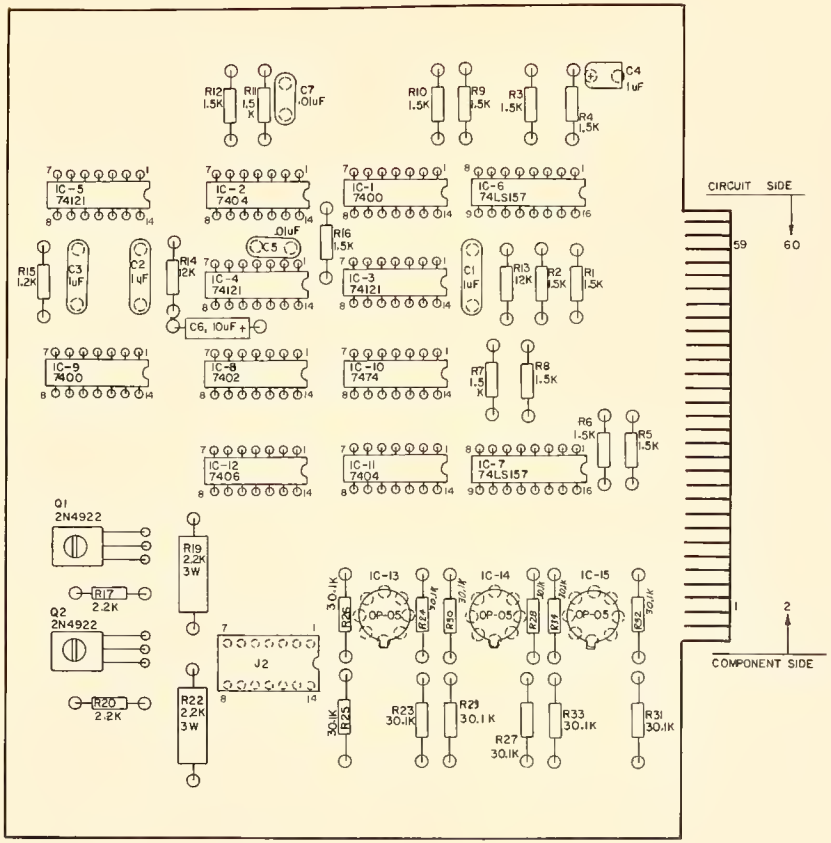


Figure 12. Z700 Schematic Circuits.



ORIGINAL DATE OF DRAWING

REVISIONS

NO	E C N	CHANGE	DATE
1			
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PIECE NO.	NOMENCLATURE	NO. REQ'D

NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

ASSY, INPUT CONTROL CARD
FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ± .000	SUBMITTED BY	
FRACTIONS ± .015	CHIEF SEC.	
ANGLES ± ½°	EXAMINED BY	
DO NOT SCALE THIS PRINT	CHIEF ENGINEER	
DEV. SEC. THIS PRINT ISSUED	APPROVED BY	
	CHIEF DIV.	

2766480-Z700

Figure 13. Z700 PC Assembly Drawing.

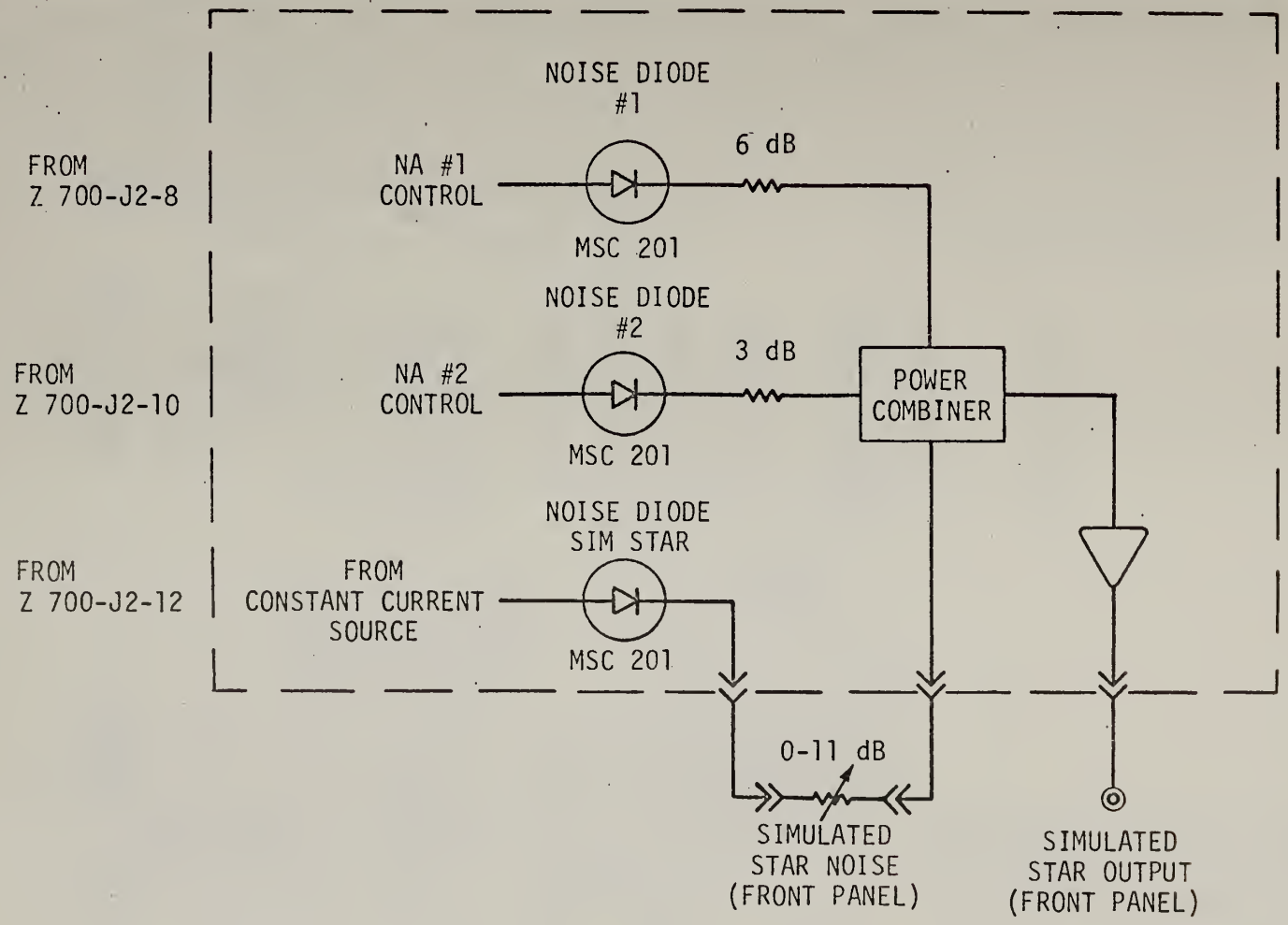
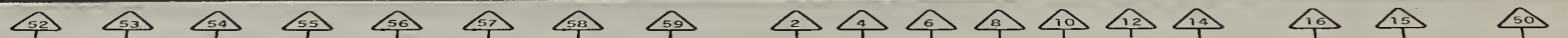


Figure 14. Z600 Block Diagram.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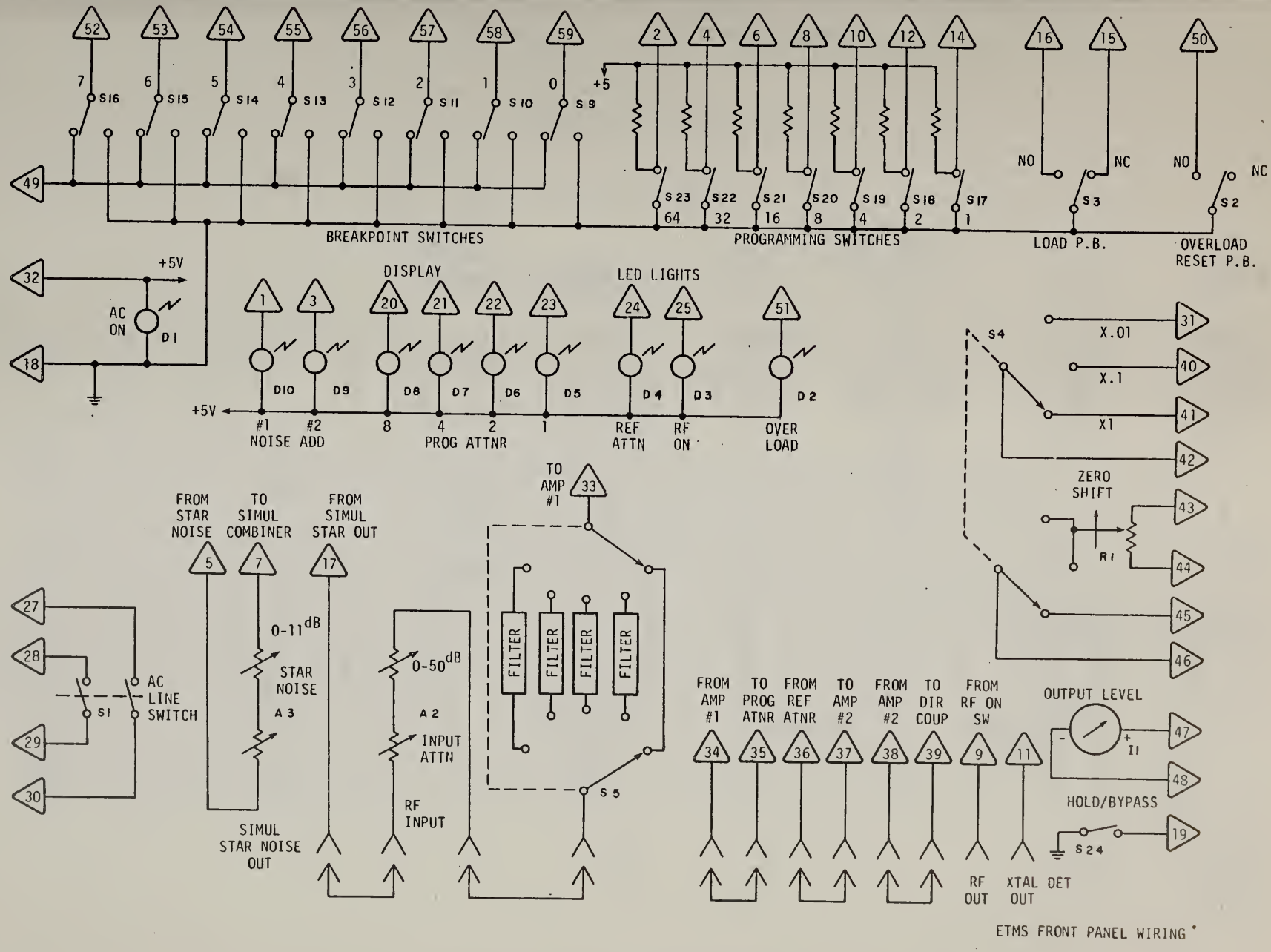


Figure 15. Front Panel Wiring.

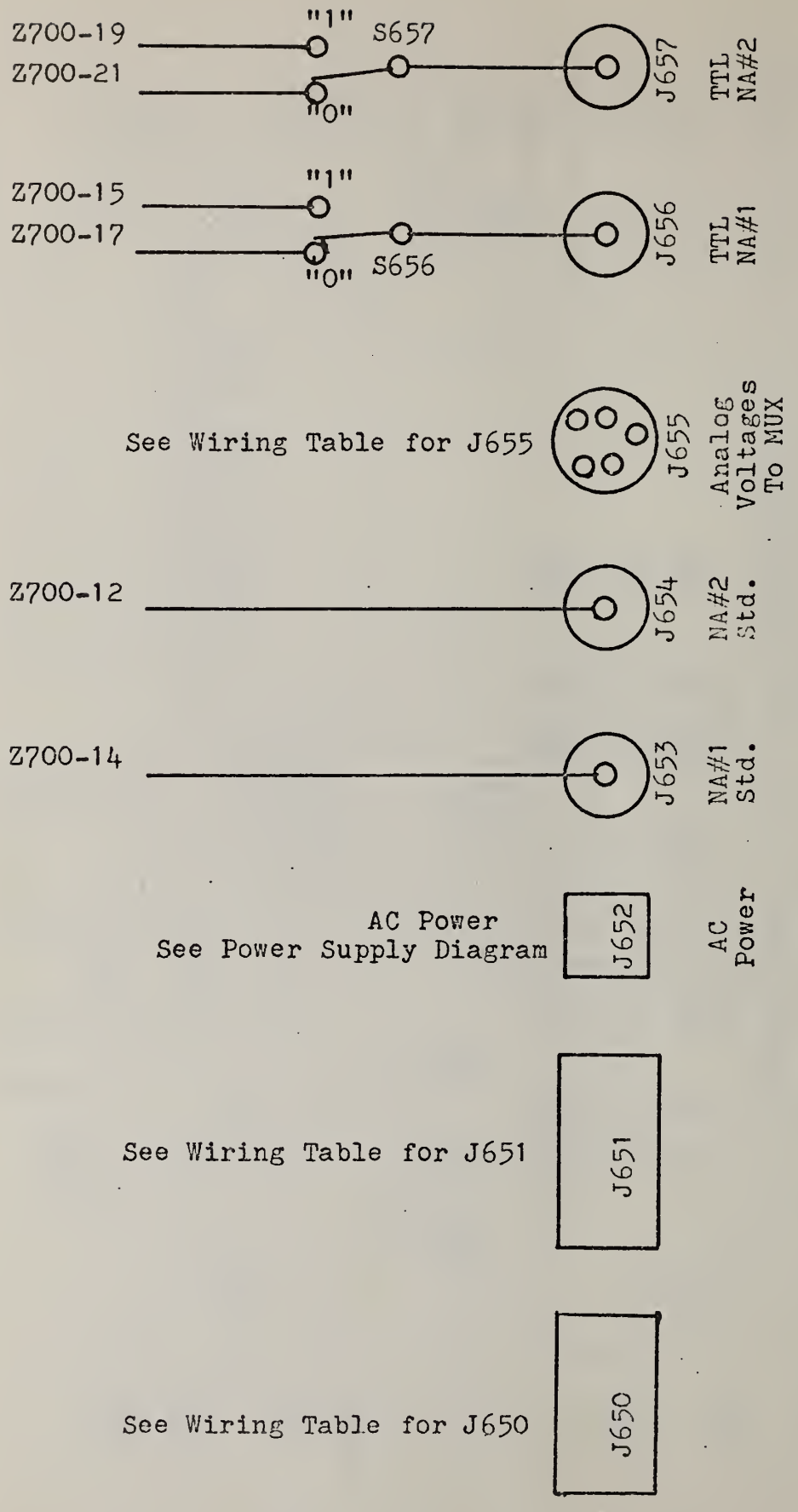


Figure 16. Rear Panel Wiring.

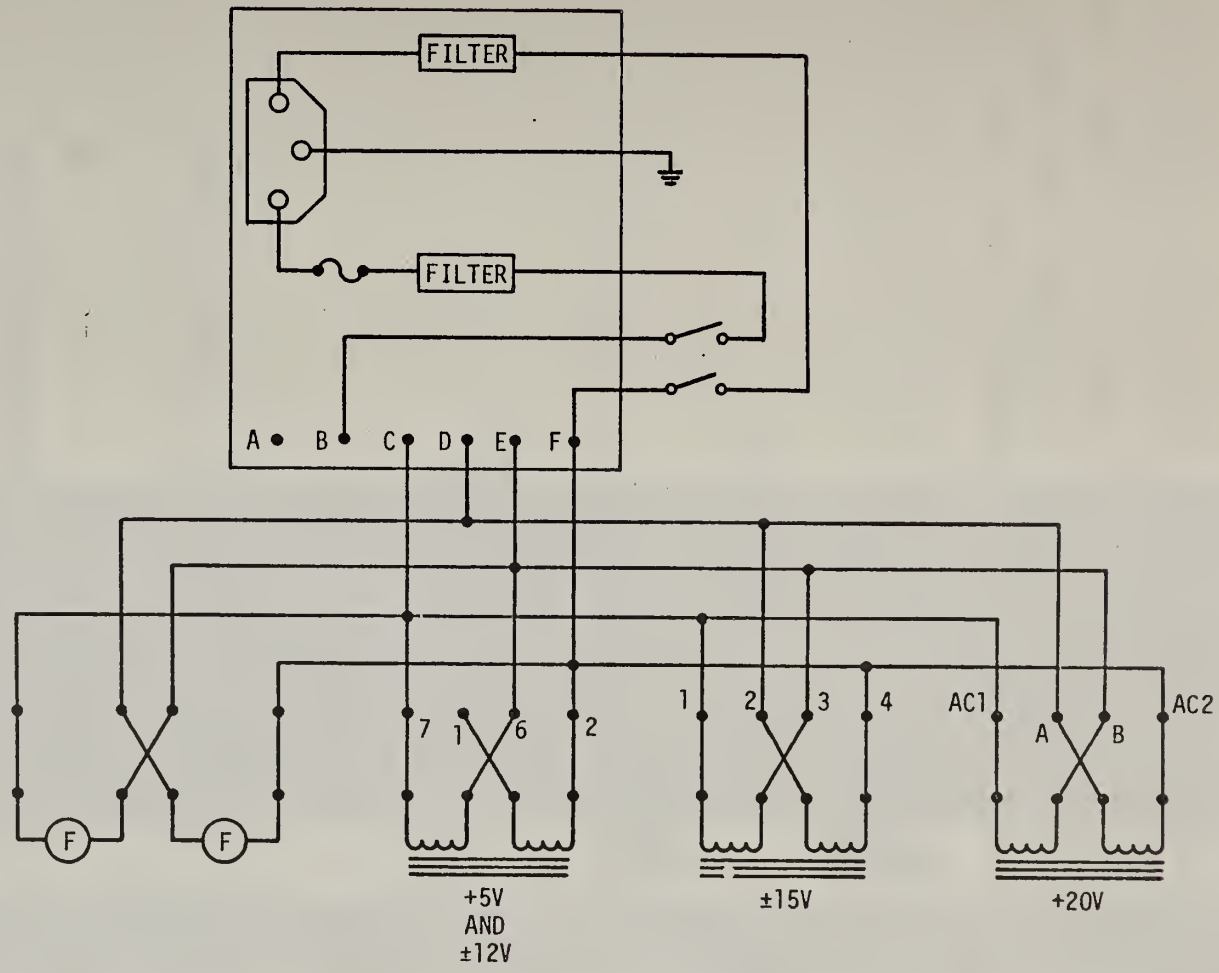


Figure 17. Control/RF Unit Primary Power Distribution.

6. MULTIPLEXER/DIGITAL VOLTMETER CONTROLLER

6.1 Introduction

The digital voltmeter control circuits and input channel multiplexer are built into a flat package which is attached to the top of the digital voltmeter (see fig. 18). This unit contains the control latches for the digital voltmeter functions, the offset-voltage reference used with the power meter measurements and the reed-relay analog multiplexer which provides 12 input channels for the digital voltmeter.

The entire package is self-contained and replaces the top cover of the DVM. No modifications to the DVM are required.

6.2 Specifications

Offset voltage reference

1 M.V. resolution programmed automatically by Channel #9.

Range. 3 ranges internally selected.

2.0 to 2.999 V for Type IV power meter

3.5 to 4.5 V for Type II power meter

4.5 to 5.5 V for HP 432 power meter

Analog Multiplexer

12 input channels

Analog channels Low Thermal EMF Reed Relay, 2 pole guarded.

Control commands are generated by the ETMS control/rf unit or ETMS calculator interface.

6.3 Y 100 MUX/DVM Control Card (Schematic, Figure 20)

The control circuits are on the Y 100 printed circuit card. Incoming command data from the ETMS control/rf unit on the four low-order bits are connected to three four-bit latches (IC-104, 105, and 106) which store the function data. The DVM range is stored in IC-106*, the DVM function (dc

*Note: The D or "8" latch is not used to program Range, but instead actuates the DVM "HOLD." This allows the DVM range control codes 16, and 19 thru 23 to program the DVM range but leave the DVM RATE in the free-running mode.

Figure 18. Multiplexer/DVM Unit.

volts; filter) in IC-105 and the input multiplexer channel IC 104. The function select data lines 5, 6, and 7 are decoded in IC 101. The output of this decoder enables the CTL pulse to the selected latch strobe to store the output data on the four data lines.

One gate of IC-103 acts as an OR gate to feed the decoded CTL pulse to trigger the ready-flag one-shot, IC 107. Any one of the three decoded CTL pulses cause the one-shot to return a ready-flag to the ETMS control/rf unit where it is combined with the flags from that chassis. Note: This flag circuit returns a flag for DVM control commands. The DVM DATA READY flag circuitry is connected to input I/O select code #2. When the input channel multiplexer function is selected, the enabled CTL pulse triggers the one-shot, IC 108, which generates a pulse to disable the multiplex driver during the time the MUX data latches are changing. This opens the previously selected input channel relay a short time before the next selected input channel relay closes thus avoiding shorting two input channels together.

Inverter driver IC's 110 and 111 drive the front panel LED indicator lights.

The range information from the voltmeter must be converted to a corresponding exponent digit to be compatible with the calculator interface. This is accomplished by the adder, IC 120--which adds + 13 hexidecimal or modulo 16 to the range data and ignores the carry bit in the result. The DVM interface, I/O select code #2 has the decimal point code hard wired between DVM data digits 3 and 4 at the jack on the rear panel (J352). This arrangement permits inputing the DVM data without any extra processing required.

6.4 Y 200 Offset Reference Voltage Card (Schematic Figure 22)

The offset voltage reference is a programmable D/A converter which accepts DVM data when input channel #9 is selected so that the offset voltage is automatically set to the voltmeter reading.

6.4.1 Digital Circuits (See Also Figure 19)

The decoder IC-205 enables the DVM data ready signal in IC-206 when the input channel multiplexer is set to channel #9. This data ready pulse triggers the one-shot, IC-207 to strobe the three most significant digits of the DVM reading currently on the data lines into the DAC.

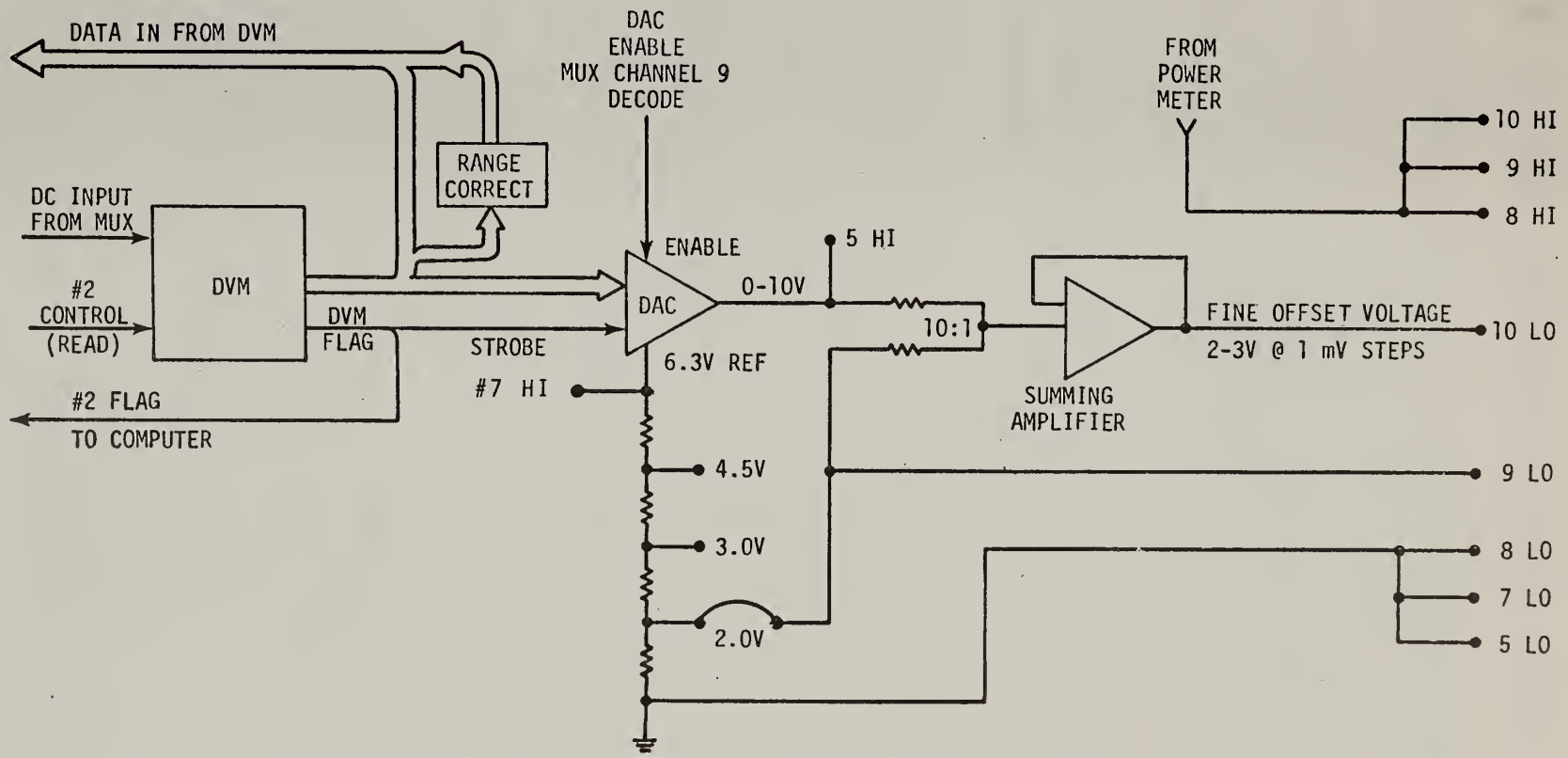


Figure 19. Data Flow-DVM.

6.4.2 Reference Voltage Circuits (Schematic, Figure 22)

The reference voltage used as an offset voltage is the combination of a fixed (coarse ref.) voltage and the programmed DAC voltage. The DAC voltage is 0 to 10 volts output but is divided by 10 before being added to the coarse reference voltage thus giving 1 millivolt resolution.

The output from the internal voltage standard of the DAC is divided in the resistive divider providing three jumper selectable voltages 4.5, 3.5, and 2.0 volts for use as the coarse reference voltage. Amplifier-follower IC-202 drives the coarse reference circuits buffering them from the voltage standard. The output of this buffer is added to the divide by 10 output of the DAC in R8 and R9 and the summing amplifier IC-203. Inverter amplifier IC-204 drives the offset voltage reference circuits.

When input channel #9 is selected, the coarse reference is connected to the DVM "LO" input, and the rf power meter to the DVM "HI" input so that the DVM reads the difference of the two voltages. This DVM reading is strobed into the DAC so that the output voltage of the offset reference circuits matches the power meter voltage within ± 1 millivolt. Normally the rf power is turned off while the offset reference voltage (DAC) is set equal to the power meter voltage. Then small voltage changes between the power meter input and the offset reference can be measured with high resolution with a good 5 or 6 digit DVM. These readings are made on input channel #10.

6.4.3 Adjustment Y 200 Voltage Offset Reference (Refer to Figures 22 and 23)

The adjustment procedure for this circuit involves programming the digital to analog converter (DAC) to zero and adjusting the dc offset to zero; grounding the input to the course reference buffer and then "zeroing" the dc offset of the buffer amplifier, summing amplifier and the inverting amplifier. Then programming the DAC to a known voltage and adjusting the DAC gain to obtain that voltage out.

The following step-by-step procedure refers to an external voltmeter; however, the procedure is arranged so that the DVM can be used.

Adjustment Procedure:

1. Disconnect rear DVM input cable J-204. Disconnect the power bridge cable J-354 on back of multiplexer.

2. Program input channel #9 using control code #102. Connect a test lead to short together the HI and LO input terminals on the front of the DVM. Place the DVM in manual control (but leave the data output button on) and turn the Rate knob fully clockwise. Adjust the DVM dc offset trimmer to obtain a zero reading on the DVM. Rotate the Rate knob fully counterwise (Ext. position) to lock the zero reading on the DVM display. Since input channel #9 was selected, the DAC is now programmed to zero reading. Execute control code #96 to disable the multiplexer and lock the DAC reading. Rotate the Rate control fully clockwise to enable the DVM.
3. Connect external voltmeter to the HI and LO input terminals of the multiplexer to read the DAC output voltage. Adjust the DAC dc offset, R16, for a zero reading on the voltmeter.
4. Remove Jumper "C" power meter select and ground the common pin. Connect the external voltmeter to TP-1 and ground. Adjust the buffer amplifier dc offset, R18, to obtain a zero reading on the voltmeter.
5. Both inputs to the summing amplifier are now zero volts. Connect the external voltmeter to TP-2 and adjust the summing amplifier dc offset, R19, to obtain a zero reading on the voltmeter.
6. Move the external voltmeter to TP-3. Adjust the inverter amplifier dc offset, R20, to obtain a zero reading on the voltmeter.
7. Set DVM to 10 volt scale and the Rate knob fully clockwise. Execute control code #102 (input channel 9) to enable the DAC. Connect the DVM LO input to ground with a test lead and the DVM HI input to + 5 volts on the power supply. Rotate the Rate control fully counterclockwise and then execute control code #96 to lock the DAC. Write down the DVM reading. Rotate the DVM Rate control fully clockwise. Connect an external voltmeter to input channel #5 HI and LO inputs to read the DAC output. Adjust the DAC gain, R17, to obtain the voltage written down from DVM in the last measurement.
8. Repeat step numbers 2 and 3 to recheck the DAC zero.
9. Move the external voltmeter to TP-3 and verify that all amplifiers have zero offset.
10. Remove test leads from DVM front panel input. Disconnect external voltmeter if one was used.
11. Replace power-meter select off-voltage jumper to "C" (if Type IV power meter is used). Reconnect J204 in rear of DVM. Reconnect J354 on rear of mux.

12. Load equipment check program and run equipment checks.

6.5 Y 300 Input Channel Multiplexer (Schematic, Figure 24)

6.5.1 Control Circuits

This printed circuit board contains a one-of-sixteen decoder-driver, IC-301. The data stored in the multiplexer latches on the Y 100 board is decoded to energize the selected reed relay coil. When the data changes, the CTL pulse is used to temporarily disable the decoder to avoid accidently shorting two multiplexer input channels together.

6.5.2 Analog Multiplexer

Each analog input channel is switched to the HI and LO inputs of the DVM through a two-pole shielded reed relay having low thermal-emf contacts. The inputs to each channel relay are pin and jack connections, so that the channel assignments could be changed should a relay fail. Input channel #11 is an auxiliary input from J-357, but could be used as a spare input if needed. The program input channel assignments would also have to be changed. (See Section 6.6)

6.5.3 Multiplexer Input Channel Assignments

The input channel assignments are given in the following table.

Input Channel	Function	Control Code
0	Hi/Lo Shorted-DVM zero	111
1	Temperature	110
2	Dew point temperature	109
3	rf amp. power supply	108
4	Sim. Noise-Add Ref. Voltage	107
5	DAC output	106
6	XTAL Detector	105
7	DAC Ref. Voltage	104
8	Power Meter	103
9	*Hi-Pwr Meter, Lo Coarse Offset	102
10	ΔV Voltage Power Measurement	101
11	auxiliary channel	100
12	open circuit	99
13	open circuit	98
14	open circuit	97
15	open circuit	96

* Enables DAC programming.

6.6 Troubleshooting

Manually program each input channel with the DVM in manual mode through the various control codes given in the previous table noting if the voltmeter reads the correct voltage. Check that the input cables are connected to the correct jacks on both ends. Check that the DVM rear panel input J204 is properly connected.

If a multiplexer relay fails to operate properly, the input channels can be changed. The analog multiplexer input leads are plugged into pin-jacks at each channel relay. These leads are long enough that they can be plugged into the auxillary input channel (#11, or #Ø if necessary) if a particular channel relay fails.

To substitute a multiplexer channel, move the two input leads to the new channel pin-jacks and add these two program lines to the measurement program after the program is loaded.

The program modifications are in the FNX(Q) function (line numbers refer to the X.03 subroutines).

```
Add:  75  If Q# (old channel control code) then 80
      76  Q = (new channel control code).
```

Then the system should operate normally. NOTE: If the program is saved with the changes installed, the Program Revision Label (line number 50) should be updated.

6.7 PARTS LIST - MUX/DVM CONTROLLER

L.D.D. 1 DEC 77 PARTS LIST- CONTRL/MULTPLX/REF UNIT (Y) DATA 6

CATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-D1	12	LED INDICATOR LIGHTS	5 VOLT	DIAL	550-0506
2	Y-D2		SAME AS D1			
3	Y-D3		SAME AS D1			
4	Y-D4		SAME AS D1			
5	Y-D5		SAME AS D1			
6	Y-D6		SAME AS D1			
7	Y-D7		SAME AS D1			
8	Y-D8		SAME AS D1			
9	Y-D9		SAME AS D1			
10	Y-D10		SAME AS D1			
11	Y-D11		SAME AS D1			
12	Y-D12		SAME AS D1			

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-P1	2	PLUG (FOR IC SOCKET)	14 PIN	3M	3406
2	Y-P2		NOT USED			
3	Y-P3		SAME AS P1	14 PIN		
4	Y-P4	23	PLUG WIRE WRAP	1 PIN	SAMT	TS-120-G-A
5	Y-P5		SAME AS P4	1 PIN		
6	Y-P6		SAME AS P4	1 PIN		
7	Y-P7		SAME AS P4	1 PIN		
8	Y-P8		SAME AS P4	1 PIN		
9	Y-P9		SAME AS P4	1 PIN		
10	Y-P10		SAME AS P4	1 PIN		
11	Y-P11		SAME AS P4	1 PIN		
12	Y-P12		SAME AS P4	1 PIN		
13	Y-P13		SAME AS P4	1 PIN		
14	Y-P14		SAME AS P4	1 PIN		
15	Y-P15		SAME AS P4	1 PIN		
16	Y-P16		SAME AS P4	1 PIN		
17	Y-P17		SAME AS P4	1 PIN		
18	Y-P18		SAME AS P4	1 PIN		
19	Y-P19		SAME AS P4	1 PIN		
20	Y-P20		SAME AS P4	1 PIN		
21	Y-P21		SAME AS P4	1 PIN		

22	Y-P22		SAME AS P4	1 PIN		
23	Y-P23		SAME AS P4	1 PIN		
24	Y-P24		SAME AS P4	1 PIN		
25	Y-P25		SAME AS P4	1 PIN		
26	Y-P26		SAME AS P4	1 PIN		
27	J1-J99		NOT USED			
28	Y-J100	1	CONN PC EDGE (Y100)	60 PIN	AMPH	261-10030-2
29	Y-J200	1	CONN PC EDGE (Y200)	60 PIN	AMPH	261-10030-2
30	Y-J300		NOT USED (J300-J350)			
31	Y-J351	2	CONN BLUE RIBBON I/O	50 PIN	AMPH	57-40500
32	Y-J352		SAME AS J351	50 PIN		
33	Y-J353	1	CONN BLUE RIBBON I/O	14 PIN	AMPH	57-40140
34	Y-J354	4	CONN PANEL RECEPTICLE	5 PIN	VIKG	VR5/4AB13
35	Y-J355		SAME AS J354	5 PIN		
36	Y-J356		SAME AS J354	5 PIN		
37	Y-J357		SAME AS J354	5 PIN		

CATEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-T1	15	TERMINAL TEFLON INSUL.		CAMB	45043520103
2	Y-T2		SAME AS T1			
3	Y-T3		SAME AS T1			
4	Y-T4		SAME AS T1			
5	Y-T5		SAME AS T1			
6	Y-T6		SAME AS T1			
7	Y-T7		SAME AS T1			
8	Y-T8		SAME AS T1			
9	Y-T9		SAME AS T1			
10	Y-T10		SAME AS T1			
11	Y-T11		SAME AS T1			
12	Y-T12		SAME AS T1			
13	Y-T13		SAME AS T1			
14	Y-T14		SAME AS T1			
15	Y-T15		SAME AS T1			
16	Y-T16	3	TERM STRIP WIRE WRAP	25 PIN	SAMT	SS-120-G-2
17	Y-T17		SAME AS T16	25 PIN		
18	Y-T18		SAME AS T16	25 PIN		

CATEGORY NO. 8----------SWITCHES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-S1	1	SWITCH AC POWER	DPDT	ALCO	MSTL-206N

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-H1	1	PLATE MOUNTING	.125 ALUM	NBS	16W X 13D
2	Y-H2	1	PANEL INDICATOR	.125 ALUM	NBS	7.5W X .25H
3	Y-H3	1	PLATE BACK UP (H2)	.125 BAKL	NBS	7.5W X .25H
4	Y-H4	1	PANEL REAR(CONNECTORS)	.125 ALUM	NBS	15W X .25H
5	Y-H5	1	COVER FORMED METAL	1/16 ALUM	NBS	16W X13D X1.6
6	Y-H6	1	STRIP REINFORCING (H5)	.125 ALUM	NBS	16L X .5W
7	Y-H7	1	STRIP REINFORCING (H5)	.125 ALUM	NBS	10L X .5W
8	Y-H8	4	STAND-OFF (Y300 CARD)	ALUM	NBS	.5L CYLINDERS
9	Y-H9		SAME AS H8	ALUM		
10	Y-H10		SAME AS H8	ALUM		
11	Y-H11		SAME AS H8	ALUM		

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-M1	1	POWER SUPPLY MODULAR	5 VOLT	SEMI	ES51000-K2
2	Y-M2	1	POWER SUPPLY MODULAR	+-15 VOLT	BB	527
3	Y-Y1	1	CONTRL/MULTPLX PC CARD		NBS	Y100
4	Y-Y2	1	BRIDGE REF PC CARD		NBS	Y200
5	Y-Y3	1	ANALG MULTPLX PC CARD		NBS	Y300

CATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y-A1	1	SOCKET (FOR M1)		SEMI	K2
2	Y-A2	1	FUSE/FILTER/AC SOCKET		CROM	6J4
3	Y-A3	1	CABLE RIBBON (P1-P3)	16	ALPH	3580/14
4	Y-A4	2	CABLE COAXIAL MIN.	24	BELD	RG174/U
5	Y-A5		SAME AS A4	24		

ATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y1-R1	1	RES FXD CARB 5% 1/4W	1K OHM	AB	CB
2	Y1-R2	1	RES FXD CARB 5% 1/4W	33K OHM	AB	CB
3	Y1-R3	2	RES FXD CARB 5% 1/4W	13K OHM	AB	CB
4	Y1-R4		SAME AS R3	13K OHM		
5	Y1-R5	1	RES FXD CARB 5% 1/4W	10K OHM	AB	CB

ATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y1-C1	3	CAP HI-K MONO 50V	1.0 UF	SPRG	5C023105X025053
2	Y1-C2		SAME AS C1	1.0 UF		
3	Y1-C3		SAME AS C1	1.0 UF		
4	Y1-C4	1	CAP TANT 10V	120 UF		
5	Y1-C5	3	CAP CERAMIC	.1 UF		
6	Y1-C6		SAME AS C5	.1 UF		
7	Y1-C7		SAME AS C5	.1 UF		
8	Y1-C8	3	CAP TANT 25V	10 UF		
9	Y1-C9	1	CAP TANT 35V	1.0 UF		
10	Y1-C10		SAME AS C8	10 UF		
11	Y1-C11		SAME AS C8	10 UF		

ATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y1-IC1	1	IC BCD TO DEC DECODER	7442N	TI	SN7442N
2	Y1-IC2	1	INT. CRKT. QUAD NOR	74LS02N	TI	SN74LS02N
3	Y1-IC3	1	IC TRIPLE INPUT NOR	74LS27N	TI	SN74LS27N
4	Y1-IC4	3	IC QUAD FF (D) OC	74LS175N	TI	SN74LS175N
5	Y1-IC5		SAME AS IC4	74LS175N		
6	Y1-IC6		SAME AS IC4	74LS175N		
7	Y1-IC7	3	INT. CRKT. ONE SHOT	74121N	TI	SN74121N
8	Y1-IC8		SAME AS IC7	74121N		

9	Y1-IC9		SAME AS IC7	74121N		
10	Y1-IC10	2	IC HEX INVERTER OC	7406N	TI	SN7406N
11	Y1-IC11		SAME AS IC10	7406N		
12	Y1-IC12		NOT USED			
13	Y1-IC13		NOT USED			
14	Y1-IC14	1	IC HEX INVERTER	74LS04N	TI	SN74LS04N
15	Y1-IC15		NOT USED			
16	Y1-IC16		NOT USED			
17	Y1-IC17		NOT USED			
18	Y1-IC18		NOT USED			
19	Y1-IC19		NOT USED			
20	Y1-IC20	1	IC BINARY FULL ADDER	74LS283N	TI	SN74LS283N

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y1-J2	1	JACK IC DUAL IN-LINE	14 PIN	SAMT	IC-314-SGG

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y1-B1	1	PC BRD-DVM CON/MUX CKT		NBS	PC-100

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y1	1	DVM CONT/MUX PC CARD		NBS	Y100

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y2-R1	1	RES FXD MF 1% 1/4W	20.0K OHM	CORG	NC5
2	Y2-R2	1	RES FXD MF 1% 1/4W	15.0K OHM	CORG	NC5
3	Y2-R3	2	RES FXD MF 1% 1/4W	10.0K OHM	CORG	NC5
4	Y2-R4a	1	RES FXD MF 1% 1/4W	27.4K OHM	CORG	NC5
5	Y2-R4b	1	RES FXD MF 1% 1/4W	SELECTED	CORG	NC5
6	Y2-R5	1	RES FXD MF 1% 1/4W	11.3K OHM	CORG	NC5
7	Y2-R6	1	RES FXD MF 1% 1/4W	14.3K OHM	CORG	NC5
8	Y2-R7	1	RES FXD MF 1% 1/4W	19.6K OHM	CORG	NC5
9	Y2-R8	2	RES FXD WW .025% 1/4W	2.00K OHM	ULTX	205A
10	Y2-R9	3	RES FXD WW .025% 1/4W	20.0K OHM	ULTX	205A
11	Y2-R10	1	RES FXD MF 1% 1/4W	1.00K OHM	CORG	NC5
12	Y2-R11		SAME AS R8	2.00K OHM		
13	Y2-R12		SAME AS R9	20.0K OHM		
14	Y2-R13		SAME AS R9	20.0K OHM		
15	Y2-R14		SAME AS R3	10.0K OHM		
16	Y2-R15	1	RES FXD CARB 5% 1/4W	12K OHM	AB	CB
17	Y2-R16	4	RES VAR TRIM CERMET	20K OHM	BRNS	3006W-1-203
18	Y2-R17	1	RES VAR TRIM CERMET	500 OHM	BRNS	3006W-1-501
19	Y2-R18		SAME AS R16	20K OHM		
20	Y2-R19		SAME AS R16	20K OHM		
21	Y2-R20		SAME AS R16	20K OHM		

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y2-C1	2	CAP HI-K MONC 50V	1.0 UF	SPRG	5C023105X025053
2	Y2-C2	6	CAP ELECYLYC 25V	4.7 UF		
3	Y2-C3		SAME AS C2	4.7 UF		
4	Y2-C4		SAME AS C1	1.0 UF		
5	Y2-C5		SAME AS C2	4.7 UF		
6	Y2-C6		SAME AS C2	4.7 UF		
7	Y2-C7	1	CAP CERAMIC DISK	.001 UF		
8	Y2-C8		SAME AS C2	4.7 UF		
9	Y2-C9		SAME AS C2	4.7 UF		

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y2-IC1	1	CONVTR D-A 3 DIG BCD	DAC40	BB	DAC40-12B-BCD
2	Y2-IC2	3	INT. CRKT. OP AMP	OP-05C	MONO	OP-05C
3	Y2-IC3		SAME AS IC2	OP-05C		
4	Y2-IC4		SAME AS IC2	OP-05C		
5	Y2-IC5	1	INT. CRKT. ONE SHOT	74121N	TI	SN74121N
6	Y2-IC6	1	IC QUAD NAND (OC)	74LS00N	TI	SN74LS00N
7	Y2-IC7	1	IC BCD TO DEC DECODER	7442N	TI	SN7442N

CATEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y2-K1	4	SOCKET IC SINGLE STRIP	20 PIN	SAMT	SS-120-G-2
2	Y2-K2		SAME AS K1	20 PIN		
3	Y2-K3		SAME AS K1 (-4 PINS)	16 PIN		
4	Y2-K4		SAME AS K1 (-4 PINS)	16 PIN		
5	Y2-J1	8	JACK WIRE WRAP SOCKET	1 PIN		
6	Y2-J2		SAME AS J1	1 PIN		
7	Y2-J3		SAME AS J1	1 PIN		
8	Y2-J4		SAME AS J1	1 PIN		
9	Y2-J5		SAME AS J1	1 PIN		
10	Y2-J6		SAME AS J1	1 PIN		
11	Y2-J7		SAME AS J1	1 PIN		
12	Y2-J8		SAME AS J1	1 PIN		

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y2-B1	1	PC BRD-BRIDGE REF. CKT		NBS	PC-200

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y2	1	BRIDGE REF. PC CARD		NBS	Y200

ATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3-D1	12	DIODE SILICON	1N4153	MOT	1N4153
2	Y3-D2		SAME AS D1	1N4153		
3	Y3-D3		SAME AS D1	1N4153		
4	Y3-D4		SAME AS D1	1N4153		
5	Y3-D5		SAME AS D1	1N4153		
6	Y3-D6		SAME AS D1	1N4153		
7	Y3-D7		SAME AS D1	1N4153		
8	Y3-D8		SAME AS D1	1N4153		
9	Y3-D9		SAME AS D1	1N4153		
10	Y3-D10		SAME AS D1	1N4153		
11	Y3-D11		SAME AS D1	1N4153		
12	Y3-D12		SAME AS D1	1N4153		

ATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3-IC1	1	IC DECODE/DEMULTPLX OC	SN74159N	TI	SN74159N

ATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3-J1	1	JACK IC DUAL IN-LINE	14 PIN	SAMT	IC-314-SGG

CATEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3-J2	39	JACK WIRE WRAP SOCKET	1 PIN		
2	Y3-J3		SAME AS J2	1 PIN		
3	Y3-J4		SAME AS J2	1 PIN		
4	Y3-J5		SAME AS J2	1 PIN		
5	Y3-J6		SAME AS J2	1 PIN		
6	Y3-J7		SAME AS J2	1 PIN		
7	Y3-J8		SAME AS J2	1 PIN		
8	Y3-J9		SAME AS J2	1 PIN		
9	Y3-J10		SAME AS J2	1 PIN		
10	Y3-J11		SAME AS J2	1 PIN		
11	Y3-J12		SAME AS J2	1 PIN		
12	Y3-J13		SAME AS J2	1 PIN		
13	Y3-J14		SAME AS J2	1 PIN		
14	Y3-J15		SAME AS J2	1 PIN		
15	Y3-J16		SAME AS J2	1 PIN		
16	Y3-J17		SAME AS J2	1 PIN		
17	Y3-J18		SAME AS J2	1 PIN		
18	Y3-J19		SAME AS J2	1 PIN		
19	Y3-J20		SAME AS J2	1 PIN		
20	Y3-J21		SAME AS J2	1 PIN		
21	Y3-J22		SAME AS J2	1 PIN		
22	Y3-J23		SAME AS J2	1 PIN		
23	Y3-J24		SAME AS J2	1 PIN		
24	Y3-J25		SAME AS J2	1 PIN		
25	Y3-J26		SAME AS J2	1 PIN		
26	Y3-J27		SAME AS J2	1 PIN		
27	Y3-J28		SAME AS J2	1 PIN		
28	Y3-J29		SAME AS J2	1 PIN		
29	Y3-J30		SAME AS J2	1 PIN		
30	Y3-J31		SAME AS J2	1 PIN		
31	Y3-J32		SAME AS J2	1 PIN		
32	Y3-J33		SAME AS J2	1 PIN		
33	Y3-J34		SAME AS J2	1 PIN		
34	Y3-J35		SAME AS J2	1 PIN		
35	Y3-J36		SAME AS J2	1 PIN		
36	Y3-J37		SAME AS J2	1 PIN		
37	Y3-J38		SAME AS J2	1 PIN		
38	Y3-J39		SAME AS J2	1 PIN		
39	Y3-J40		SAME AS J2	1 PIN		

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3-B1	1	PC BRD ANALG MLTPX CKT		NBS	PC-300

ATEGORY NO. 11----------RELAYS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3-K1	12	RELAY ELECTRICAL DPST	5 VOLT	COTO	CR-3202-5-701
2	Y3-K2		SAME AS K1			
3	Y3-K3		SAME AS K1			
4	Y3-K4		SAME AS K1			
5	Y3-K5		SAME AS K1			
6	Y3-K6		SAME AS K1			
7	Y3-K7		SAME AS K1			
8	Y3-K8		SAME AS K1			
9	Y3-K9		SAME AS K1			
10	Y3-K10		SAME AS K1			
11	Y3-K11		SAME AS K1			
12	Y3-K12		SAME AS K1			

ATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	Y3	1	ANALOG MULTIPLXER CARD		NBS	Y300

6.8 WIRING LIST

MUX/DVM FRONT PANEL

FUNCTION	CONNECTED TO
+5V	5V PWR SUPPLY
MUX D "8" LED	Z100-5
MUX C "4" LED	Z100-7
MUX B "2" LED	Z100-9
MUX A "1" LED	Z100-11
+5V	5V PWR SUPPLY
DVM FUNCTION D "8" LED	Z100-15
DVM FUNCTION C "4" LED	Z100-13
DVM FUNCTION B "2" LED	Z100-17
DVM FUNCTION A "1" LED	Z100-19
+5V	5V PWR SUPPLY
DVM RANGE D "8" LED	Z100-21
DVM RANGE C "4" LED	Z100-27
DVM RANGE B "2" LED	Z100-25
DVM RANGE A "1" LED	Z100-23

WIRING LIST
J-100

	1	2	
	3	4	
INPUT CHANNEL LED D	5	6	Y200 -29
INPUT CHANNEL LED C	7	8	Y200 -31
INPUT CHANNEL LED B	9	10	Y200 -33
INPUT CHANNEL LED A	11	12	Y200 -35
FUNCTION LED C	13	14	J351 -48
FUNCTION LED D	15	16	
FUNCTION LED B	17	18	J351 -50
FUNCTION LED A	19	20	J351 -49
RANGE LED D	21	22	J351 -45
RANGE LED A	23	24	J351 -42
RANGE LED B	25	26	J351 -43
RANGE LED C	27	28	J351 -44
	29	30	
J353 -4	31	32	
J353 -3	33	34	
J353 -1	35	36	J352 -44
J353 -2	37	38	J352 -28
J353 -12	39	40	J351 -45
J353 -5	41	42	J352 -27
J353 -6	43	44	J351 -24
J353 -8	45	46	
J353 -13	47	48	
J351 -23	49	50	
J352 -25	53	54	
J351 -22	55	56	
+5V	57	58	+5V
GND	59	60	GND

WIRING LIST

J-200

GND	1	2	GND
J351 -9	3	4	
J351 -10	5	6	
J351 -11	7	8	
J351 -12	9	10	
J351 -13	11	12	
J351 -14	13	14	
J351 -15	15	16	
J351 -16	17	18	
J351 -17	19	20	
J351 -18	21	22	
J351 -19	23	24	
J351 -20	25	26	
J352 -48	27	28	
Y100 -6	29	30	
Y100 -8	31	32	
Y100 -10	33	34	
Y100 -12	35	36	
Y300 -7HI	37	38	
Y300 -5HI	39	40	
	41	42	
Y300 9LO	43	44	
	45	46	
Y300 -10LO	47	48	
	49	50	
ANALOG GND	51	52	ANALOG GND
-15V	53	54	-15V
+15V	55	56	+15V
+5V	57	58	+5V
ANALCG GND	59	60	ANALOG GND

WIRING LIST

PIN NO.		Y-300	SIGNAL
0	HI	Y300 -0 GRD Y300 -0 LO	DVM ZERO
0	LO	Y300 -0 HI	
1	HI	J356 -B	TEMP
1	LO	J356 -C	
2	HI	J356 -D	DEW POINT
2	LO	J356 -E	
3	HI	J355 -B	+20V
3	LO	J355 -A	
4	HI	J355 -C	+12V
4	LO	Y300 -3 LO	
5	HI	Y200 -39	DAC
5	LO	Y200 -51/52	
6	HI	J355 -E	XTAL DET.
6	LO	J355 -D	
7	HI	Y200 -39	DAC REF
7	LO	Y200 -51/52	
8	HI	J354 -E	PWR METER
8	LO	Y200 -51/52	ANLG GND
9	HI	Y300 -8 HI	SET DAC
9	LO	Y200 -43	
10	HI	Y300 -9 HI	V PWR
10	LO	Y200 -47	
11	HI	J357 -B	AUXILLARY
11	LO	J357 -C	

HIGH	DVM J204-7	DVM HI
LOW	DVM J204-3	DVM LO
GAURD	DVM J204-2	DVM GAURD

J1-1	Y100 -J2/1	MUX RESET
J1-7	Y100 -J2/7	GND
J1-8	Y100 -J2/8	DATA A
J1-9	Y100 -J2/9	DATA B
J1-10	Y100 -J2/10	DATA C
J1-11	Y100 -J2/11	DATA D
J1-14	Y100 -J2/14	+5V

WIRING LIST

J-351

1	J352-6	26	J352-29
2	J352-12	27	J352-30
3	J352-18	28	J352-31
4	J352-24	29	J352-50
5	J352-5	30	J352-43
6	J352-11	31	
7	J352-17	32	
8	J352-23	33	
9	J352-4	34	J352-48
10	J352-10	35	GND
11	J352-16	36	
12	J352-22	37	
13	J352-3	38	GND
14	J352-9	39	
15	J352-15	40	
16	J352-21	41	
17	J352-2	42	Y100-24
18	J352-8	43	Y100-26
19	J352-14	44	Y100-28
20	J352-20	45	Y100-22
21	J352-1	46	J352-47
22	Y100-55	47	Y100-16
23	Y100-49	48	Y100-14
24	Y100-44	49	Y100-20
25	Y100-40	50	Y100-18

WIRING LIST

J-352

1	J351-21	26	Y100-51
2	J351-17	27	Y100-42
3	J351-13	28	Y100-38
4	J351-9	29	J351-26
5	J351-5	30	J351-27
6	J351-1	31	J351-28
7	GND	32	
8	J351-13	33	
9	J351-14	34	
10	J351-10	35	Y100-3
11	J351-6	36	Y100-3
12	J351-2	37	Y100-3
13	GND	38	Y100-3
14	J351-19	39	GND
15	J351-15	40	
16	J351-11	41	
17	J351-7	42	
18	J351-3	43	J351-30
19	GND	44	GND
20	J351-20	45	
21	J351-16	46	
22	J351-12	47	J351-46
23	J351-8	48	J351-34
24	J351-4	49	GND
25	Y100-53	50	J351-29

WIRING LIST

J353

1	Y100-35
2	Y100-37
3	Y100-33
4	Y100-31
5	Y100-41
6	Y100-43
7	GND
8	
9	
10	
11	
12	Y100-39
13	Y100-47
14	

J354

A	
B	
C	
D	Y200-51/52
E	Y300-8HI

J355

A	Y300-3LO
B	Y300-3HI
C	Y300-4HI
D	Y300-6LO(SHIELD)
E	Y300-6HI

J356

A	GND
B	Y300-1HI
C	Y300-1LO
D	Y300-2HI
E	Y300-2LO

J357

A	GND
B	Y300-11HI
C	Y300-11LO
D	
E	

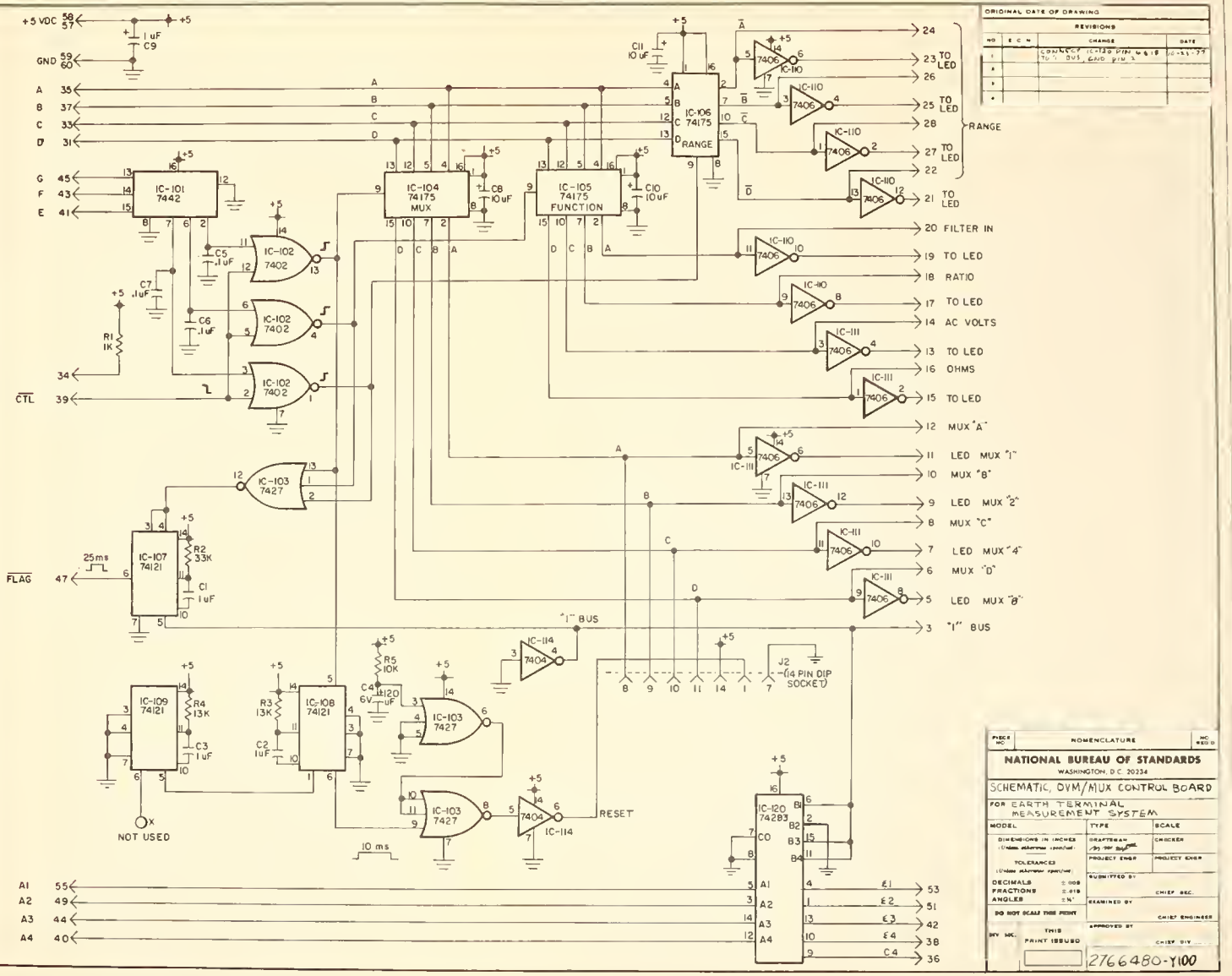
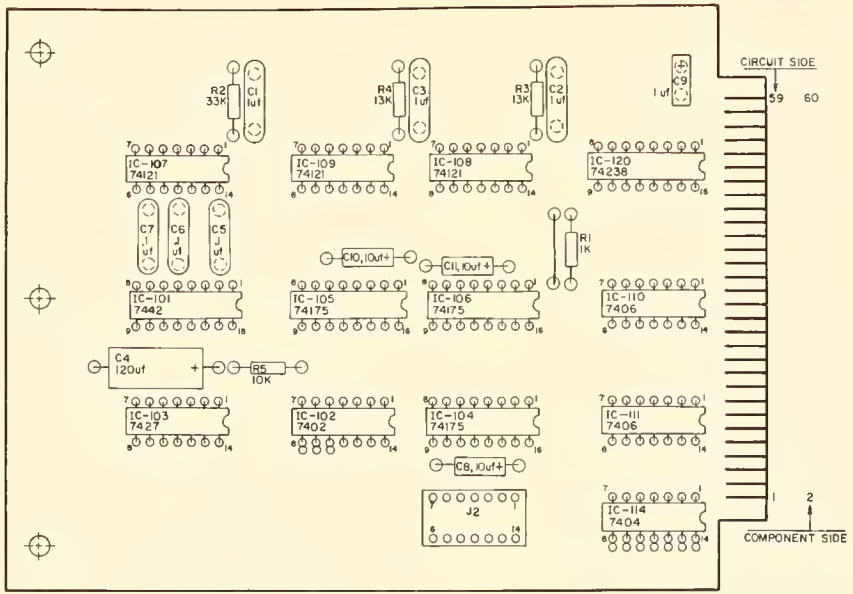


Figure 20. Y100 Schematic Circuits.



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TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
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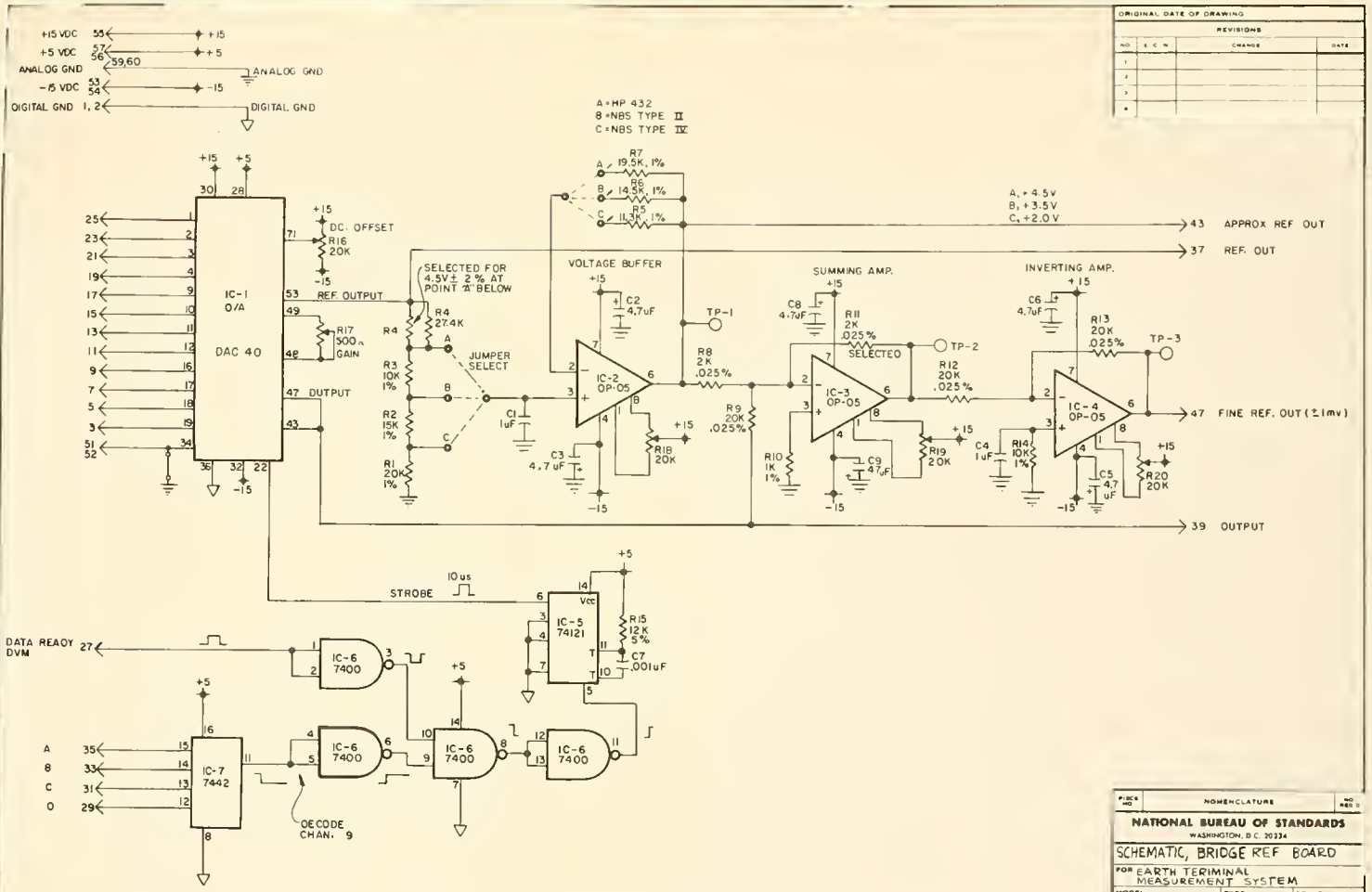
2766480-Y100

Figure 21. Y100 PC Assembly Drawings.



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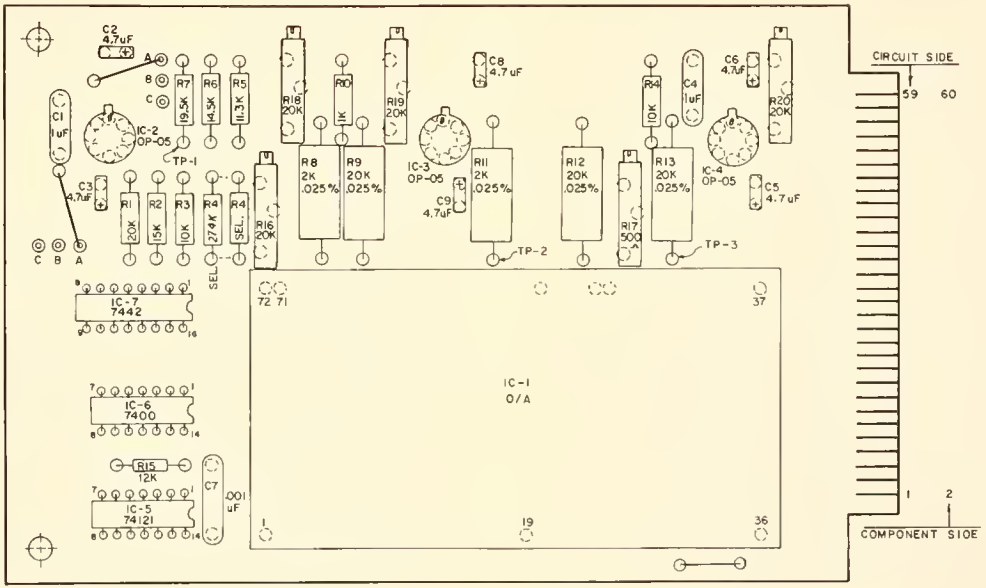
	2766480-Y200	

Figure 22. Y200 Schematic Circuits.



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MODEL	TYPE	SCALE
II		

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Figure 23. Y200 PC Assembly Drawing.

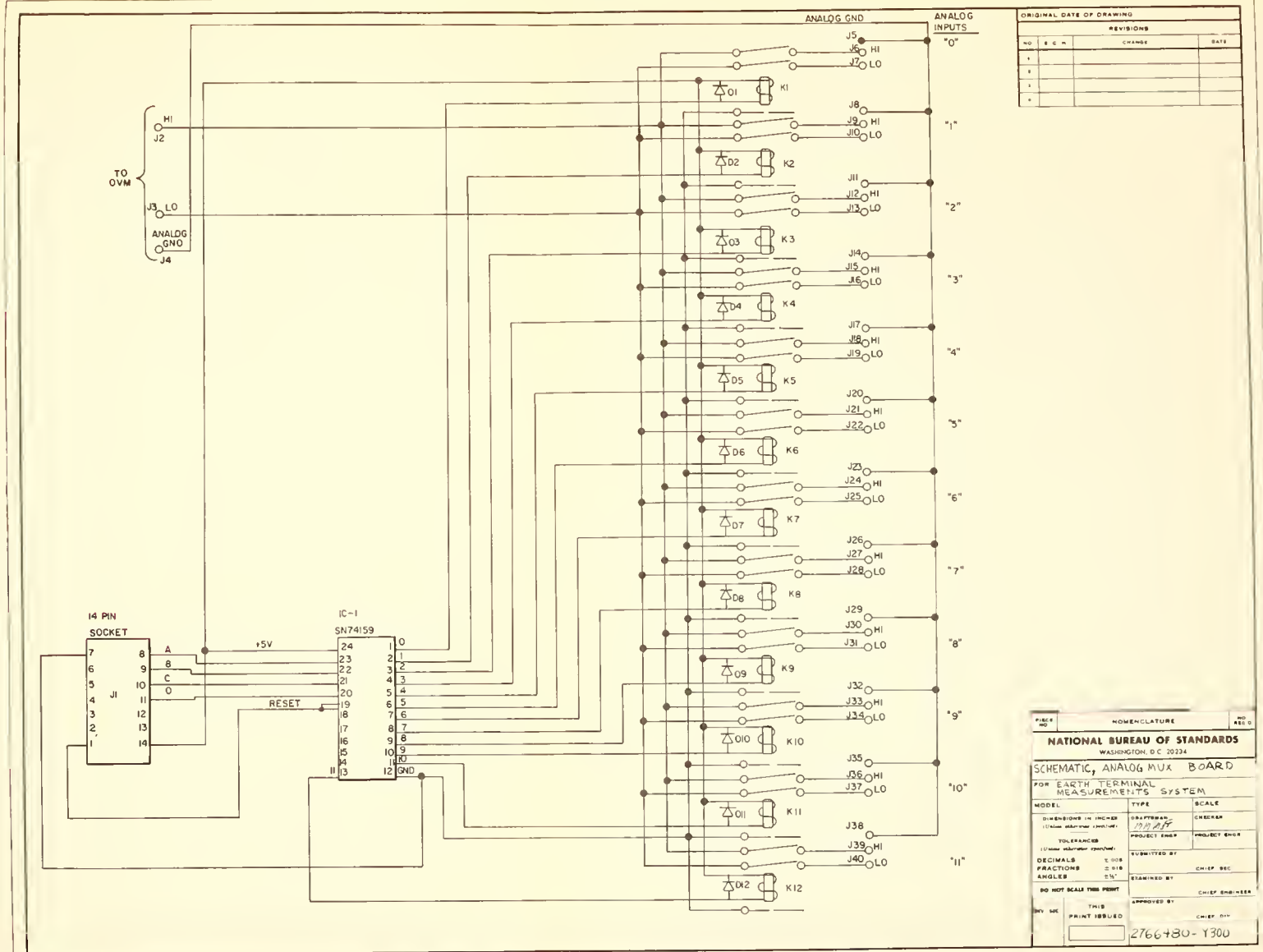


Figure 24. Y300 Schematic Circuits.

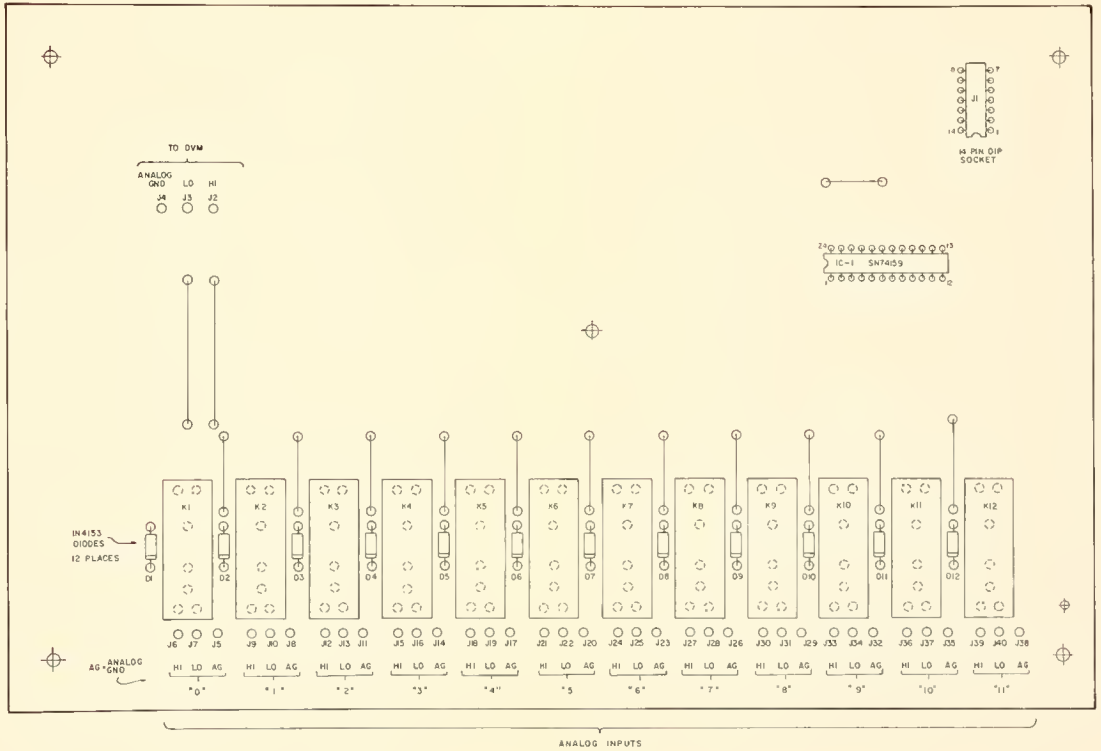


Figure 25. Y300 PC Assembly Drawing.

7. POWER DETECTOR INSTRUMENT MANUAL

7.1 Description: (Figure 26)

The rf detector is a commercial thermister type rf detector mount surrounded by insulation foam. This mount has a dc isolation block on the input and a stainless steel coaxial feed line for thermal isolation. The NBS Type IV power meter is connected to the rf detector in a four wire measurement configuration to eliminate lead resistance errors. The power meter self-balances the thermister detector to 200 Ω. The dc output from the Type IV power meter is connected to the digital voltmeter via input channel #8.

The normal measuring sequence is: (1) Switch rf off in ETMS control/rf unit; (2) Measure and record zero rf power meter voltage on DVM channel #8; (3) Switch DVM input to channel #9 to enable DAC. Read difference between power meter and coarse reference voltage and automatically set DAC to difference voltage; (4) Switch to DVM channel #10 and read and record offset voltage residual; (5) Switch on rf power and read and record voltage change ΔV on DVM channel #10; (6) Switch rf off and recheck offset voltage residual for any reference voltage drift or power meter "zero" drift; and (7) Calculate rf power as described elsewhere.

7.2 Specifications

RF thermister mount: Specification frequency from 1 MHz to 1000 MHz at 0 to 10 milliwatts power. (See manufacturer's instruction manual for details.)
Power meter: The NBS Type IV power meter is a self-balancing dc measurement of rf power by dc substitution. The accuracy of the power measurement is determined by the accuracy and resolution of the auxiliary voltmeter used to measure the bridge voltage.

7.3 RF Power Detector Mount

Refer to the manufacturer's instruction manual included with the system for information on this unit.

7.4 NBS Type IV Power Meter

Refer to the NBS Type IV power meter instrument manual included with the system.

Figure 26. Power Detector Unit.

7.5 PARTS LIST - POWER DETECTOR

.D.D. 9 FEB 78 PARTS LIST- POWER DETECTOR UNIT (U) DATA 18

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	U-J1	2	JACK TYPE N TO .141	COAX	OSM	OSN 402-1
2	U-J2		SAME AS J1	COAX		
3	U-J3	1	CONNECTOR THERM. MOUNT	6 PIN	HP	1251-0152

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	U-H1	1	INSTRUMENT CASE		BUD	BB-1801-RB
2	U-H2	1	FACE PANEL FOR H1	.09375 AL	NBS	
3	U-H3	1	REAR PANEL FOR H1	.09375 AL	NBS	

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	U-M1	1	NBS TYPE IV POWR METER		NBS	TYPE IV
2	U-T1	1	THERMISTOR MOUNT		HP	478A-H55
3	U-N1	1	NOISE SUPPRESS/DC BLK		WEIN	936N

CATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	U-K1	1	COAX MIN SEMI-RIGID SS	4	UT	UT/.141SS

Figure 26. Power Detector Unit.

7.6 WIRING LIST

P-101 REMOTE

1	
2	
3	
4	
5	
6	PWR METER OUT (-) J354-E
7	
8	PWR METER OUT (4) J354-D

P-102 BOLOM.

1	J478A-H55-4 (E-)
2	
3	J478A-H55-4 (I-)
4	
5	J478A-H55-1 (I+)
6	
7	J478A-H55-1 (E+)
8	

8. CLOCK AND TEMPERATURE/DEW POINT INSTRUCTION MANUAL (FIGURE 27)

8.1 Introduction

This unit contains a commercial digital clock having a crystal-oscillator time base, four thumb-wheel switches which are used to enter date (month/day) information into the calculator, and temperature and dew point meters which are connected by long cables with remote probes to monitor outside conditions. These probes are enclosed in an environmental enclosure to shield them from the direct effects of the sun and breezes. The enclosure case can be extended in normal operation, but should be left closed if windy conditions exist.

The dc outputs of the temperature and dew point meters are connected to the DVM via input channels 1 and 2, respectively.

8.2 Specifications

Time: The clock is a commercially manufactured model with a crystal time base. It has a power-outage clock-failure signal that is used to initiate a program warning message. (See manufacturer's instruction manual.)
Date: The manual thumb-wheel switches on the front panel are used to input month and date information to calculator.
Temperature monitor: The temperature monitor is a thermister sensor type meter with a range of 0 to 100°F. Extended ranging is available on the DVM reading only.
Dew point monitor: The dew point monitor is a heated lithuim-cloride element containing a thermister sensor type meter with a range of 12° to 96°F. (See manufacturer's instruction manual.)

Thirty-meter (100-ft.) extension cables are supplied to remotely locate the temperature and dew point sensors to monitor outside conditions.

8.3 Digital Clock

The commercial digital clock provides parallel BCD data to the calculator on I/O select code #3. These data are combined with the BCD data for month and day from the thumb-wheel switches. When the calculator requests time from the clock, the clock is "locked" to prevent updating while the data are transferred. If a one-second "tick" occurs during this time, it is stored in the clock input circuit until data transfer is completed. Then the time is updated.

Refer to the manufacturer's instruction manual for information on this unit.

Figure 27. Clock and Temperature/Dew-Point Unit.

8.4 X3 Clock Inhibit/Flag Card (Schematic, Figure 28)

This printed circuit card preforms the control interfacing between the clock and calculator. It also has pull-up resistors used in the thumb-wheel switch data lines.

When the CTL pulse from the calculator requests clock data, it triggers the one-shot, IC-1. This one-shot pulse inhibits clock updating on pin 33 of J3 and returns a ready-flag to the calculator on pin 34 of J3.

The calculator can take as long as 55 milliseconds to read in the data; therefore, this hold pulse is approximately 70 ms in duration.

The maximum repetitive rate that time can be read into the calculator is 10 to 12 times per second.

8.4.1 Troubleshooting

Check that the interface cable is properly connected. Verify that a control pulse CTL is arriving at the one-shot and that the return flag pulse and the inhibit pulse are being generated. Use the Enter (3,*)Q1,Q command to interrogate the clock date/time.

8.5 X1 Temperature and Dew-Point Sensors (Schematic, Figure 30)

This printed circuit card is the temperature bridge and amplifier and the dew-point bridge and amplifier circuits.

The two circuits are identical with the exception of the resistance values in the bridge and the composite resistors R1 and R31.

The remote thermister probes form one leg of the bridge. The thermister elements of the temperature and dew-point probes are identical; however, the dew-point probe is surrounded by a spool of wicking soaked in lithium chloride (LiCl) solution. The LiCl absorbs moisture from the atmosphere, decreasing its electrical resistance. An ac current passing through the LiCl heats it up, drying the spool until equilibrium is reached. The thermister element measures the elevated temperature of the probe. Dew-point temperature is indicated as a function of this temperature.

The temperature probe has a metal guard frame around it but senses the atmospheric temperature. The output of the bridge circuit is connected to a

differential input instrument amplifier circuit having a gain of 10 formed by three of the amplifiers in IC-1 (or IC-2 in the dew-point circuit). The output buffer amplifier offsets the signal to establish the "zero degree" point on the temperature scale.

The output of the amplifiers are connected to the DVM and also to front panel digital meters. The front panel meter scales can be changed to read above 99° by switching DIP switches S1 and S2 (or S3 and S4) off. The front panel meters do not read below zero degrees nor above 99.9; however, the DVM temperature data are correct outside this range.

8.5.1 Alignment of Temperature Sensor (Refer to Figures 30 and 31)

Procedure:

(1) Disconnect the temperature probe and place X1 card on pc extension.
Note: The adjustment of R40 is not critical and is set to approximately midrange.

(2) Short TP-6 and TP-7 together and connect TP-6 to ground (TP-5). Monitor TP- with a voltmeter and adjust R52, for a zero reading on the voltmeter. Keeping the shorting jumper between TP-6 and TP-7, remove the ground TP-6 connection. Adjust common mode rejection, R48, for a zero reading on the voltmeter. Remove shorting jumper between TP-6 and TP-7.

(3) Connect a high Z dc voltmeter to test points TP-6 and TP-7.

(4) Connect an 8085-Ω resistor between pins 2 and 3 of the rear panel temperature jack. Adjust bridge balance, R33, for a zero reading on the voltmeter.

(5) Change the input resistor on pins 2 and 3 to 39,965 Ω and adjust range, R36 to obtain 108 millivolts reading on the voltmeter.

(6) Move the voltmeter to TP-8 and ground and adjust the gain trimmer R41 for a voltmeter reading of 1.08 volts.

(7) Change the input resistor to 12,248 Ω. Connect the voltmeter to TP-9 and adjust the offset, R52, to obtain a voltmeter reading of +770 millivolts.

The output voltage will be in degrees fahrenheit and will be scaled to 10 millivolts per degree.

8.5.2 Alignment of Dew-Point Sensor

Procedure:

(1) Disconnect the dew-point probe and place X-1 cord on the pc extension.
Note: The adjustment of R10 is not critical and is set to approximately midrange.

(2) Short TP-1 and TP-2 together and connect TP-1 to ground (TP-5). Monitor test point 4 with a voltmeter and adjust R22 for a zero reading on the voltmeter. Keeping the shorting jumper between TP-1 and TP-2, remove the ground from TP-1. Adjust the common mode rejection potentiometer, R18, for a zero reading on the voltmeter. Remove shorting jumper between TP-1 and TP-2.

(3) Connect a high Z dc voltmeter between TP-1 and TP-2.

(4) Connect a 1715-Ω resistor between pins 2 and 3 of the dew-point jack on the rear panel. Adjust bridge balance control, R3, for zero volts on the voltmeter.

(5) Change the input resistor on pins 2 and 3 to 10566 Ω and adjust Range R6 for 108 millivolts on the voltmeter.

(6) Move the voltmeter to TP-3 and adjust the gain trimmer R11 for a voltmeter reading of 1.08 volts.

(7) Change the input resistor to 8898 Ω. Connect the voltmeter to TP-4 and adjust offset adj., R22 for a voltmeter reading of +180 millivolts.

The output voltage is scaled 10 millivolts per degree on dew-point temperature.

8.5.3 Troubleshooting

Note: Refer to the caution warning on the manufacturer's data sheets for the dew-point probe.

The dew-point sensor will cycle several times and can require an hour before stabilizing.

Check that all cables are properly connected and that the temperature and dew-point probes are not interchanged.

If the temperature and dew-point readings seem to vary randomly, ascertain that the remote probes are not located close to the exhaust fans of air condition equipment or other heat sources.

8.6 X2 Temperature/Dew-Point Power Supply (Schematic, Figure 32)

This card furnishes regulated 6.5 volts and 5.0 volts for the temperature/dew-point sensors and digital panel meters respectively.

8.7 AC Power Distribution (Schematic, Figure 34)

All power supplies are the divided primary type and are switched between 115 and 230 volts by changing the pc card switch in the fuse module on the rear panel.

8.8 PARTS LIST-CLOCK/TEMPERATURE/DEW-POINT

D.D. 1 DEC 77 PARTS LIST- TEMP/DEW PT./CLOCK CHASSIS (X) DATA 4

TEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X2-R3	1	RES FXD WW 5% 12W	125 OHM		

TEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-J1	1	CONN PC EDGE (XI CARD)	60 PIN	AMPH	261-10030-2
2	X-J2	1	CONN PC EDGE (X2 CARD)	60 PIN	AMPH	261-10030-2
3	X-J3	1	CONN PC EDGE (X3 CARD)	60 PIN	AMPH	261-10030-2
4	X-J4	1	CONN JACK (TEMP PROBE)	4 PIN	SWCT	C4F
5	X-J5	1	CONN JACK (D.P. PROBE)	4 PIN	SWCT	C4F
6	X-J6	1	CONN JACK (ANALOG)	5 PIN	VIKG	VR5/4AB13
7	X-J7	1	CONN JACK TOP (CLOCK)	30 PIN	SAE	SAC 15D/1-2
8	X-J8	1	CONN JK BOTTOM (CLOCK)	44 PIN	SAE	SAC 22D/1-2
9	X-J9	1	CONN JACK (TEMP DPM)	20 PIN	VIKG	2VH10/1AN-5
0	X-J10	1	CONN JACK (D.P. DPM)	20 PIN	VIKG	2VH10/1AN-5
1	X-J11	1	CONN BLUE RIBBON I/O	50 PIN	AMPH	57-40500

TEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-T1	1	MINIATURE TERM BLOCK	14 PIN	CNCH	14-140

TEGORY NO. 8----------SWITCHES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-S1	1	THUMB WHEEL SWITCH	4 DECADE	UNMX	SF-22A
2	X-S2	1	SWITCH AC POWER	SPST	ALCO	MSTL-206N

L.D.D. 1 DEC 77 PARTS LIST- TEMP/DEW PT./CLOCK CHASSIS (X) DATA

CATEGORY NO. 9----------METERS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-M1	1	DIG PANL MTR (D.P.)	3 DIGIT	NLS	PM3 39-250-1
2	X-M2	1	DIG PANL MTR (TEMP)	3 DIGIT	NLS	PM3 39-250-1

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-H1	1	INSTRUMENT CASE		BUD	
2	X-H2	1	FACE PANEL FOR H1	.09375 AL	NBS	
3	X-H3	1	SHELF BRACKET	.06250 AL	NBS	9 1/2 X 7 1/2
4	X-H4	1	L-BRACKET (PR SUPPLY)	.09375 AL	NBS	1.75W X2.5H X
5	X-H5	1	SUPPORT BRKT (CLOCK)	.06250 AL	NBS	
6	X-H6	2	SUPPORT BRKT (DPM'S)	.06250 AL	NBS	
7	X-H7	4	SHELF POSTS		NBS	2 3/4H
8	X-H8	1	PC CARD CAGE	4 CARD	SCBE	
9	X-H9	1	RESISTOR CLIP			

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-M1	1	DIGITAL PANEL CLOCK	24 HR	NEPT	6700S(+OPTION
2	X-M2	1	MODULAR POWER SUPPLY	+-15V.	EB	527
3	X-PR1	1	TEMPERATURE PROBE		YSI	705
4	X-PR2	1	DEW POINT PROBE		YSI	9101
5	X-X1	1	TEMP/DEW PT. PC CARD		NBS	X1
6	X-X2	1	POWER SUPPLY PC CARD		NBS	X1
7	X-X3	1	CLOCK INHIBIT PC CARD		NBS	X3

CATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X-L1	1	LAMP CURRENT LIMIT	12 V	GE	#55
2	X-A1	1	SOCKET FOR L1		LCFT	07-20
3	X-A2	1	LENSE FOR L1		CHGM	6063-000-634
4	X-F1	1	FUSE/FILTER/AC SOCKET		CROM	6J4
5	X-T1	1	TRANSFORMER DUAL PRIM	115/220V	YSI	B-09125

TEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1-R1	1	RES FXD MF 1% 1/4W	6.65K OHM	CORG	NC5
2	X1-R2	1	RES FXD MF 1% 1/4W	1.62K OHM	CORG	NC5
3	X1-R3	1	RES VAR TRIM CERMET	500 OHM	BRNS	3006W-1-501
4	X1-R4	2	RES FXD MF 1% 1/4W	3.48K OHM	CORG	NC5
5	X1-R5		SAME AS R4	3.48K OHM		
6	X1-R6	6	RES VAR TRIM CERMET	5.00K OHM	BRNS	3006W-1-502
7	X1-R7	1	RES FXD MF 1% 1/4W	24.9K OHM	CORG	NC5
8	X1-R8	2	RES FXD MF 1% 1/4W	100 OHM	CORG	NC5
9	X1-R9	2	RES FXD MF 1% 1/4W	2.00K OHM	CORG	NC5
10	X1-R10	3	RES VAR TRIM CERMET	1.00K OHM	BRNS	3006W-1-102
11	X1-R11		SAME AS R6	5.00K OHM		
12	X1-R12	2	RES FXD MF 1% 1/4W	7.50K OHM	CORG	NC5
13	X1-R13	4	RES FXD MF 1% 1/4W	39.2K OHM	CORG	NC5
14	X1-R14		SAME AS R13	39.2K OHM		
15	X1-R15	12	RES FXD MF 1% 1/4W	100 K OHM	CORG	NC5
16	X1-R16		SAME AS R15	100 K OHM		
17	X1-R17	2	RES FXD MF 1% 1/4W	90.9K OHM	CORG	NC5
18	X1-R18	2	RES VAR TRIM CERMET	20.0K OHM	BRNS	3006W-1-203
19	X1-R19		SAME AS R15	100 K OHM		
20	X1-R20		SAME AS R15	100 K OHM		
21	X1-R21		SAME AS R15	100 K OHM		
22	X1-R22		SAME AS R6	5.00K OHM		
23	X1-R23		SAME AS R15	100 K OHM		
24	X1-R24	2	RES FXD MF 1% 1/4W	20.0K OHM	CORG	NC5
25	X1-R25	2	RES FXD MF 1% 1/4W	2.21K OHM	CORG	NC5
26	X1-R31	1	RES FXD MF 1% 1/4W	14.7K OHM	CORG	NC5
27	X1-R32	1	RES FXD MF 1% 1/4W	7.68K OHM	CORG	NC5
28	X1-R33		SAME AS R10	1.00K OHM		
29	X1-R34	2	RES FXD MF 1% 1/4W	6.98K OHM	CORG	NC5
30	X1-R35		SAME AS R34	6.98K OHM		
31	X1-R36		SAME AS R6	5.00K OHM		
32	X1-R37	1	RES FXD MF 1% 1/4W	21.0K OHM	CORG	NC5
33	X1-R38		SAME AS R8	100 OHM		
34	X1-R39		SAME AS R9	2.00K OHM		
35	X1-R40		SAME AS R10	1.00K OHM		
36	X1-R41		SAME AS R6	5.00K OHM		
37	X1-R42		SAME AS R12	7.50K OHM		
38	X1-R43		SAME AS R13	39.2K OHM		
39	X1-R44		SAME AS R13	39.2K OHM		
40	X1-R45		SAME AS R15	100 K OHM		
41	X1-R46		SAME AS R15	100 K OHM		
42	X1-R47		SAME AS R17	90.9K OHM		

43	X1-R48	SAME AS R18	20.0K OHM
44	X1-R49	SAME AS R15	100 K OHM
45	X1-R50	SAME AS R15	100 K OHM
46	X1-R51	SAME AS R15	100 K OHM
47	X1-R52	SAME AS R6	5.00K OHM
48	X1-R53	SAME AS R15	100 K OHM
49	X1-R54	SAME AS R24	20.0K OHM
50	X1-R55	SAME AS R25	2.21K OHM

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1-C1	2	CAP HI-K MONO 50V	1.0 UF	SPRG	5C023105X0250
2	X1-C2		SAME AS C1	1.0 UF		
3	X1-C3	4	CAP CERAMIC	0.1 UF	SPRG	
4	X1-C4		SAME AS C3	0.1 UF		
5	X1-C5		SAME AS C3	0.1 UF		
6	X1-C6		SAME AS C3	0.1 UF		
7	X1-C7	3	CAP TANT 25V	10 UF		
8	X1-C8	2	CAP ELECTLYC 50V	50 UF	SPRG	30D TE-1307
9	X1-C9		NOT USED			
10	X1-C10		SAME AS C7	10 UF		
11	C11-C37		NOT USED			
12	X1-C38		SAME AS C8	50 UF		
13	X1-C40		SAME AS C7	10 UF		

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1-IC1	2	I.C. QUAD OP AMP	A,B,C,&D	NATL	LM324
2	X1-IC2		SAME AS IC1	E,F,G,&H		

CATEGORY NO. 7----------TERMINALS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1-T1	9	TEST POINT JACK			
2	X1-T2		SAME AS T1			
3	X1-T3		SAME AS T1			
4	X1-T4		SAME AS T1			

5	X1-T5	SAME AS T1
6	X1-T6	SAME AS T1
7	X1-T7	SAME AS T1
8	X1-T8	SAME AS T1
9	X1-T9	SAME AS T1

TEGORY NO. 8----------SWITCHES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1-S1	1	SW SPST 8 ROCKER DIP	ROCKER 1	GRAY	76B08
2	X1-S2		SECTION OF S1	ROCKER 2		
3	X1-S3		SECTION OF S1	ROCKER 3		
4	X1-S4		SECTION OF S1	ROCKER 4		

TEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1-B1	1	PC BRD FOR T/D.P. CRKT		NBS	PC-1

TEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X1	1	TEMP/DEW PT. PC CARD		NBS	X1

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X2-R1	1	RES FXD MF 1% 1/4W	267 OHM	CORN	NC5
2	X2-R2	1	RES FXD MF 1% 1/4W	1.10K OHM	CORN	NC5
3	X2-R3	1	CHASSIS MOUNTED	125 OHM		
4	X2-R4	1	RES FXD CARB 5% 1/4W	2.70K OHM	AB	CB

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X2-C1	1	CAP ELECTLYC 50V	500 UF	CD	WBR 500-50
2	X2-C2	1	CAP HI-K MONO 50V	1 UF	SPRG	5C023105X0250
3	X2-C3	2	CAP CERAMIC	.1 UF	SPRG	
4	X2-C4	1	CAP ELECTLYC 50V	50 UF	SPRG	30D TE-1307
5	X2-C5		SAME AS C3	.1 UF		

CATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X2-CR1	1	DIODE SILICON 1A 400V	1 AMP	RCA	1N4004

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X2-IC1	1	VOLTAGE REGULATOR	6.5V	NATL	LM 317T
2	X2-IC2	1	VOLTAGE REGULATOR	5.0V	MOT	MC7805CP

D.D. 1 DEC 77 PARTS LIST- TEMP/DEW PT. PWR SUPPLY (X2) DATA 2

TEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
	X2-B1	1	PC BRD- PWR SPLY CRKT		NBS	PC-2
2	X2-H1	2	SCREW 4-40	1/4		
3	X2-H2	2	NUT 4-40			
4	X2-H3	2	WASHER FLAT 4-40			

TEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X2	1	POWER SUPPLY PC CARD		NBS	X2

CATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X3-R1	17	RES FXD CARB 5% 1/4W	1.0K OHM	AB	CB
2	X3-R2		SAME AS R1	1.0K OHM		
3	X3-R3		DELETED	1.0K OHM		
4	X3-R4	1	RES FXD CARB 5% 1/4W	510 OHM	AB	CB
5	X3-R5	1	RES FXD CARB 5% 1/4W	10 K OHM	AB	CB
6	X3-R6		SAME AS R1	1.0K OHM		
7	X3-R7		SAME AS R1	1.0K OHM		
8	X3-R8		SAME AS R1	1.0K OHM		
9	X3-R9		SAME AS R1	1.0K OHM		
10	X3-R10		SAME AS R1	1.0K OHM		
11	X3-R11		SAME AS R1	1.0K OHM		
12	X3-R12		SAME AS R1	1.0K OHM		
13	X3-R13		SAME AS R1	1.0K OHM		
14	X3-R14		SAME AS R1	1.0K OHM		
15	X3-R15		SAME AS R1	1.0K OHM		
16	X3-R16		SAME AS R1	1.0K OHM		
17	X3-R17		SAME AS R1	1.0K OHM		
18	X3-R18		SAME AS R1	1.0K OHM		
19	X3-R19		SAME AS R1	1.0K OHM		

CATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X3-C1	2	CAP TANT 25V	10 UF		
2	X3-C2		SAME AS C1	10 UF		

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X3-IC1	1	FF ONE SHOT	74121	TI	SN74121N

D.D. 1 DEC 77 CLOCK FLAG/INHIBIT PC CARD (X3) DATA 3

TEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X3-B1	1	PC BRD- CLK IHBT CRKT		NBS	PC-3

TEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	X3	1	CLK INHIBIT PC CARD		NBS	X3

8:9 CLOCK WIRING LIST

J-1

	1	A	
	2	B	X3-1&2 +5V
	3	C	
	4	D	
	5	F	J1-15 (OSC)
	-	-	
J1-F	15	S	

J-2

	1	A	
	2	B	
	3	C	
GND X3-60	4	D	GND X3-60
	5	F	X3-34 (DSBL)
	6	H	
J11-15	7	J	
	8	K	J11-17
J11-18	9	L	J11-16
J11-19	10	M	J11-21
	11	N	J11-20
J11-23	12	P	
	13	Q	
J11-26	14	R	J11-25
J11-27	15	S	J11-24
J11-30	16	T	J11-29
J11-31	17	U	J11-28
	18	V	
J11-34	19	W	J11-33
J11-35	20	X	J11-32
J11-38	21	Y	J11-37
J11-39	22	Z	J11-36

WIRING LIST

J-X1

J456 -C GND J4 -3 GND J5 -3 J456 - D	1	2	X2 -59 GND
	3	4	COMM 15VPS/=5VPS
+6.5V X2 -55	5	6	
	7	8	
	9	10	
J4-2	11	12	
J4-1	13	14	
	15	16	
J5-2	17	18	
J5-1	19	20	
	21	22	
	23	24	
	25	26	
	27	28	
-15 VPS	29	30	
	31	32	
+15 VPS	33	34	
	35	38	
	39	40	
	41	42	D.P. DPM-1
D.P. + J456 -D	43	44	
	45	46	D.P. DPM-B
TEMP + J456 -B	47	48	TEMP DPM-1
	49	50	
TEMP DPM-H	51	52	TEMP DPM-B
D.P. DPM-H	53	54	
	55	56	
	57	58	
	59	60	

WIRING LIST

J-X2

	1	2	
	3	4	
	5	6	
	7	8	
	9	10	
	11	12	
24V AC TO #55 LAMP	13	14	
J5-4 TO #55 LAMP	15	16	
	17	18	
TO R3	19	20	
	21	22	
	23	24	
	25	26	
	27	28	
	29	30	
	31	32	
	33	34	
	35	36	
TEMP DPM-9 D.P. DPM-9	37	38	
	39	40	
	41	42	
	43	44	
	45	46	
	47	48	
	49	50	
TO R3	51	52	
	53	54	
X1-5	55	56	
24V AC	57	58	TEMP DPM GND
X1-2/GND	59	60	D.P. DPM GND

WIRING LIST

J-X3

CLOCK J1-B +5V	1	2	+5V CLOCK J1-B
X10 DAY TWS C	3	4	J11-1 C8
X10 DAY TWS B	5	6	J11-2 B8
X10 DAY TWS A	7	8	J11-3 A8
X1 DAY TWS D	9	10	J11-4 D7
X1 DAY TWS C	11	12	J11-5 C7
X1 DAY TWS B	13	14	J11-6 B7
X1 DAY TWS A	15	16	J11-7 A7
X10 MONTH TWS B	17	18	J11-8 B10
X10 MONTH TWS A	19	20	J11-9 A10
X1 MONTH TWS D	21	22	J11-10 D9
X1 MONTH TWS C	23	24	J11-11 C9
X1 MONTH TWS B	25	26	J11-12 B9
X1 MONTH TWS A	27	28	J11-13 A9
X10 DAY TWS D	29	30	J11-14 D8
X10 MONTH TWS D	31	32	J11-43 D10
FLAG J11-41	33	34	CLOCK J2-F (DSBL)
CTL J11-40	35	36	
	37	38	
X10 MONTH TWS C	39	40	J11-44 C10
	41	42	
J11-45	43	44	J11-46 "1" BUSS
	45	46	
	47	48	
	49	50	
	51	52	
	53	54	
	55	56	
	57	58	
TWS-COMMON J11-49&50	59	60	CLOCK J2-2&D GND

DPM WIRING LIST

J-9 TEMP

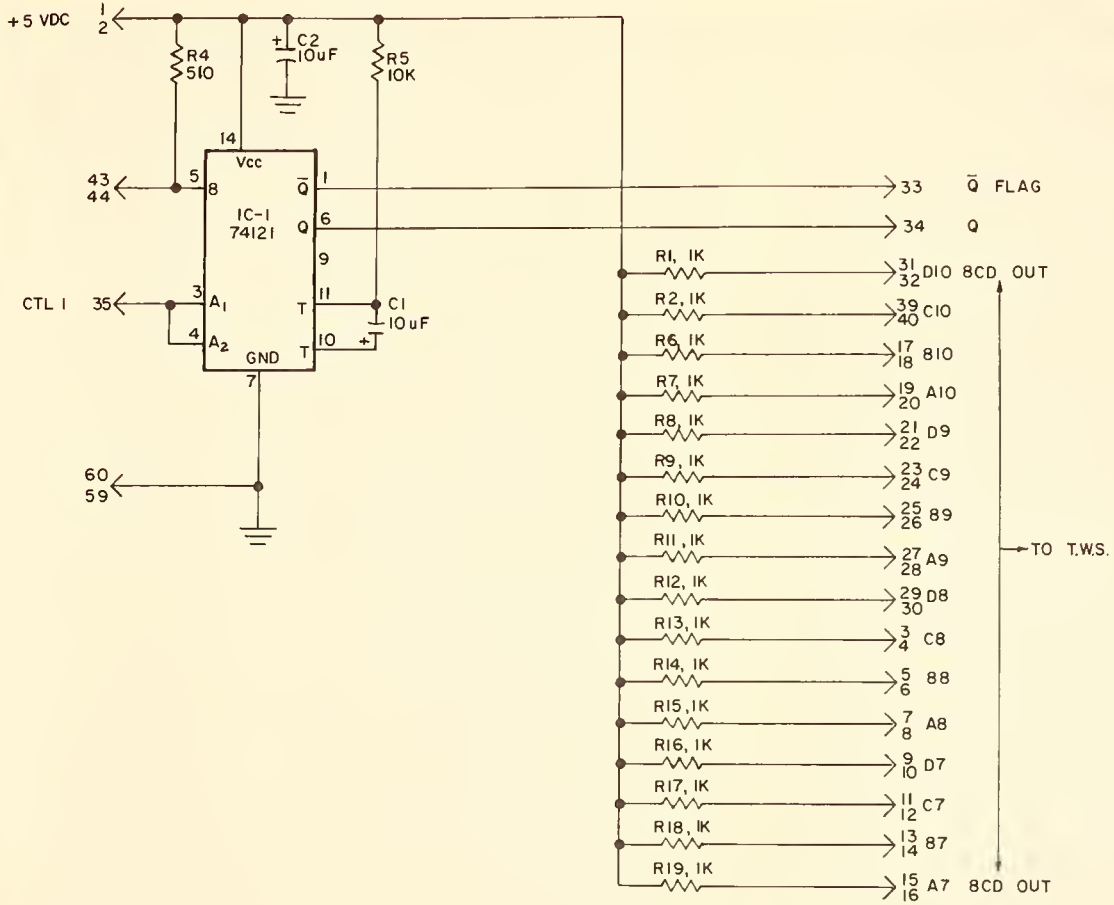
X1-48	1	A	
	2	B	X1-52 (DEC. PT.)
	3	C	
	4	D	
(IN-) X1-2	5	F	
	6	H	X1-51 (IN+)
	7	J	
	8	K	
+5V X2-37	9	L	X2-58 GND
J9-9	10	M	X2-58

J-10 DEW PT.

X1-42	1	A	
	2	B	X1-46 (DEC. PT)
	3	C	
	4	D	
(IN-) X1-4	5	F	
	6	H	X1-53 (IN+)
	7	J	
	8	K	
+5V X2-37	9	L	X2-60 GND
J10-9	10	M	X2-60

J-11 CLOCK

1	X3-4	26	J2-14
2	X3-6	27	J2-15
3	X3-8	28	J2-U
4	X3-10	29	J2-T
5	X3-12	30	J2-16
6	X3-14	31	J2-17
7	X3-16	32	J2-X
8	X3-18	33	J2-W
9	X3-20	34	J2-19
10	X3-22	35	J2-20
11	X3-24	36	J2-2
12	X3-26	37	J2-Y
13	X3-28	38	J2-21
14	X3-30	39	J2-22
15	J2-7	40	X3-35
16	J2-L	41	X3-33
17	J2-K	42	
18	J2-9	43	X3-32
19	J2-10	44	X3-40
20	J2-N	45	X3-43
21	J2-M	46	X3-44
22	J2-11	47	GND
23	J2-12	48	
24	J2-S	49	X3-59/GND
25	J2-R	50	



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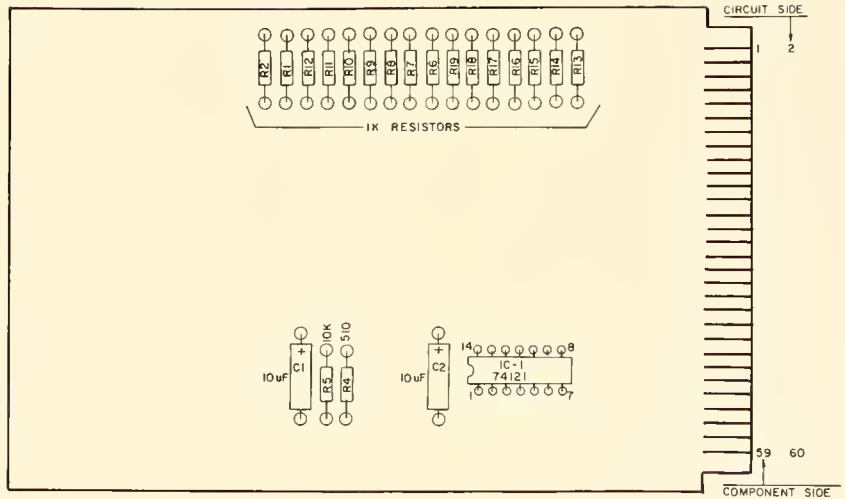
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D. C. 20234

SCHEMATIC, CLOCK INHIBIT BOARD
FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN MMM	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ±.005	SUBMITTED BY	CHIEF, SEC.
FRACTIONS ±.015	EXAMINED BY	
ANGLES ±½°		CHIEF ENGINEER
DO NOT SCALE THIS PRINT	APPROVED BY	
DIV. SEC.	THIS PRINT ISSUED	CHIEF, DIV.

2766480-X3

Figure 28. X3 Schematic Circuits.



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WASHINGTON, D.C. 20234

ASSY, CLOCK INHIBIT BOARD
FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL	TYPE	SCALE
DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED	DRAFTSMAN [illegible]	CHECKER
TOLERANCES UNLESS OTHERWISE SPECIFIED	PROJECT ENGR	PROJECT ENGR
DECIMALS ± .000 FRACTIONS ± .015 ANGLES ± 1°	SUBMITTED BY CHIEF SEC	
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2766480 - X3

Figure 29. X3 PC Assembly Drawing.

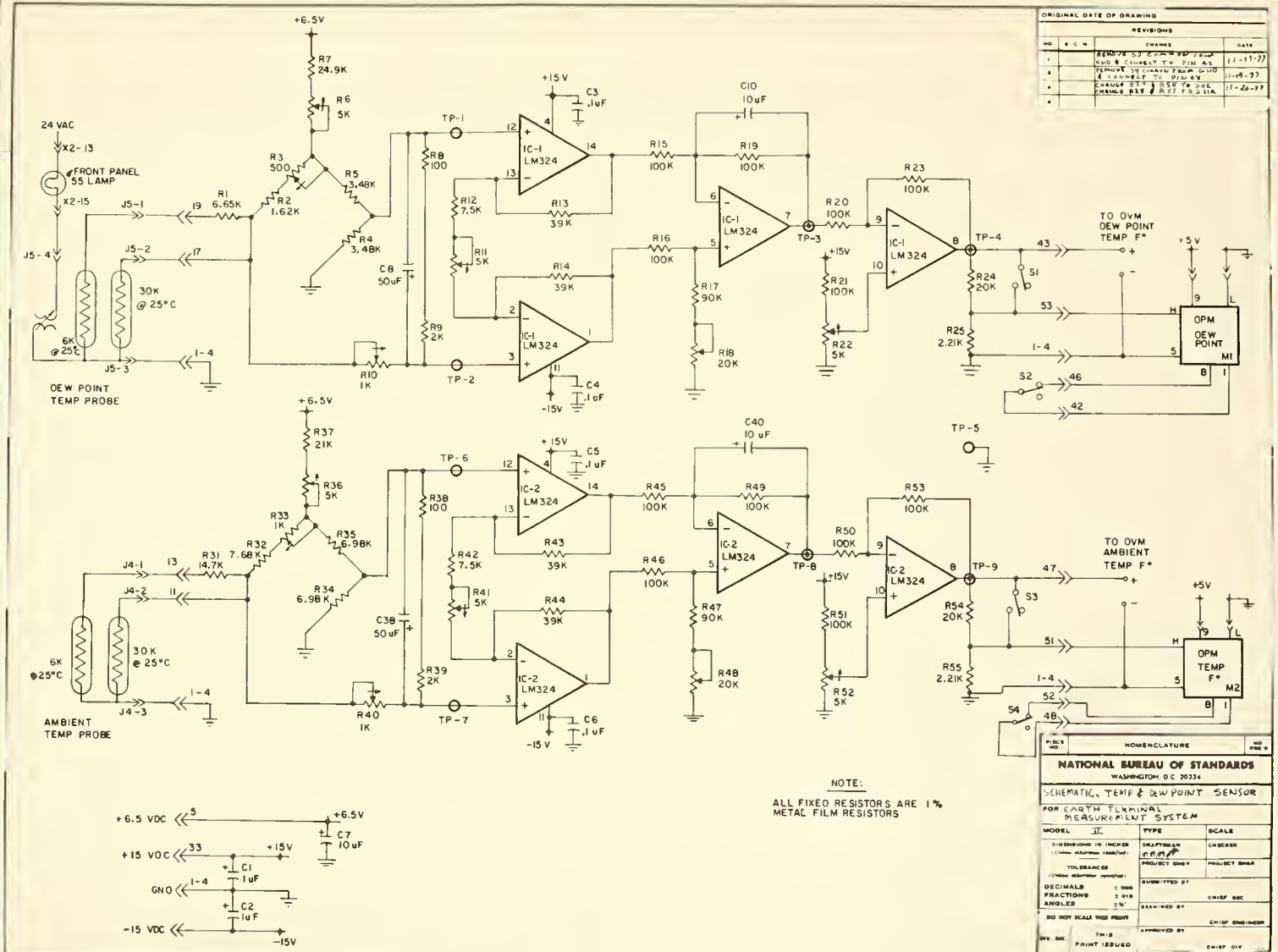
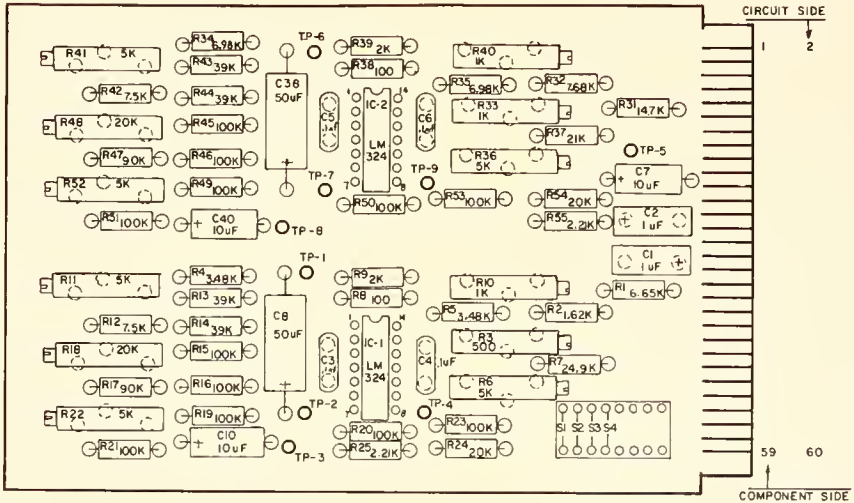


Figure 30. X1 Schematic Circuits.



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2		CHANGE R25 & R55 TO 2.21K	11-21-77
3			
4			

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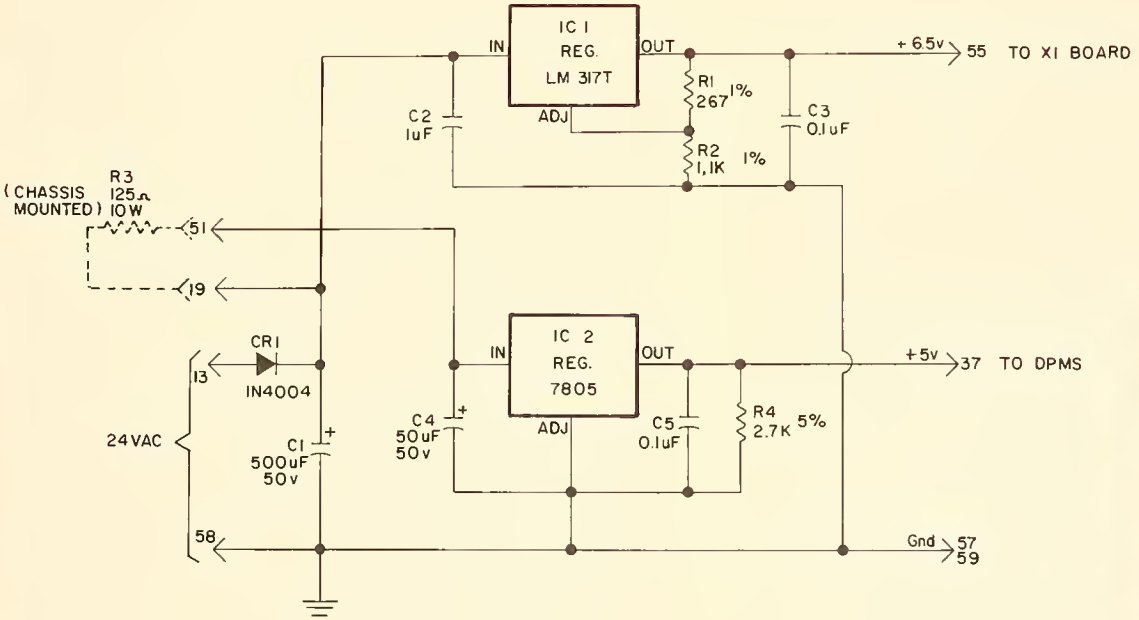
WASHINGTON D.C. 20234

ASSY, TEMP. & DEW POINT SENSOR
FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL II	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN	CHECKED LDD
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ± .005 FRACTIONS ± .015 ANGLES ± 1°	SUBMITTED BY	CHIEF SEC
DO NOT SCALE THIS PRINT	EXAMINED BY	CHIEF ENGINEER
DIV. SEC. THIS PRINT ISSUED	APPROVED BY	CHIEF DIV

2766480 - X1

Figure 31. X1 PC Assembly Drawing.



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WASHINGTON, D.C. 20234

SCHEMATIC, T/DP POWER SUPPLY

FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN MMM	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ±.005	SUBMITTED BY	
FRACTIONS ±.015		CHIEF, SEC.
ANGLES ±½°	EXAMINED BY	
DO NOT SCALE THIS PRINT		CHIEF ENGINEER
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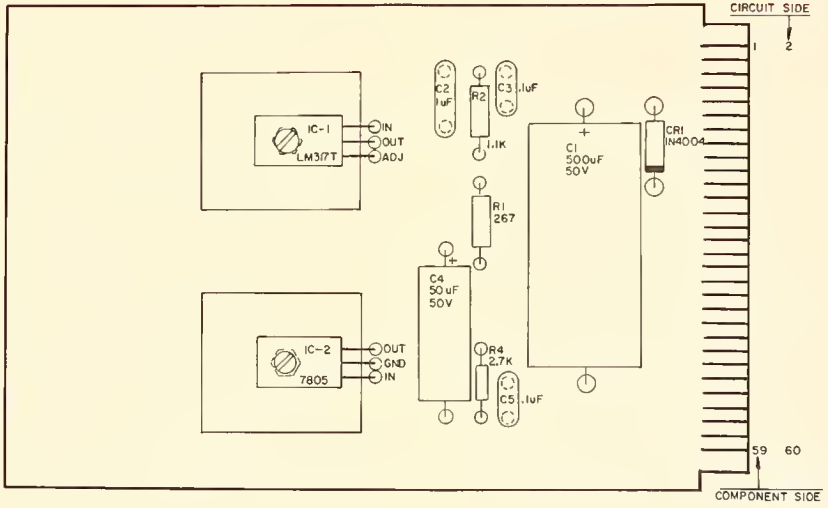
	2766480-X2	

Figure 32. X2 Schematic Circuits.

NBS 548



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	NATIONAL BUREAU OF STANDARDS WASHINGTON, D.C. 20234	
	ASSY, T/DP PWR SUPPLY FOR EARTH TERMINAL MEASUREMENT SYSTEM	

MODEL	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN	CHECKED
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ± .005 FRACTIONS ± .015 ANGLES ± ½°	SUBMITTED BY CHIEF SEC	
DO NOT SCALE THIS PRINT	EXAMINED BY CHIEF ENGINEER	
DEV SEC	THIS PRINT ISSUED	APPROVED BY CHIEF DIV
		2766780-X2

Figure 33. X2 PC Assembly Drawing.

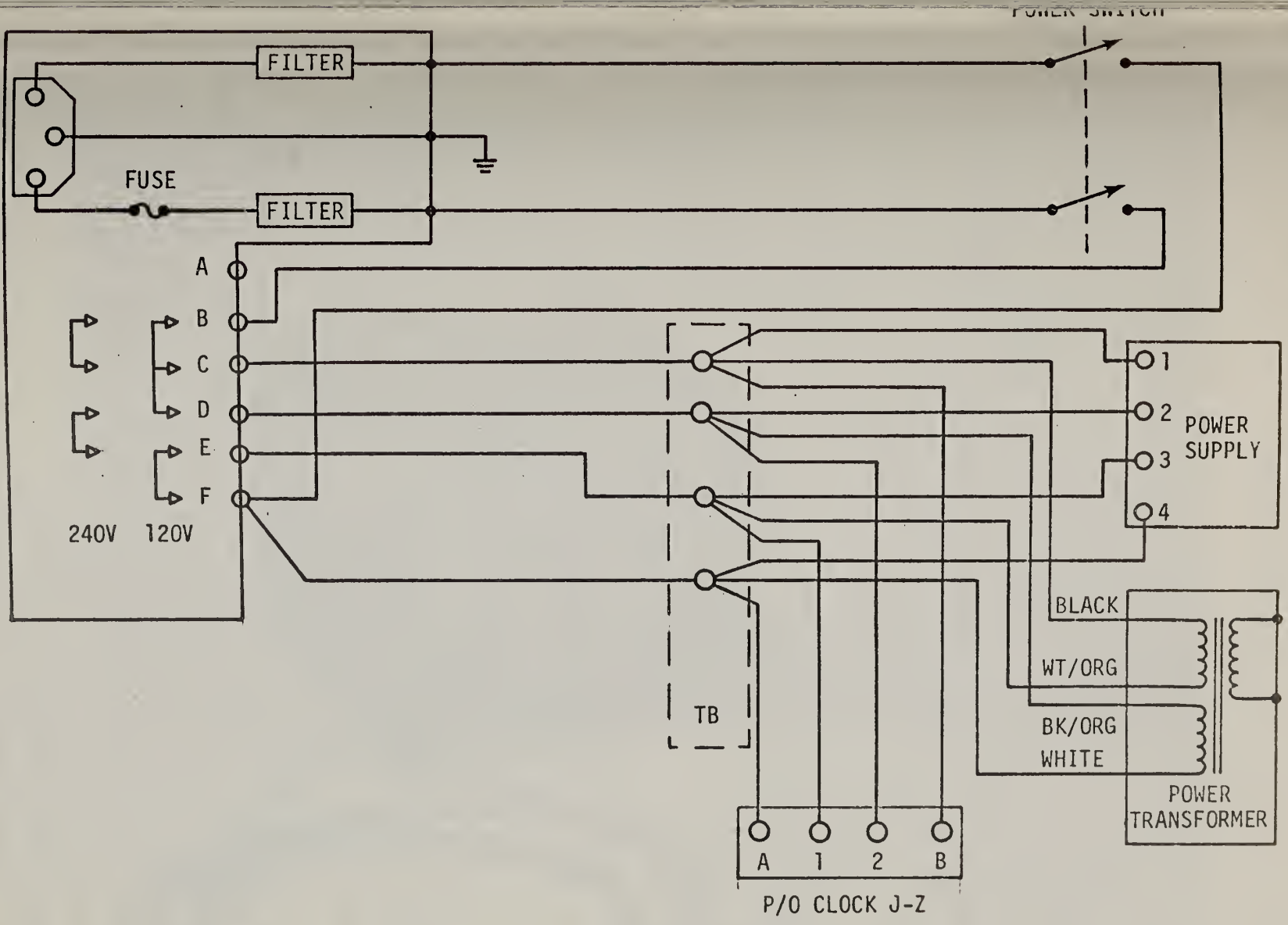


Figure 34. Clock/Temperature AC Power Distribution.

9. NOISE-ADD STANDARD AND POWER SUPPLY INSTRUCTION MANUAL

9.1 Introduction

The noise-add standard is a stable dual-diode noise generator module which is mounted at the throat of the antenna to inject a known level of added noise into the receiver system of the earth terminal under ETMS calculator control. This noise-add signal is injected during each measurement to provide information needed to correct for receiver system gain changes.

The noise-add module is powered by a constant power supply which is controlled remotely from the ETMS via two coaxial control cables.

9.2 Specifications

Dual diode noise-add standard: The 7.0 to 7.4 GHz frequency noise-diode output level is approximately 3 dB less than diode No. 2.

Noise-add current supply: This external module contains a long-term stability voltage reference which is used to determine the constant-current to each noise-add diode.

Input power: 115/230 V 50/60 Hz.

Input control: Two coaxial lines from ETMS control console.

9.3 Noise-Add Module (Figure 35)

The X-band noise-add module combines the noise outputs of two solid-state noise diodes. The output of this module is injected at the directional-coupler immediately ahead of the low-noise amplifier via a short semi-rigid coaxial cable.

The two noise diodes are remotely switched via the bias power supply from the ETMS control/rf console. The signals from the diodes are combined through two, 3 dB hybrid couplers in a manner which reduces the output level of #1 diode to approximately 3 dB below the output level of diode #2 (see fig. 36).

Each noise add diode is a dual source. If one diode should become defective, the diode substrate can be reversed to utilize the spare diode; however, all previous calibration history will be lost.

Note: Avoid connecting or disconnecting the bias current supply cables without first turning the ac power switch "off" on the bias power supply.

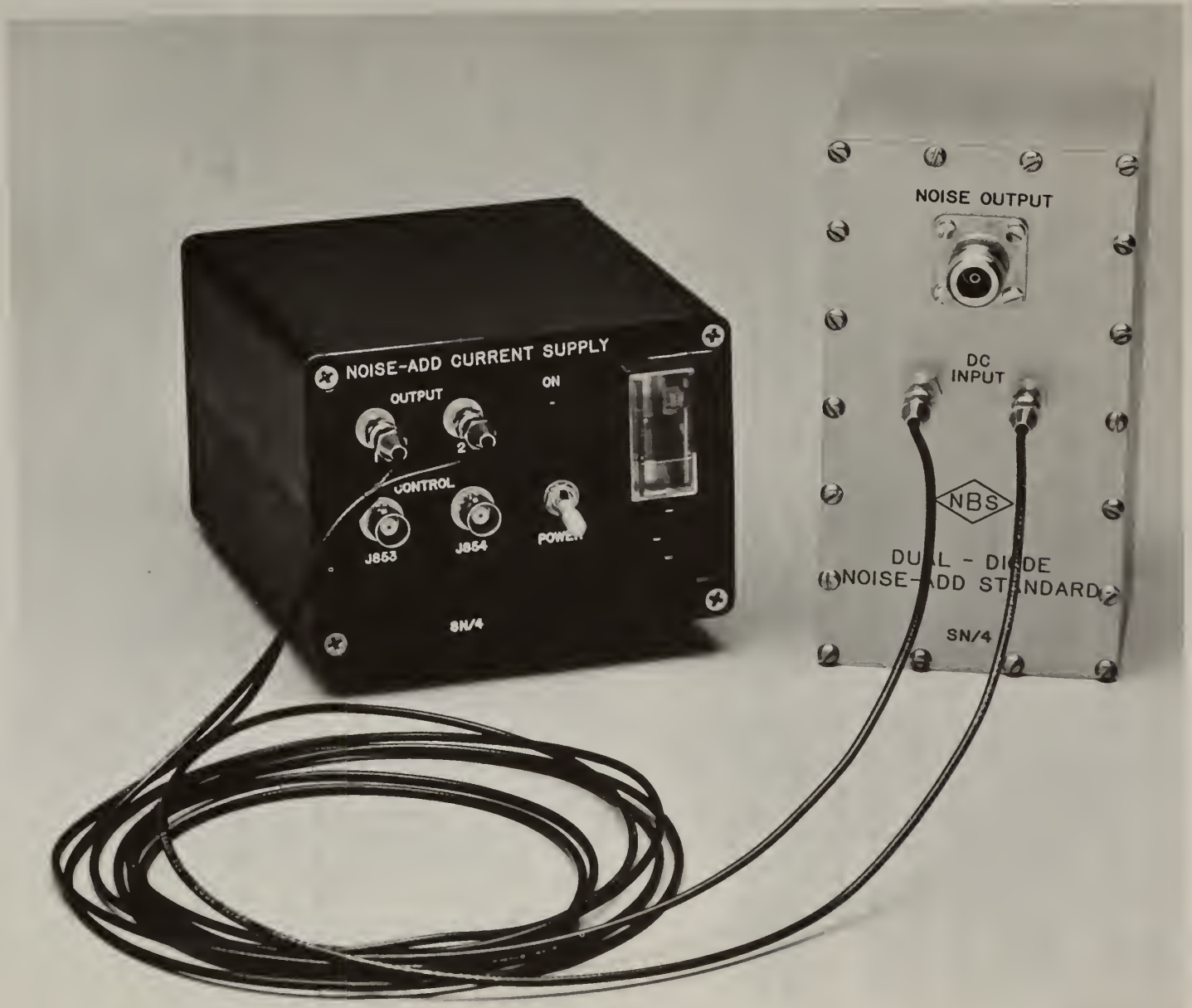


Figure 35. Noise-Add Standard Unit.

9.4 Noise-Add Power Supply (Schematic, Figure 37)

The noise-add power supply furnishes constant current bias to the noise-add module. The constant current generators [9] for the noise diodes are referenced to a 10 volt standard reference. The circuits in the generator are symetrical to eliminate output variation with temperature change.

The output current is switched (shunted) to ground to turn the noise diode off.

These switch transistors Q1 and Q2 are controlled from the remote input lines via optical isolators IC-3 and IC-4. When the input to the optical coupler is open circuited or at + 15 volts the noise diode is turned on. Conversely, when the input is shorted the noise diode is off.

The resistance values in the current sources were selected to adjust the outputs of the diodes to approximately 3 dB difference in noise power level at the combined output of the two, 3 dB hybrid couplers.

9.5 Troubleshooting

Note: Ascertain that the par-amp connected to the noise-add unit is switched to the down-link. Initially verify that each noise-add diode is working by observing the output of the down-link on a spectrum analyzer and manually switch noise-add #1 and #2 off and on. Determine that noise-add #2 injects a larger noise power. Reverse the control cables at the ETMS control/rf console if necessary. If the remote cables are suspected, open and short circuit the BNC control inputs to the noise-add power supply observing the results on the spectrum analyzer.

These noise-add and power supply modules have matching serial numbers and have been checked on the NBS noise calibration system before being shipped. If the noise-add module is to be used as a reference standard for continuity of data over long time spans, it should be rechecked periodically.

9.6 PART LIST - NOISE ADD UNIT & POWER SUPPLY

D.D. 1 DEC 77 PARTS LIST- NOISE ADD PWR SUPPLY (V) DATA 12

TEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-R23	1	RES FXD CARB 5% 1/2W	910 OHM	AB	EB

TEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V-D1	1	LED (INDICATOR LAMP)		HP	5082-4655

TEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V-J1	2	JACK BNC PANEL		AMPH	UG-1094/u
2	V-J2		SAME AS J1			
3	V-J3	2	JACK SMA PANEL		OSM	220
4	V-J4		SAME AS J3			

TEGORY NO. 8----------SWITCHES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V-S1	1	SWITCH DPDT LOCKING	3 AMP	ALCO	MSTL-206N

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V-H1	1	HOUSING TEKARD CASE		DEST	K33-5

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V-V1	1	CONST. CURRENT PC CARD		NBS	V800
2	V-V2	1	POWER SUPPLY PC CARD		NBS	V900

CATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V-F1	1	FUSE/FILTER/AC SOCKET		CRCM	6J4

TEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	W-J1	1	CONN PANEL N-SMA (JKS)	COAX	OSM	21011
2	W-J2	2	CONN PANEL SMA-SMA	COAX	OSM	209A
3	W-J3		SAME AS J2	COAX		
4	W-P1	2	CONN SMA-.141 SLMI RIG	COAX	OSM	201-1A
5	W-P2		SAME AS P1	COAX		
6	W-P3	2	CONN EL SMA-.141 S-RIG	COAX	OSM	221-1
7	W-P4		SAME AS P3	COAX		
8	W-P5	4	CONN SMA-SMA (PLUGS)	COAX	OSM	218
9	W-P6		SAME AS P5	COAX		
0	W-P7		SAME AS P5	COAX		
1	W-P8		SAME AS P5	COAX		

TEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	W-H1	1	HOUSING MILLED OUT BLK	ALUM	NBS	6L X3.25W X2.63D
2	W-H2	1	HOUSING FRONT PANEL	.125 ALUM	NBS	6L X 3.25W
3	H3-H6	4	SCREW (PANL CONN) 4-40	.25		
4	H7-H24	18	SCREW (FACE PANL) 4-40	.375		

TEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	W-N1	2	DUAL NOISE DIODE ASS'Y		NBS	2766480
2	W-N2		SAME AS N1			
3	W-M1	2	COUPLER 3dB QUADRATURE	COAX	MERR	QHM-2-6AG
4	W-M2		SAME AS M1	COAX		
5	W-M3	2	TEE/DC BLK/MONITOR SMA	COAX	OSM	203356
6	W-M4		SAME AS M3	COAX		
7	W-M5	3	TERMINATION MIN SMA	50 OHM	OSM	20020P
8	W-M6		SAME AS M5	50 OHM		
9	W-M7		SAME AS M5	50 OHM		

CATEGORY NO. 13----------MISCELLANEOUS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	W-A1	1	CABLE .141 S-RIG COAX	3	UNIF	
2	W-A2	1	CABLE .141 S-RIG COAX	1	UNIF	

ATEGORY NO. 1----------RESISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-R1	16	RES FXD WW .025% 1/4W	SELECTED	ULTX	205A
2	V8-R2		SAME AS R1	SELECTED		
3	V8-R3		SAME AS R1	SELECTED		
4	V8-R4		SAME AS R1	SELECTED		
5	V8-R5		SAME AS R1	SELECTED		
6	V8-R6		SAME AS R1	SELECTED		
7	V8-R7		SAME AS R1	SELECTED		
8	V8-R8		SAME AS R1	SELECTED		
9	V8-R9	2	RES FXD CARB 5% 1/4W	10K OHM	AB	CB
10	V8-R10	2	RES FXD CARB 5% 1/4W	510 OHM	AB	CB
11	V8-R11		SAME AS R1	SELECTED		
12	V8-R12		SAME AS R1	SELECTED		
13	V8-R13		SAME AS R1	SELECTED		
14	V8-R14		SAME AS R1	SELECTED		
15	V8-R15		SAME AS R1	SELECTED		
16	V8-R16		SAME AS R1	SELECTED		
17	V8-R17		SAME AS R1	SELECTED		
18	V8-R18		SAME AS R1	SELECTED		
19	V8-R19		SAME AS R9	10K OHM		
20	V8-R20		SAME AS R10	510 OHM		
21	V8-R21	2	RES FXD CARB 5% 1/2W	1.5K OHM	AB	EB
22	V8-R22		SAME AS R21	1.5K OHM		

ATEGORY NO. 2----------CAPACITORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-C1	3	CAP HI-K MONO 50V	1.0 UF	SPRG	5C023105X025053
2	V8-C2		SAME AS C1	1.0 UF		
3	V8-C3		SAME AS C1	1.0 UF		

CATEGORY NO. 3----------TRANSISTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-Q1	2	TRANSISTOR SILICON PNP	2N3906	MOT	2N3906
2	V8-Q2		SAME AS Q1	2N3906		

CATEGORY NO. 4----------DIODES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-CR1	2	DIODE ZENER 12.7V	1N5242A	MOT	1N5242A
2	V8-CR2		SAME AS D1	1N5242A		

CATEGORY NO. 5----------INTEGRATED CIRCUITS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-IC1	2	INT. CRKT. OP AMP	OP-05C	MONO	OP-05
2	V8-IC2		SAME AS IC1	OP-05C		
3	V8-IC3	2	I.C. OPTICAL COUPLER	LIT-5		LTI-5
4	V8-IC4		SAME AS IC3	LIT-5		
5	V8-IC5	1	VOLTAGE-REF. PREC	10V	CV	PVSN 10G

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-J1	1	JACK IC DUAL IN-LINE	14 PIN	SAMT	IC-314-SGG
2	V8-J2	2	CONNECTOR COAXIAL	BNC	AMPH	UG-1094/u
3	V8-J3	2	CONNECTOR COAXIAL	SMA	OSM	220
4	V8-J4		SAME AS J2	BNC		
5	V8-J5		SAME AS J3	SMA		

TEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8-B1	1	PC BRD - CONST. I CRKT		NBS	PC-800
2	V8-H1	2	SCREW (CERTA-VOLT)			

TEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V8	1	CONST. CURRENT PC CARD		NBS	V800

CATEGORY NO. 6----------CONNECTORS----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V9-J1	2	JACK IC DUAL IN-LINE	14 PIN	SAMT	IC-314-SGG
2	V9-J2		SAME AS J1	14 PIN		

CATEGORY NO. 10----------HARDWARE----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V9-B1	1	PC BRD-PWR SUPPLY CRKT		NBS	PC-900
2	V9-H1	1	BRACKET - PWR SUPPLYS	.062 AL		
3	V9-H2	4	SCREW 4-40	3/4		
4	V9-H3	4	NUT 4-40			
5	V9-H4	4	WASHER LOCK 4-40			

CATEGORY NO. 12----------SUBASSEMBLIES----------

	DSGN	QTY	DESCRIPTION	VALUE	MFG	PART NUMBER
1	V9	1	POWER SUPPLY CARD		NBS	V900
2	V9-M1	2	MODULAR POWER SUPPLY	+-15V	BB	527
3	V9-M2		SAME AS M1	+-15V		

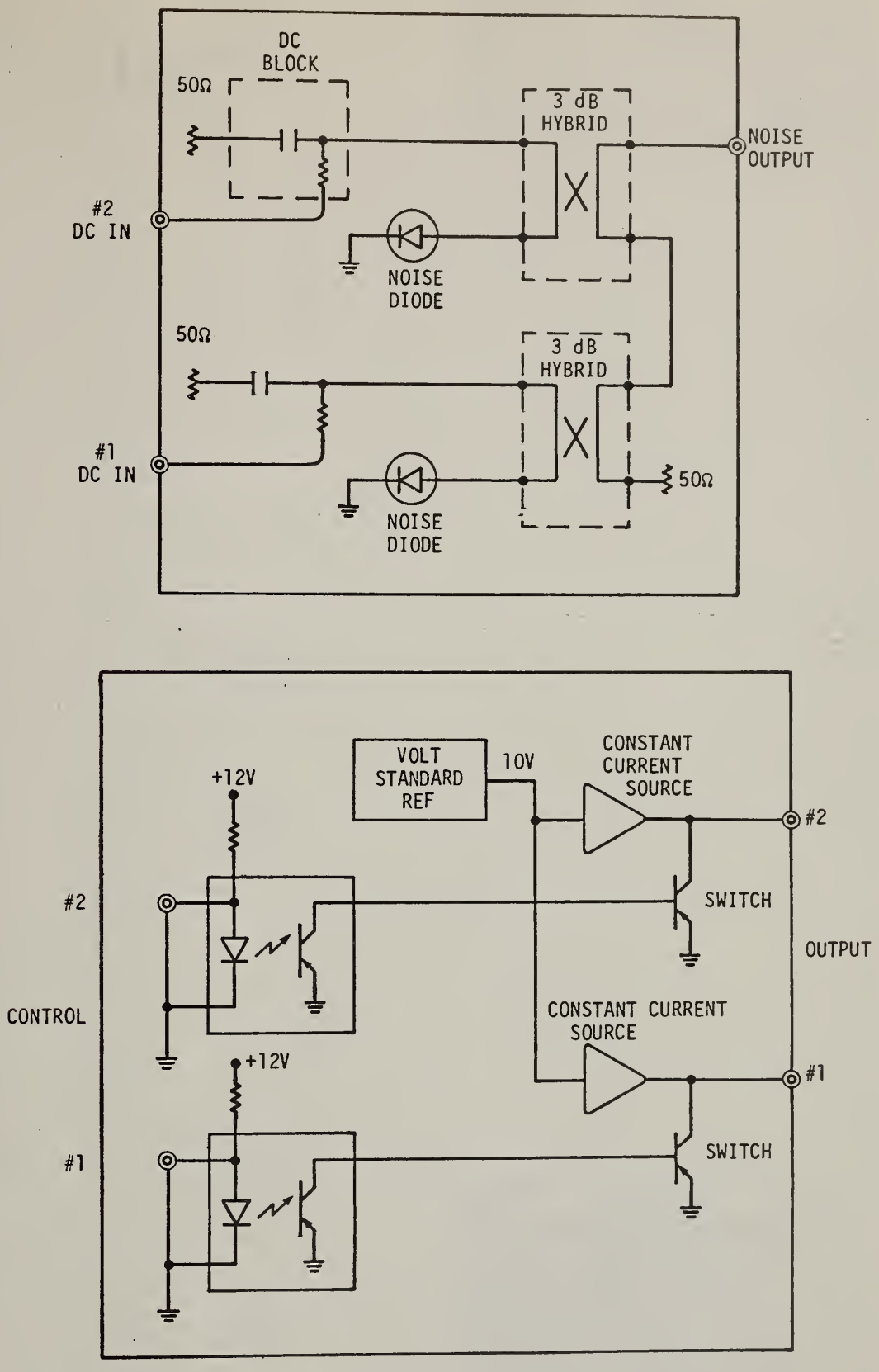
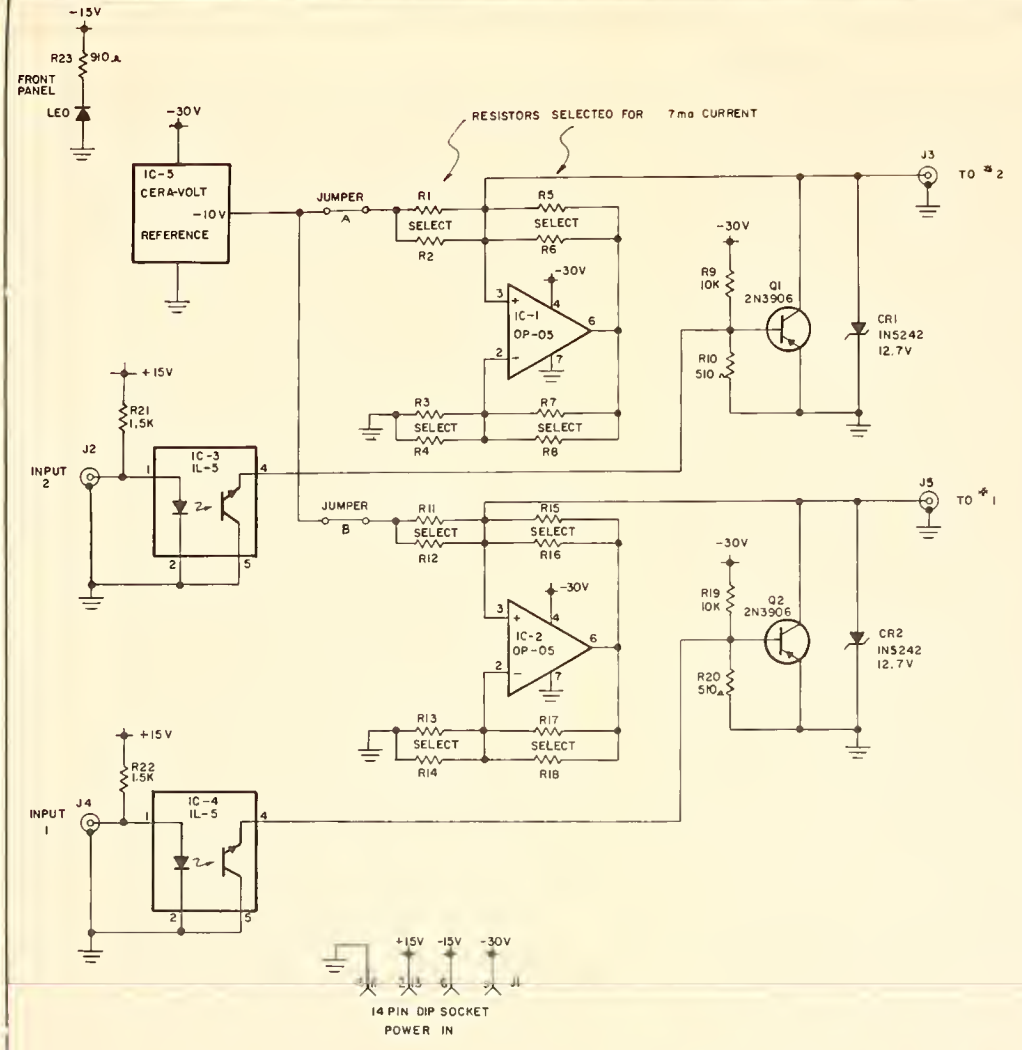


Figure 36. Noise-Add Schematic.



ORIGINAL DATE OF DRAWING

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1			
2			
3			
4			

PIECE NO | NOMENCLATURE | NO REQ'D

NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

SCHEMATIC, NOISE ADD (CONSTANT CURRENT GENERATOR CARD
FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL II | TYPE | SCALE

DIMENSIONS IN INCHES (Unless otherwise specified) | DRAFTSMAN | CHECKER

TOLERANCES (Unless otherwise specified) | PROJECT ENGR | PROJECT ENGR

DECIMALS ± .000
FRACTIONS ± .015
ANGLES ± ½°

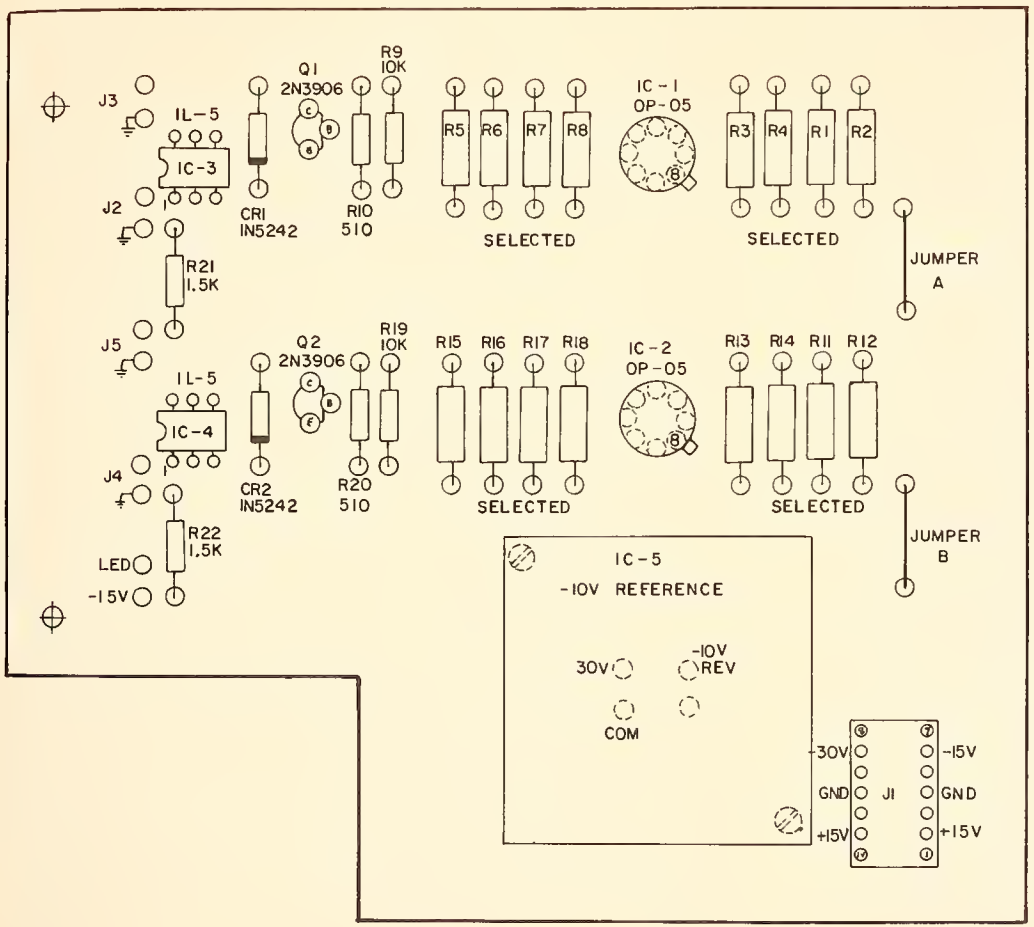
SUBMITTED BY
CHIEF SEC
EXAMINED BY
CHIEF ENGINEER

DO NOT SCALE THIS PRINT

DIV. SEC. | THIS PRINT ISSUED | APPROVED BY
CHIEF DIV

2766480 - V800

Figure 37. V800 Noise-Add Constant Current Schematic.



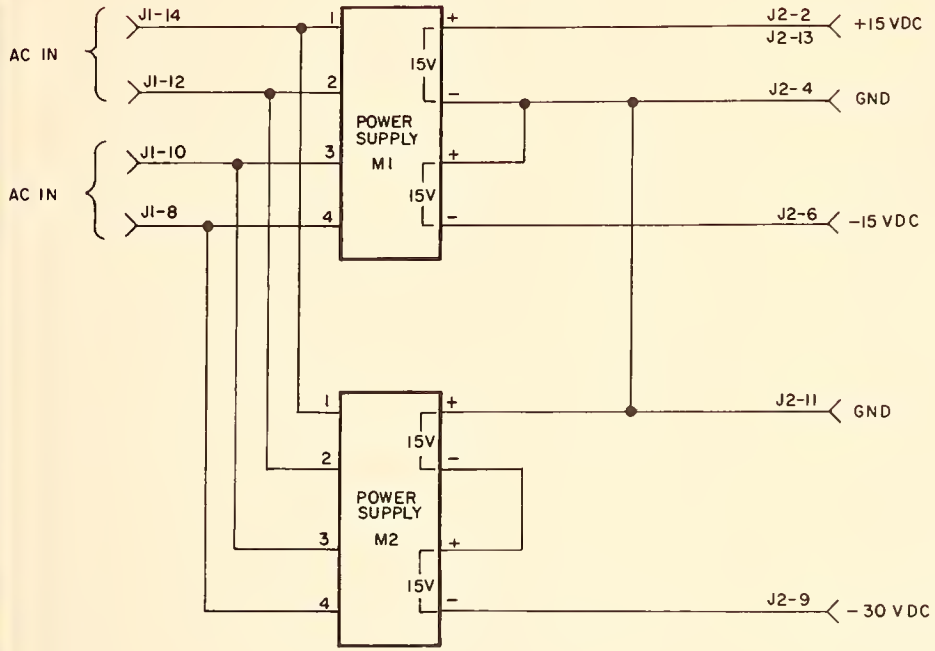
ORIGINAL DATE OF DRAWING			
REVISIONS			
NO	E C N	CHANGE	DATE
1			
2			
3			
4			

PIECE NO	NOMENCLATURE	NO. REQ'D
	NATIONAL BUREAU OF STANDARDS WASHINGTON, D.C. 20234	
	ASSY, NOISE ADD. CONSTANT CURRENT GEN	
	FOR EARTH TERMINAL MEASUREMENT SYSTEM	

MODEL II	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN Mm Mott	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ±.00E FRACTIONS ±.01E ANGLES ±½°	SUBMITTED BY CHIEF, EEC	
DO NOT SCALE THIS PRINT	EXAMINED BY CHIEF ENGINEER	
DIV. NO. THIS PRINT ISSUED	APPROVED BY CHIEF, DIV.	
	2766480-V800	

Figure 38. V800 PC Assembly Drawing.

NBS 548



ORIGINAL DATE OF DRAWING			
REVISIONS			
NO	E C N	CHANGE	DATE
1			
2			
3			
4			

PIECE NO	NOMENCLATURE	NO REQ'D
NATIONAL BUREAU OF STANDARDS WASHINGTON, D. C. 20234		
SCHEMATIC, NOISE ADD POWER SUPPLY BD		
FOR EARTH TERMINAL MEASUREMENT SYSTEM		
MODEL II	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified) TOLERANCES (Unless otherwise specified) DECIMALS ±.005 FRACTIONS ±.015 ANGLES ±½°	DRAFTSMAN M.M.M.	CHECKER
	PROJECT ENGR	PROJECT ENGR
	SUBMITTED BY CHIEF, SEC.	
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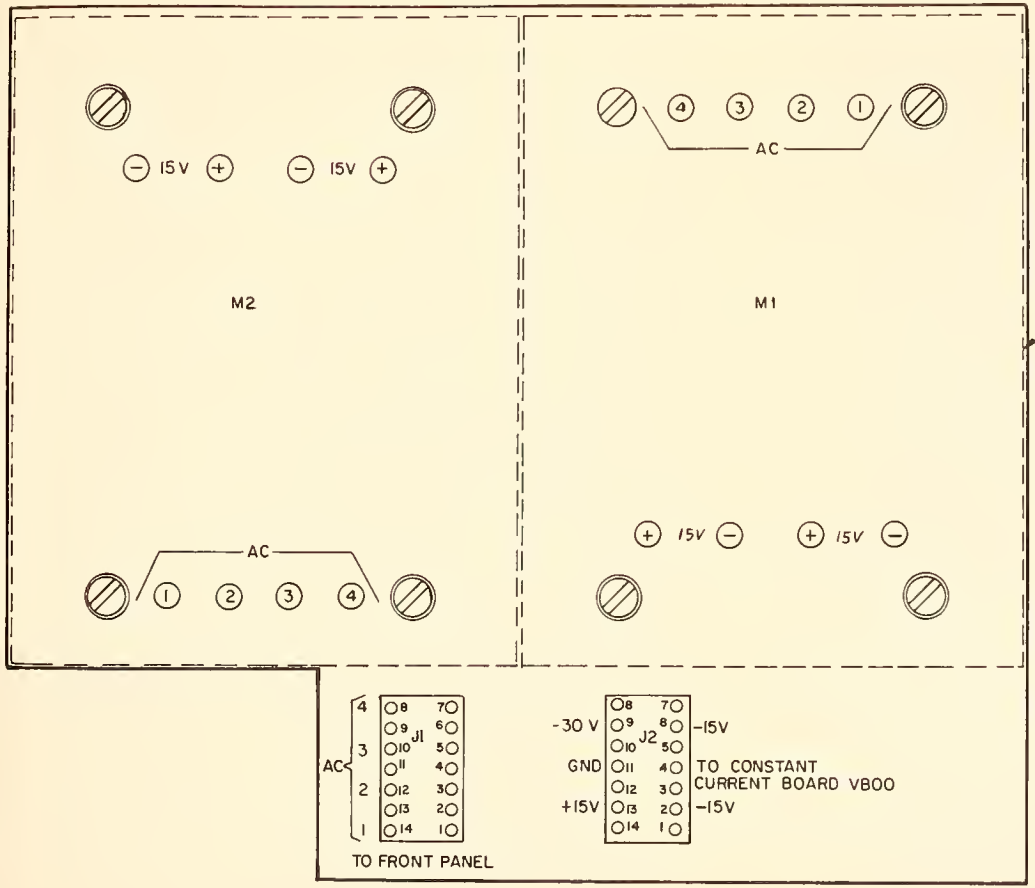
DIV. SEC. THIS PRINT ISSUED	APPROVED BY CHIEF, DIV.	
	2766480 - V900	

Figure 39. V900 Power Supply Schematic.



ORIGINAL DATE OF DRAWING			
REVISIONS			
NO	E C N	CHANGE	DATE
1			
2			
3			
4			

PIECE NO	NOMENCLATURE	NO REQ'D
	ASSY, NOISE ADD PWR SUPPLY BOARD	

NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

FOR EARTH TERMINAL MEASUREMENT SYSTEM

MODEL	TYPE	SCALE
DIMENSIONS IN INCHES (Unless otherwise specified)	DRAFTSMAN MMM	CHECKER
TOLERANCES (Unless otherwise specified)	PROJECT ENGR	PROJECT ENGR
DECIMALS ±.005	SUBMITTED BY	
FRACTIONS ±.015		CHIEF, SEC
ANGLES ±½°	EXAMINED BY	
DO NOT SCALE THIS PRINT		CHIEF ENGINEER
DIV. SEC.	APPROVED BY	
THIS PRINT ISSUED		CHIEF, DIV
	2766480-V900	

NBS 548

Figure 40. V900 PC Assembly Drawing.

10. INTERCONNECTION CABLES

10.1 CABLE LIST

QTY RQD	DESCRIPTION	FROM/TO
5	15 cm (6 inch) BNC Coax	
1	60 cm (2 ft.) Type "N" RF Det. Input	
1	120 cm (4 ft.) Type "N" Coax	
1	15 cm (6 inch) Type "N" to Term. IF Adaptor	
2	6 meter (20 ft.) BNC with BNC to Type "N" Adaptor and Type "N" Female Plug	J-653/J-654
1	45 cm (18 inch) Rigid SMA to Type "N" Coax	
2	90 cm (3 ft.) BNC with BNC to Type "N" Adaptor	
1	10 cm (4 inch) Adaptor Type BNC to Viking 5 Pin (Aux Voltage Input)	J357
1	BCD I/O Cable No. 3	J400/9830
1	BCD I/O Cable No. 2	J352/9830
1	TTL I/O Cable No. 4	J650/9830
1	Cassette I/O Cable No. 5	9865A/9830
1	Printer I/O Cable	9866B/9830
1	A.C. Power Interconnect	J651/J653
1	RF Unit to MUX Control	J655/J355
1	RF Unit Analog Voltages	J654/Pwr. Det. Remote
1	Bridge Voltage	J356/J456
1	Temp. Dew. Pt. from MUX	J351/J201-202
1	DVM to MUX Control	J204/MUX
1	DVM Input	
7	A.C. Power Cords	
2	1.5 meter (5 ft.) Noise Add. SMA	
1	Dew Point Sensor	
1	Temperature Sensor	
1	30 meter (100 ft.) Dew. Pt. Sens. Ext. Cable	
2	15 meter (50 ft.) Temp. Sens. Ext. Cables	

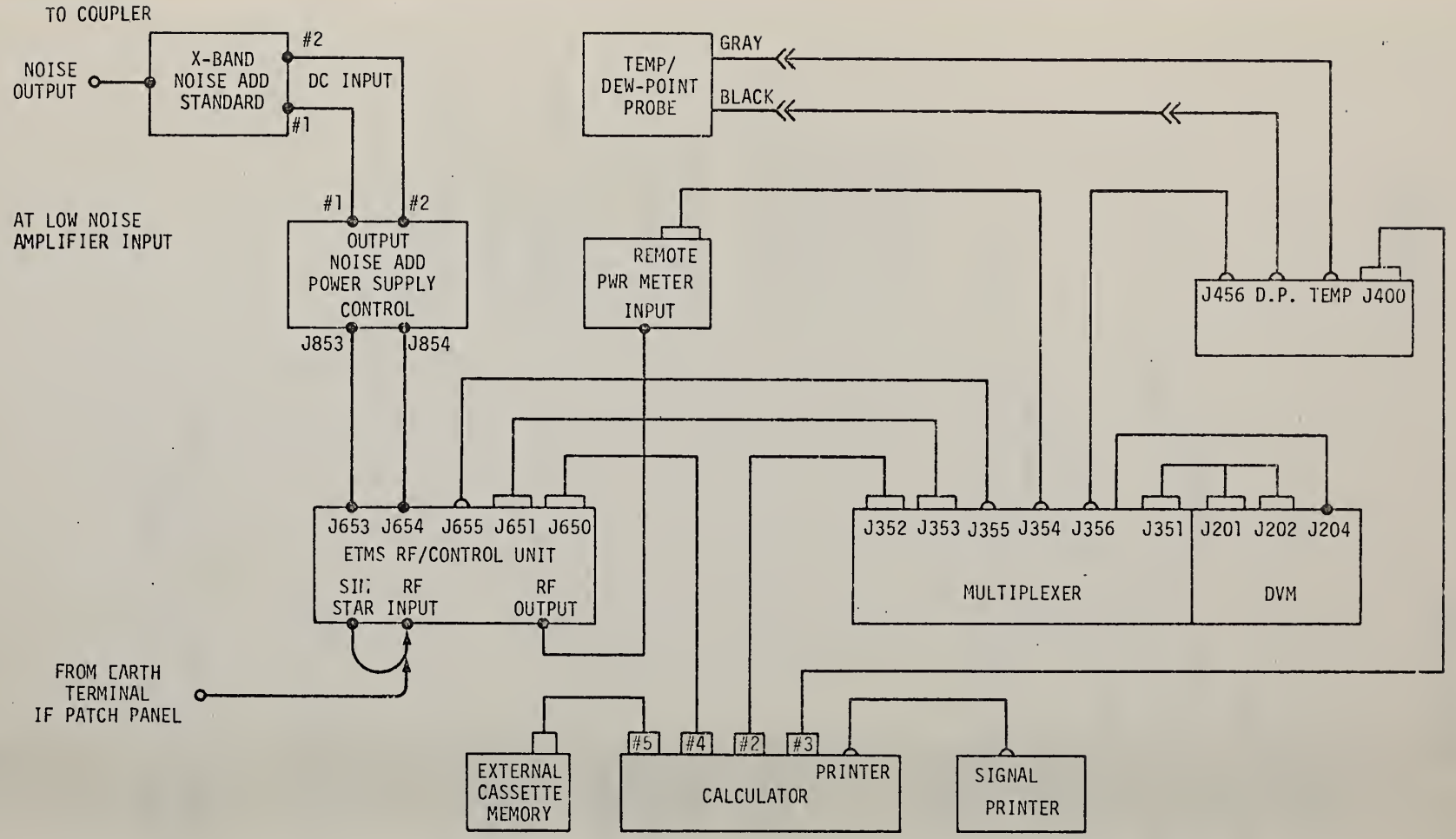


Figure 41. System Interconnection Cables.

10.2 Cable Wiring List

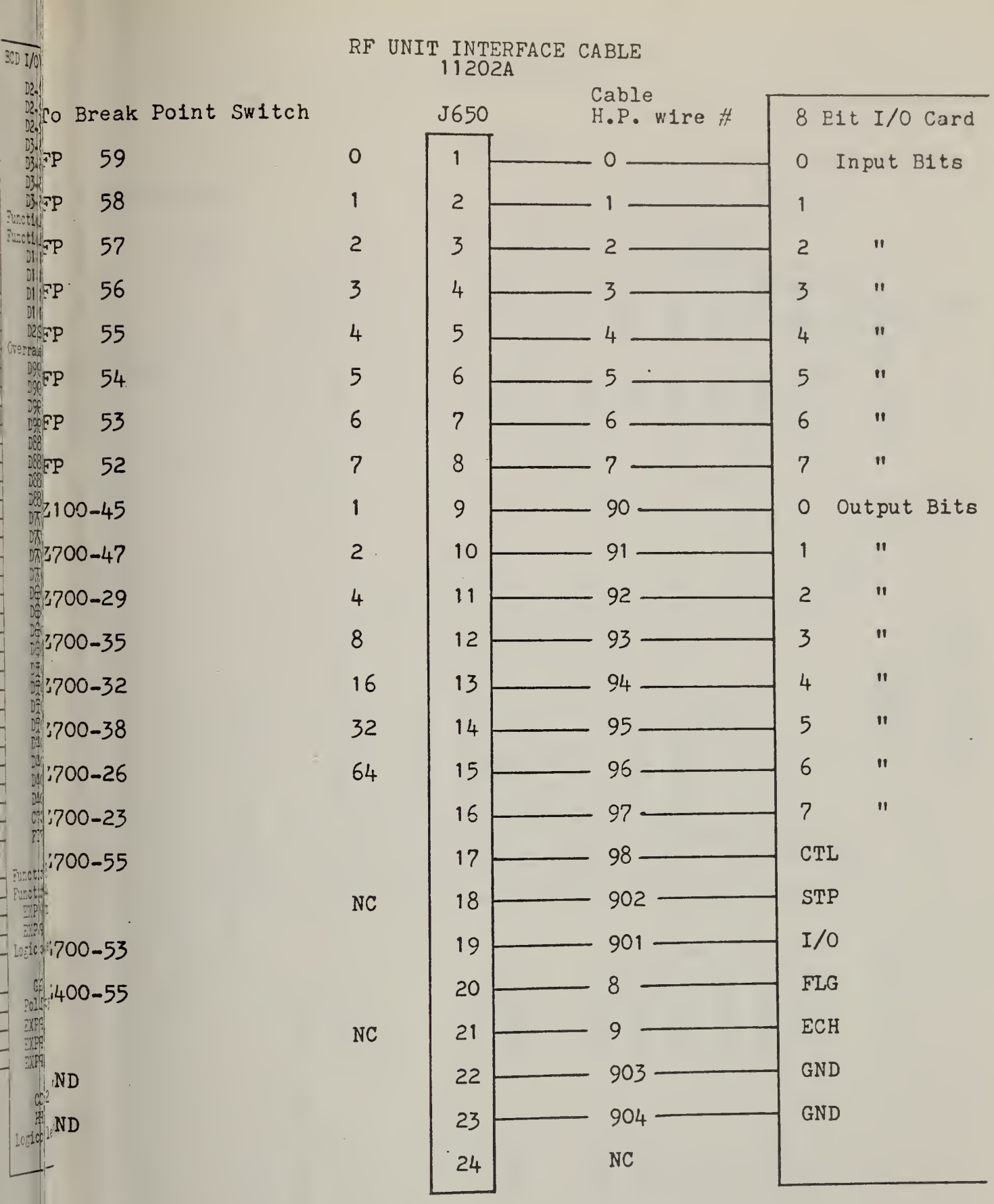
MULTIPLEXER/DVM BCD I/O CABLE 11203A

Signal	Source	J352	Wire #	BCD I/O Card
100K	J351-21	1	925	D4-1
10K	J351-17	2	5	D5-1
1K	J351-13	3	4	D6-1
100K	J351-4	4	3	D7-1
10K	J351-5	5	2	D8-1
1K	J351-1	6	1	D9-1
	GND	7	934	D4-2
20K	J351-18	8	91	D5-2
2K	J351-14	9	7	D6-2
200K	J351-10	10	8	D7-2
20K	J351-6	11	9	D8-2
2K	J351-2	12	90	D9-2
	GND	13	938	D4-4
40K	J351-19	14	902	D5-4
4K	J351-15	15	93	D6-4
400K	J351-11	16	94	D7-4
40K	J351-7	17	95	D8-4
4K	J351-3	18	96	D9-4
	GND	19	956	D4-8
80K	J351-20	20	912	D5-8
8K	J351-16	21	904	D6-8
800K	J351-12	22	905	D7-8
80K	J351-8	23	906	D8-8
8K	J351-4	24	907	D9-8
1	Y100-58	25	0	EXP-1
2	Y100-51	26	913	EXP-2
3	Y100-42	27	97	EXP-4
4	Y100-38	28	908	EXP-8
DC	J351-26	29	6	Function-1
AC	J351-27	30	92	Function-2
Ohms	J351-28	31	98	Function-4
	NC	32	903	Function-8
		33	918	D1-1
		34	923	D2-1
"1"	Y100-3	35	924	D3-1
"1"	Y100-3	36	928	D3-2
"1"	Y100-3	37	948	D3-8
"1"	Y100-3	38	937	D3-4
	GND	39	926	D1-2
		40	927	D2-2
		41	935	D1-4
		42	936	D2-4
Overrange	J351-30	43	914	Overrange
Carry	Y100-3	44	916	EXP Sign
		45	946	D1-8
		46	947	D2-8
Direct Command	J351-46	47	958	Control 1
Data Ready	J351-34	48	967	Flag
	GND	49	968	GND
Polarity( )	J351-29	50	901	Polarity(−)
			917	Logic Select(−)
		NC	915	Logic Select(+)
		NC	945	H/L
		NC	957	CTL 2

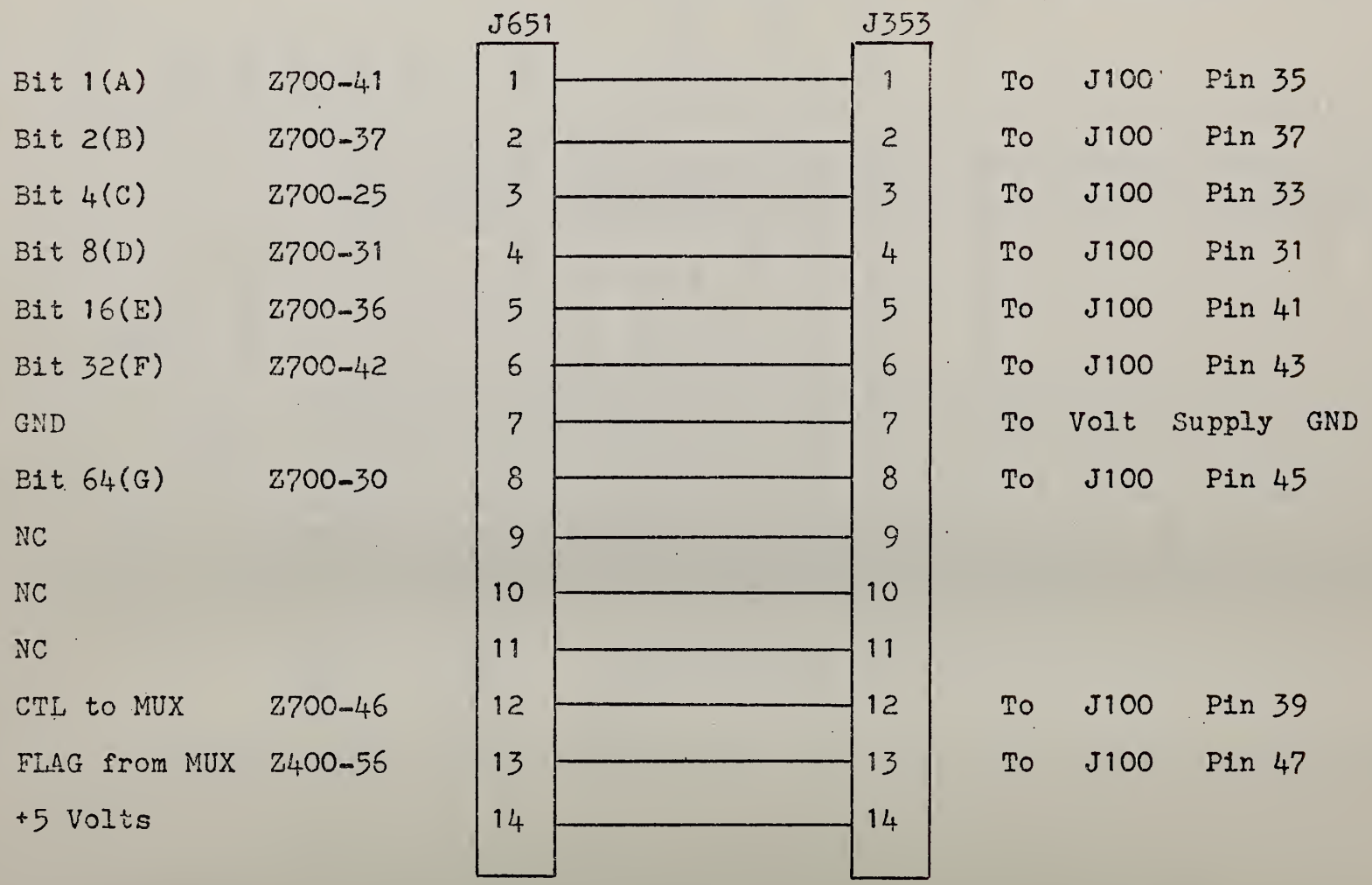
CLOCK I/O CABLE 11203A

Signal	Source	P400/J11	Wire #	BCD I/O Card
C 10's Day	X3-4	1	936	D2-4
B " "	X3-6	2	927	D2-2
A " "	X3-8	3	923	D2-1
D "1" Day	X3-10	4	948	D3-8
C " "	X3-12	5	937	D3-4
B " "	X3-14	6	928	D3-2
A " "	X3-16	7	924	D3-1
B 10's Month	X3-18	8	92	Function-2
A " "	X3-20	9	6	Function-1
D "1" Month	X3-22	10	946	D1-8
C " "	X3-24	11	935	D1-4
B " "	X3-26	12	926	D1-2
A " "	X3-28	13	918	D1-1
D 10's Day	X3-30	14	947	D2-8
Pwr Fail	J2-7	15	914	Overrange
A "1" Second	J2-L	16	1	D9-1
B " "	J2-K	17	90	D9-2
C " "	J2-9	18	96	D9-4
D " "	J2-10	19	907	D9-8
A 10's Second	J2-N	20	2	D8-1
B " "	J2-M	21	9	D8-2
C " "	J2-11	22	95	D8-4
D " "	J2-12	23	906	D8-8
A "1" Minutes	J2-5	24	3	D7-1
B " "	J2-R	25	8	D7-2
C " "	J2-14	26	94	D7-4
D " "	J2-15	27	905	D7-8
A 10's Minutes	J2-U	28	4	D6-1
B " "	J2-T	29	7	D6-2
C " "	J2-16	30	93	D6-4
D " "	J2-17	31	904	D6-8
A "1" Hours	J2-X	32	5	D5-1
B " "	J2-W	33	91	D5-2
C " "	J2-19	34	902	D5-4
D " "	J2-20	35	912	D5-8
A 10's Hours	J2-2	36	925	D4-1
B " "	J2-Y	37	934	D4-2
C " "	J2-21	38	938	D4-4
D " "	J2-22	39	956	D4-8
Command	X3-35	40	958	CTL-1
Ready Flag	X3-33	41	967	Flag
		42		
D 10's Month	X3-32	43	903	Function-8
C " "	X3-40	44	98	Function-4
"1"	X3-43	45	916	EXP Sign
"1"	X3-44	46	913	EXP-2
	GND	47	917	Logic Select(-)
		48		
	X3-59/GND	49	968	GND
	GND	50	901	Polarity
			0	EXP-1
			97	EXP-4
			908	EXP-8
		NC	957	CTL-2
		NC	945	H/L
		NC	915	Logic Select(+)

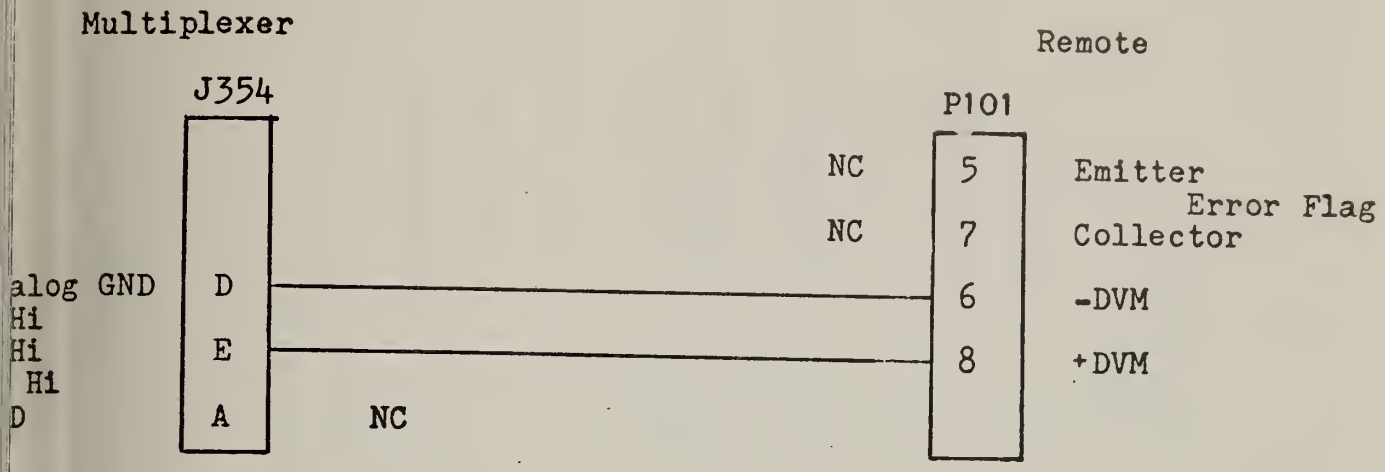
RF UNIT INTERFACE CABLE
11202A

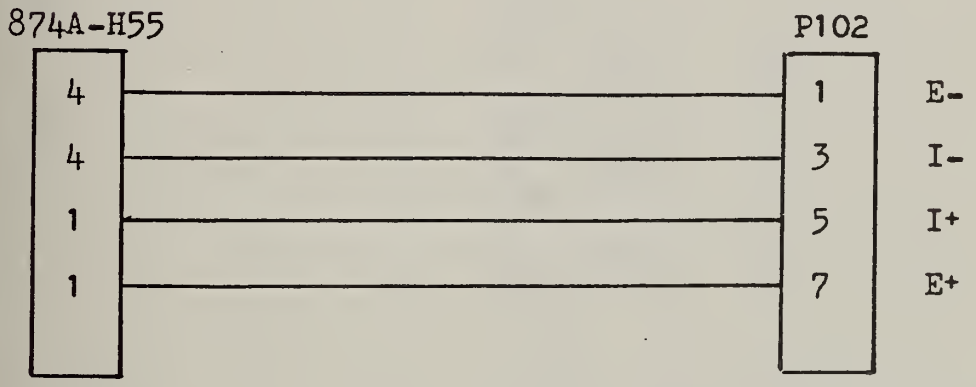


CONTROL CABLE

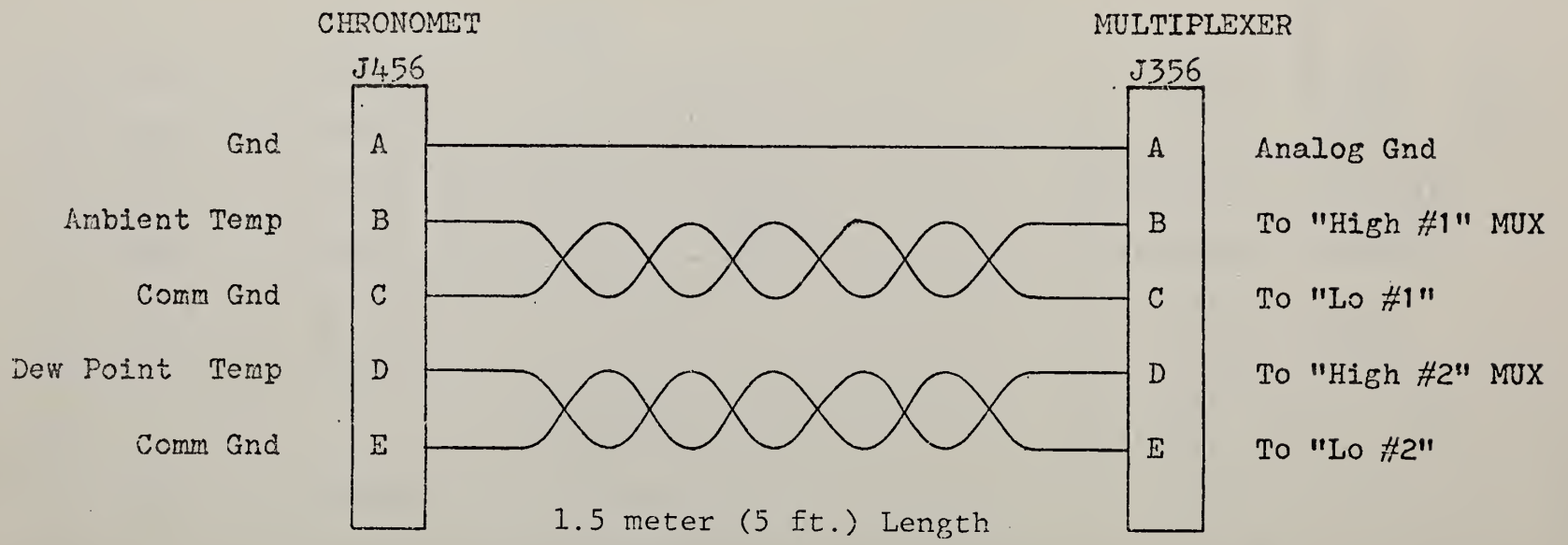


Cables

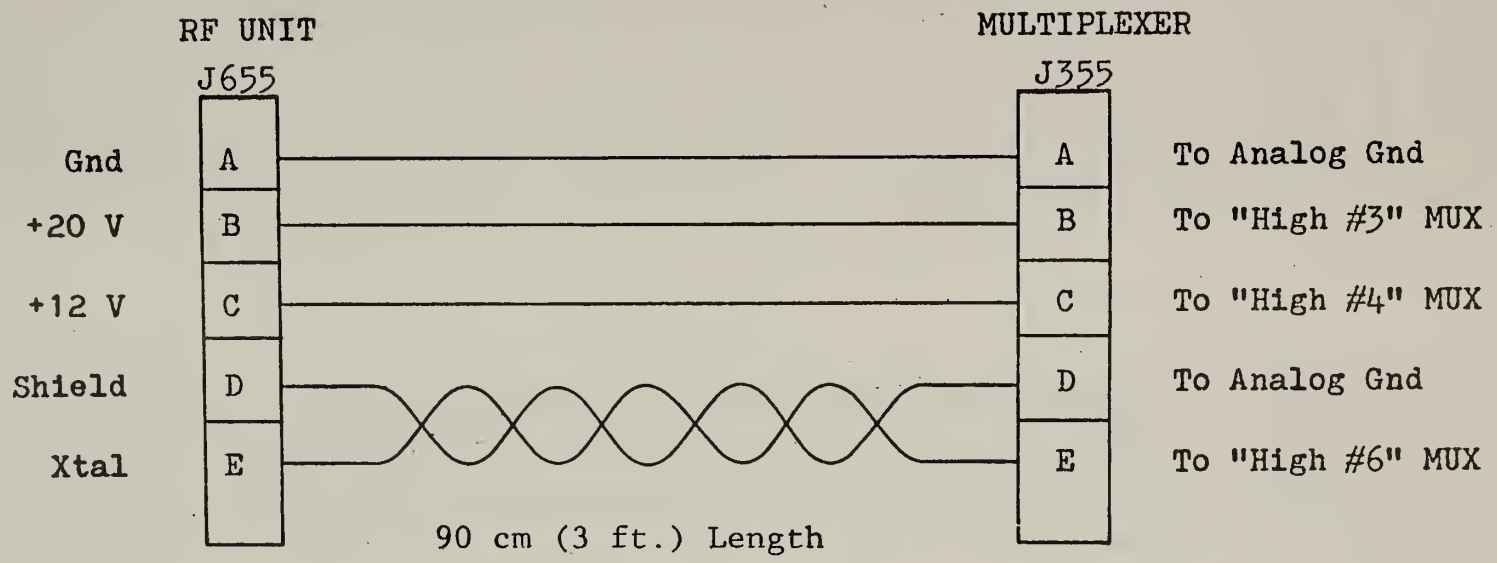

Multiplexer
J354
Remote
P101
NC
NC
5
7
Emitter
Error Flag
Collector
alog GND
Hi
Hi
Hi
D
D
E
A
NC
6
8
-DVM
+DVM


874A-H55
P102
4
4
1
1
1
3
5
7
E-
I-
I+
E+

TEMPERATURE/DEW POINT ANALOG CABLE

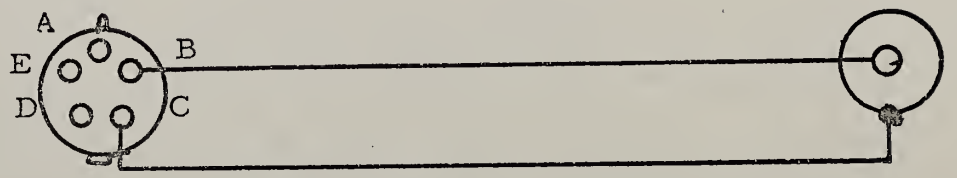


RF UNIT ANALOG CABLE



MULTIPLEXER AUXILIARY INPUT CABLE

(CHANNEL # 11)



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BNC

ACKNOWLEDGMENTS

This measurement system was developed through the combined efforts of a large number of people. This author is indebted especially to William C. Daywitt, Lanny D. Driver, and David F. Wait for the development of the theory and extensive software; to Gerome R. Reeve for the initial equipment design; and to Thomas H. Bremer and Douglas P. Kremer for their efforts in the packaging design and assembly.

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[4] Dent, W. A., H. D. Aller, E. T. Olsen, "The Evolution of the Radio Spectrum of Cassiopeia A," The Astrophysical Journal, 188, PPL11-13, Feb. 1974.

[5] Daywitt, W. C., "Error Equations Used in the NBS Precision G/T Measurement System,," NBSIR 76-842, Sept. 1976.

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[7] Kanda, M., "An Improved Solid-State Noise Source," IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-29, No. 8, pp. 990-995, Dec. 1976.

[8] Larsen, N. T., "NBS Type IV RF Power Meter Operation and Maintenance," NBSIR 77-866, Oct. 1977.

[9] Smith, J. I., Modern Operational Circuit Design, pp. 155-160, Wiley Inter-Science, New York (1971).

[10] The Fahrenheit temperature scale is used instead of the Celcius scale because it is easier to implement a temperature scale which is non-negative over the measurement range.

APPENDIX A: SPARE PARTS AND SUPPLIES

3 Boxes Paper
1 Box Prog. Cassettes
1 Box Blank Cassettes
1 Logic Probe
1-15V Power Supply
1-5V Power Supply
1-12V Power Supply
1-20 Power Supply
1-Type IV Power Meter
1-Temp/DP Enclosure/W Probes
1-11202A Card
1-11203A Card
1-Aertech Amplifier
1-1C Test Clip
1-Dew-point Bobbin
1-Coax Relay
1-Aux Mux Adapter
1-HP 478A-H55
1-PC ext. Card.
2-Mux Relays
2-LED
1-SN 74159N
1-MC 201 Noise Diode
2-OP-05 Amp.
1-7824 Voltage Regulator
1-15 meter (50 ft.) Probe Ext. Cable Red
1-15 meter (50 ft.) Probe Ext. Cable Blue
1-30 meter (100 ft.) Probe Ext. Cable
60 meter (200 ft.) Nylon Cord
1-Fan
1-X1 PC Card
1-X2 PC Card
1-X3 PC Card
1-Y100 PC Card
1-Y200 PC Card
1-Z400 PC Card
1-Z500 PC Card
1-Z700 PC Card

APPENDIX B

PARTS LIST MANUFACTURER'S CODE TABLE

3M
3M Company, Electronics Products Division
3M Center
St. Paul, Minnesota 55101

AB
Allen-Bradley Company
1201 S. Second Street
Milwaukee, Wisconsin 53204

AERT
Aertech Industries
825 Stewart Drive
Sunnyvale, California 94086

ALCO
Alcoswitch Division of Alco Electronic Products, Inc.
P.O. Box 1348
Lawrence, Massachusetts 01842

ALPH
ALPHA Wire Corporation
711 Lidgerwood Avenue
Elizabeth, New Jersey 07207

AMER
American Microwave Connector Division
Omni Spectra, Inc.
Waltham, Massachusetts 02154

AMPH
Amphenol Connector Division
Bunker-Ramo Corporation
Broadview, Illinois 60153

AVNT
Avantek Incorporated
3175 Bowers Avenue
Santa Clara, California 95051

BB
Burr-Brown Research Corporation
6730 South Tucson Blvd.
Tucson, Arizona 85734

BELD
Beldon Corporation, Electronic Division
P.O. Box 1331
Richmond, Indiana 47374

BRNS
Bourns, Incorporated, Trimpot Division
1200 Columbia Avenue
Riverside, California 92507

BUD
Bud Radio Incorporated
4605 East 355th Street
Willoushby, Ohio 44094

CAMB
Cambridge Thermionic Corporation
445 Concord Avenue
Cambridge, Massachusetts 02138

CD
Cornell-Dubilier Electronics Division
Federal Pacific Electric Company
Newark, New Jersey 07101

CHGM
Chicago Miniature Lamp Company
4433 North Ravenswood Avenue
Chicago, Illinois 60640

CIRQ
Ciratel Incorporated
10504 Wheatley Street
Kensington, Maryland 20795

CNCH
CINCH/TRW Electronic Components Div.
1501 Morse Avenue
Elk Grove Village, Illinois 60007

CORG
Corning Glass Works
Electronic Products Division
Corning, New York 14830

CORM
Corcom, Incorporated
2635 North Kildare Avenue
Chicago, Illinois 60639

CORN
Corning Glass Works
Electronic Products Division
Corning, New York 14830

COTO
Coto-Coil, Incorporated
65 Pavilion Avenue
Providence, Rhode Island 02905

CROM
Corcom, Incorporated
2635 North Kildare Avenue
Chicago, Illinois 60639

CY
Codi Semiconductor Corporation
Pollitt Drive
Fair Lawn, New Jersey 07410

DATL
Datel Systems, Incorporated
1020 Turnpike Street
Canton, Massachusetts 02021

DEST
Destek Industries
P.O. Box 24163
Los Angeles, California 90024

DIAL
Dialight Corporation
Division of North American Phillips Corporation
Brooklyn, New York 11237

DLVN
Devalon Electronics, Inc.
14605 North 73rd Street
Scottsdale, Arizona 85260

DUNC
Duncan Electric Company, Incorporated
2865 Fairview Road
Lafayette, Indiana 47902

EFJ
E. F. Johnson Company
299 10th Avenue
Waseca, Minnesota 56093

GARY
Garry Manufacturing, Inc.
1010 Jersey Avenue
New Brunswick, New Jersey 08902

GE
General Electric Company
Electronic Components Division
Hudson Falls, New York 12839

GRAY
Grayhill, Incorporated
569 Hillgrove Avenue
La Grange, Illinois 69525

HP
Hewlett Packard Company
1501 Page Mill Road
Palo Alto, California 94304

INIF
Uniform Tubes, Incorporated
Microdelay Division
Collegeville, Pennsylvania 19426

ITSL
Intersil, Incorporated
10900 North Tantau Avenue
Cupertino, California 95014

LAMB
Lambda Electronics Corporation
Division of Veeco
Melville, New York 11746

LCFT
Leecraft Mfg., Inc.
21-16 44th Road
Long Island City, N.Y. 11101

MALL
P. R. Mallory & Company, Incorporated
P.O. Box 372
Indianapolis, Indiana 46206

MERR
Merrimac Industries, Incorporated
41 Fairfield Place
West Caldwell, New Jersey 07006

MID
Midwest Microwave, Incorporated
3800 Packard Road
Ann Arbor, Michigan 48104

MIDW
Midwest Microwave, Incorporated
3800 Packard Road
Ann Arbor, Michigan 48104

MODT
Modutec, Incorporated
18 Marshall Street
Norwalk, Conneticut 06854

MONO
Precision Monolithics, Incorporated
1500 Space Drive
Santa Clara, California 95050

MOT
Motorala Semiconductor Products, Incorporated
2002 West 10th Place
Tempe, Arizona 85281

NATL
National Semiconductor Corporation
2900 Semiconductor Drive
Santa Clara, California 95051

NBS
National Bureau of Standards
Division 723.05 325 South Broadway
Boulder, Colorado 80303

NEPT
Newport Laboratories, Incorporated
630 East Young Street
Santa Clara, California 92705

NLS
Non-Linear Systems, Incorporated
533 Stevens Avenue
Solana Beach, California 92075

OSM
Omni Spectra, Incorporated
21 Continental Blvd.
Merrimack, New Hampshire 03054

PANM
Pamotor, Incorporated
770 Airport Blvd.
Burlingame, California 94010

POMA
Pomona Electronics, Incorporated
P.O. Box 2767
Pomona, California 91766

RCA
Radio Corporation of America
Front & Cooper
Camden, New Jersey 08102

SAE
Stanford Applied Engineering, Incorporated
340 Martain Avenue
Santa Clara, California 95050

SAMT
Samtec, Incorporated
2652 Charlestown Road
New Albany, Indiana 47150

SCBE
Scanbe Canosa Industries
3445 Fletcher Avenue
El Monte, California 91731

SEAC
Seacor, Incorporated
598 Broadway
Norwood, New Jersey 07648

SEMI
Semiconductor Circuits, Incorporated
306 River Street
Haverhill, Massachusetts 01830

SPRG
Sprague Electric Company
481 Marshall Street
North Adams, Massachusetts 01247

SWCT
Switchcraft, Incorporated
5555 North Elston
Chicago, Illinois 82389

TELC
Telonic Altair, Incorporated
P.O. Box 277
Laguna Beach, California 92652

TELD
Teledyne Microwave, Incorporated
1290 Terra Bella Avenue
Mountain View, California 94040

TI
Texas Instruments, Incorporated
P.O. Box 5012
Dallas, Texas 75222

TROM
Trompter Electronics, Incorporated
8936 Comanche
Chatsworth, California 91311

ULTX
Ultronix, Incorporated
P.O. Box 1090
Grand Junction, Colorado 81501

UNIF
Uniform Tubes
Microdelay Division
Collegeville, Pennsylvania 19426

UT

Uniform Tubes
Microdelay Division
Collegeville, Pennsylvania 19426

VIKG

Viking Industries, Incorporated
9324 Topanga Cyn Blvd.
Chatsworth, California 91311

WAKE

Wakefield Engineering, Incorporated
Teal & Audobon Road
Wakefield, Massachusetts 01880

WEIN

Weinschel Engineering Company
P.O. Box 577
Gaithersburg, Maryland 20760

YSI

Yellow Springs Instrument Company
P.O. Box 279
Yellow Springs, Ohio 45387

APPENDIX C

CONTROL CODES

Program Switches and WBYTE

24	DVM AUTO RANGE
27	DVM 0.1 RANGE
28	DVM 1.0 RANGE
29	DVM 10.0 RANGE
30	DVM 100.0 RANGE
31	DVM 1000.0 RANGE
32	DVM DC VOLTS FILTER OUT
33	DVM DC VOLTS FILTER IN
34, 35	DVM RATIO-NOT USED IN ETMS
48	PROG ATTNR 15 dB
47	PROG ATTNR 14 dB
62	PROG ATTNR 1 dB
63	PROG ATTNR 0 dB
64	RF OFF/6 dB STEP IN
65	RF ON/6 dB STEP OUT
66	RF OFF
67	RF IN
68	6 dB IN
69	6 dB OUT
80	NOISE ADD ON
81	NOISE ADD OFF
82	NOISE ADD #1 ON
83	NOISE ADD #1 OFF
84	NOISE ADD #2 ON
85	NOISE ADD #2 OFF
100	INPUT CHANNEL #11 DVM
101	INPUT CHANNEL #10 DVM
102	INPUT CHANNEL # 9 DVM
103	INPUT CHANNEL # 8 DVM
104	INPUT CHANNEL # 7 DVM
105	INPUT CHANNEL # 6 DVM
106	INPUT CHANNEL # 5 DVM
107	INPUT CHANNEL # 4 DVM
108	INPUT CHANNEL # 3 DVM
109	INPUT CHANNEL # 2 DVM
110	INPUT CHANNEL # 1 DVM
111	INPUT CHANNEL # Ø DVM

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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 manual describes the equipment and maintenance procedures to support the earth terminal measurements system (ETMS) developed by the National Bureau of Standards for making measurements of earth terminal and satellite parameters such as figure of merit (G/T), antenna gain relative to a reproducible reference level, ratio of carrier power to the operating noise temperature (C/kT), and satellite effective isotropic radiated power (EIRP). System equipment specifications, site set-up instructions, equipment theory of operation, troubleshooting and maintenance are included. This manual does not include measurement theory nor measurement operating procedures that are described in the Earth Terminal Measurement System-Operation Manual.

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)

Earth terminal measurement system; effective isotropic radiated power; figure of merit; noise temperature; satellite communication.

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