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for information systems –

computer graphics – graphical kernel system (GKS) functional description

ANSI X3.124-1985

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American National Standard for Information Systems –

Computer Graphics – Graphical Kernel System (GKS) Functional Description

Secretariat

Computer and Business Equipment Manufacturers Association

Approved June 24, 1985

American National Standards Institute, Inc

Abstract

The graphical kernel system (GKS) is a set of basic functions for computer graphics programming useable by many graphics producing applications. This standard (1) allows graphics application programs to be easily transported between installations, (2) aids graphics applications programmers in understanding and using graphics methods, and (3) guides device manufacturers on useful graphics capabilities.

This standard defines an application level programming interface to a graphics system. Hence, it contains functions for (1) outputting graphical primitives, (2) controlling the appearance of graphical primitives with attributes, (3) controlling graphical workstations, (4) controlling transformations and coordinate systems, (5) generating and controlling groups of primitives called segments, (6) obtaining graphical input, (7) manipulating groups of device-independent instructions called metafiles, (8) inquiring the capabilities and states of the graphics system, and (9) handling errors. Twelve upwardly compatible levels of conformance are defined, addressing the most common classes of equipment and applications.

American National Standard

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Foreword

(This Foreword is not part of American National Standard X3.124-1985.)

This American National Standard provides a set of basic functions for computer graphics programming. These functions taken as a whole are called the graphical kernel system (GKS). The design of this standard is based on the work of many groups. Much of the early design methodology was developed at the Workshop on Graphics Standards Methodology held in May 1976 in Seillac, France, under IFIP WG5.2 sponsorship. GKS itself was originally developed by Deutsches Institut fur Normung (DIN), the West German standardization institute, in 1978 and was subsequently refined extensively between 1980 and 1982 by Working Group 2 of the Subcommittee on Programming Languages of the Technical Committee on Information Processing of the International Organization for Standardization (ISO TC 97/SC5/WG2). The resulting International Standard (Information Processing – Computer Graphics – Graphical Kernel System (GKS) Functional Description, ISO 7942-1985) was the basis for this American National Standard. The development of the GKS was heavily influenced by the work of the Graphic Standards Planning Committee of the Special Interest Group on Computer Graphics of the Association for Computing Machinery (ACM SIGGRAPH GSPC). This work, known as the Core System Proposal, was published and widely distributed in 1977 and again (in a revised version) in 1979.

This American National Standard on GKS is identical to ISO 7942-1985 (GKS) in almost all areas. All functional capabilities of ISO GKS are found in the ANSI GKS . The ANSI GKS does, however, differ in the following ways:

(1) A new minimal output level (denoted m) is defined.

(2) A new section defining a conforming program and a conforming implementation replaces a more restrictive conformance statement found in the body of the ISO GKS standard document.

(3) Several of the Annexes in the ISO GKS document have been modified. Also, the word "Annex" has been changed to "Appendix."

(4) The default for ASFs is INDIVIDUAL.

(5) The data records for INPUT have been defined.

Appendix G contains a detailed list of all the differences betwen ANSI X3.124-1985 and ISO 7942-1985.

This standard is supplemented by a derivative standard, American National Standard for Information Systems – Computer Graphics – Graphical Kernel System (GKS) FORTRAN Binding, ANSI X3.124.1-1985. ANSI X3.124-1985 corresponds to ISO 7942-1985 in that it represents the functional aspects of GKS. ANSI X3.124.1-1985 contains specifications not present in this standard, namely, the syntax for using GKS functions and data types from American National Standard Programming Language FORTRAN, ANSI X3.9-1978, colloquially known as FORTRAN '77. Three additional language bindings of GKS are under development by Technical Committee X3H3: Pascal, Ada, and C. These standards, when approved by X3 and ANSI, will be published as ANSI X3.124.2, X3.124.3, and X3.124.4, respectively. Internationally, these language bindings of GKS will be published as parts of a multipart ISO standard, currently known as ISO/DP 8651-1984.

This standard was developed by Technical Committee X3H3 of Accredited Standards Committee X3 under two projects authorized by X3; namely, project 268D and project 362D. More specifically, GKS, as a whole, meets the goals of project 268D, while the minimal output level m found in this American National Standard, but not present in ISO 7942-1985, meets the goals of project 362D.

This standard was approved as an American National Standard by the American National Standards Institute on June 24, 1985.

Suggestions for improvement of this standard will be welcome. They should be sent to the Computer and Business Equipment Manufacturers Association, 311 First Street, NW, Suite 500, Washington, DC 20001.

This standard was processed and approved for submittal to ANSI by Accredited Standards Committee on Information Processing Systems, X3. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

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Technical Committee X3H3 on Computer Graphics, which developed the draft proposals, which held the U.S. Technical Advisory Group responsibilities for ISO TC 97/SC5/WG2, and through which this standard was completed, had the following members:

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American National Standard for Information Systems –

Computer Graphics – Graphical Kernel System (GKS) Functional Description

0 Introduction

The Graphical Kernel System (GKS) provides a set of functions for computer graphics programming. GKS is a basic graphics system that can be used by the majority of applications that produce computer generated pictures.

The main reasons for introducing a standard for basic computer graphics are:

a) to allow application programs involving graphics to be easily portable between different installations;

b) to aid the understanding and use of graphics methods by application programmers;

c) to serve manufacturers of graphics equipment as a guideline in providing useful combinations of graphics capabilities in a device.

In order to reach these main objectives, the GKS design was based on the following requirements:

d) GKS should include all the capabilities that are essential for a broad spectrum of graphics, from simple passive output to highly interactive applications.

e) The whole range of graphics devices, including vector and raster devices, microfilm recorders, storage tube displays, refresh displays and colour displays should be controllable by GKS in a uniform way.

f) GKS should provide all the capabilities required by a majority of applications without becoming unduly large.

These requirements were used to formulate a number of principles that were used to judge specific design alternatives. Thus it was possible to contribute to the overall design goais while focussing on certain aspects. Five design aspects were identified, each having a group of principles

g) Design goals: The following principles should not be violated by any technical design:

1) consistency: the mandatory requirements of GKS should not be mutually contradictory;

2) compatibility: other standards or commonly accepted rules of practice should not be violated;

3) orthogonality: the functions or modules of GKS should be independent of each other, or the dependency should be structured and well defined.

h) Functional capabilities: The following principles were used to define the extent of GKS:

1) completeness: all functions that a majority of applications want to use on a given level of functionality should be included;

2) minimality: functions that are unnecessary for applications of a given level of functionality should not be provided;

3) compactness: an application should be able to achieve a desired result by a set of functions and parameters that is as small as possible;

4) richness: a rich set of functions offers an extensive range of facilities that stretches beyond the basic functions and includes higher order capabilities.

It is obvious that there is a trade off between the principles in this group. Therefore, the functions of GKS are organized in twelve levels. An implementation of GKS provides at least the functions of one of these levels. While the lowest level contains only a minimal set of functions, higher levels are allowed to extend beyond the basic needs towards greater richness.

i) User interface design: The following principles were used to define the user interface design:

1) user friendliness: GKS should allow the design of a desirable user interface;

2) clarity: the concepts and functional capabilities of GKS should be easily understandable, especially by the application programmer;

3) error handling: failure of system functions or modules, caused by errors of the system itself or by the application program, should be treated in such a way that the error reaction is clearly understandable and informative to the application programmer and that the impact on the system and the application program is as small as possible.

Clarity and sound error handling are essential parts of user friendliness. Error handling is an integral part of GKS. To aid clarity, the system and its state can be presented to the user in an easily comprehensible manner.

Clarity applies not only to the system design but also to the system description. To this end, the GKS specification is divided into a general description, a description of the underlying logical data structures representing the state of the system, and a description of the functions and their effects on these data structures.

j) Graphics devices: The following principles are associated with the range of graphics devices that can be addressed by GKS:

1) device independence: GKS functions should be designed to allow an application program, using these functions, to address facilities of quite different graphics output and input devices without modification of the program structure;

2) device richness: the full capabilities of a wide range of different graphics output and input devices should be accessible from the functions of GKS.

These principles led to a fundamental concept underlying the GKS architecture: the concept of multiple independent graphical workstations connected to and driven by GKS. The application program can inquire the capabilities of every workstation. The GKS design includes escape functions that are easily identifiable within an application program and can be used to access special facilities of a particular device.

k) Implementation: The last group of principles is related to the implementation of GKS:

1) implementability: it should be possible to support the GKS functions in most host languages, on most operating systems and with most graphics devices;

2) language independence: it should be possible to access the standard facilities of GKS from all ISO standard programming languages;

3) efficiency: GKS should be capable of being implemented without time consuming algorithms;

4) robustness: the operator and application programmer should be protected in the best possible way from hardware or software failure of the system.

The five groups of principles are interconnected. For example, design goals and functional capabilities both contribute to user friendliness. Efficiency is also important when considering response time in an interactive environment. Some principles may be conflicting, such as richness versus minimality, comprehensive error handling versus efficiency, and compactness versus device richness. Compromises needed to be made to achieve the overall design objective: GKS should have an easily comprehensible structure and a set of functions that enables a vast majority of computer graphics users to design portable, device independent application programs addressing the whole range of computer graphics equipment.

0.1 Conformance

An implementation conforms to a specific level of this standard if it provides, at least, all the functions specified in that level, but not all the functions of the next higher level. Any function specified by the standard that is provided by an implementation must execute according to the semantics specified in this standard. In addition, an implementation may provide functions not specified in any level of this standard as long as these extensions do not cause standard functions to execute incorrectly. These extensions should be constructed to obey the philosophy of GKS.

A program conforms to a specific level of this standard if it does not use any functions outside of that level.

To conform to the standard, an implementation or program that is written for a language for which a standard binding has been developed must use the syntax specified in that language binding.

1 Scope and Field of Application

This American National Standard specifies a set of functions for computer graphics programming, the Graphical Kernel System (GKS). GKS is a basic graphics system for applications that produce computer generated two dimensional pictures on line graphics or raster graphics output devices. It supports operator input and interaction by supplying basic functions for graphical input and picture segmentation. It allows storage and dynamic modification of pictures. A fundamental concept in GKS is the workstation, consisting potentially of a number of input devices and a single output device. Several workstations can be used simultaneously. The application program is allowed to adapt its behaviour at a workstation to make best use of workstation capabilities. This standard includes functions for storage on and retrieval from an external graphics file. Last, but not least, the functions are organized in upward compatible levels with increasing capabilities.

For certain parameters of the functions, GKS defines value ranges as being reserved for registration or future standardization. The meanings of these values will be defined using the procedures established in an International Standard under development (Procedures for registration of graphical items).

Part 1 of GKS defines only a language independent nucleus of a graphics system. For integration into a language, GKS is embedded in a language dependent layer containing the language conventions, for example, parameter and name assignment. Language bindings are contained in Part 2.

The appendicies are given for information; they do not form part of the specification.

2 References

ANSI X3.4-1977	7-bit coded character set for information processing interchange
ISO 7942	Information Processing, Graphical Kernel System (GKS), Functional Description
ISO 646	7-bit coded character set for information processing interchange
ISO 2022	Information processing - ISO 7-bit and 8-bit coded character sets - Code extension techniques
ISO 2382/13	Data processing - Vocabulary - Section 13: Computer Graphics
ISO 6093 [1)]	Information processing - Representation of numeric values in character strings for information interchange
ISO 8632 [1)]	Information processing - Computer graphics - Metafile for transfer and storage of picture description information Part 1 : Functional description Part 2 : Character encoding Part 3 : Binary encoding Part 4 : Clear text encoding

1) In course of preparation

3 Definitions

This section gives the definition of the important terms of the Graphical Kernel System (GKS).

NOTE As far as possible, commonly accepted graphics terminology is used.

3.1 acknowledgement: Output to the operator of a logical input device indicating that a trigger has fired.

3.2 aspect ratio: A ratio of x to y used to describe the shape of a rectangle in a particular coordinate system (for example, of a workstation window or a workstation viewport).

3.3 aspects of primitives: Ways in which the appearance of a primitive can vary. Some aspects are controlled directly by primitive attributes; some can be controlled indirectly through a bundle table. Primitives inside segments have an aspect controlled through the segment containing them, for example highlighting; primitives outside segments do not.

3.4 attribute: A particular property that applies to a display element (output primitive) or a segment. Examples: highlighting, character height. In GKS, some properties of workstations are called workstation attributes.

3.5 baseline: A horizontal line within a character body (see figure 3) which, for many character definitions, has the appearance of being a lower limit of the character shape. A descender passes below this line. All baselines in a font are in the same position in the character bodies.

3.6 bundle index: An index into a bundle table for a particular output primitive. It defines the workstation dependent aspects of the primitive.

3.7 bundle table: A workstation dependent table associated with a particular output primitive. Entries in the table specify all the workstation dependent aspects of a primitive. In GKS, bundle tables exist for the following output primitives: polyline, polymarker, text and fill area.

3.8 capline: A horizontal line within a character body (see figure 3) which, for many character definitions, has the appearance of being the upper limit of the character shape. An ascender may pass above this line and in some languages an additional mark (for example an accent) over the character may be defined above this line. All caplines in a font are in the same position in the character bodies.

3.9 cell array: A GKS output primitive consisting of a rectangular grid of equal size rectangular cells, each having a single colour.

NOTE These cells do not necessarily map one-to-one with pixels.

3.10 centreline: A vertical line bisecting the character body (see figure 3).

3.11 character body: A rectangle used by a font designer to define a character shape (see figure 3). All character bodies in a font have the same height.

3.12 choice device: A GKS logical input device providing a non-negative integer defining one of a set of alternatives.

3.13 clipping: Removing parts of display elements that lie outside a given boundary, usually a window or viewport.

3.14 colour table: A workstation dependent table, in which the entries specify the values of the red, green and blue intensities defining a particular colour.

3.15 coordinate graphics; line graphics: Computer graphics in which display images are generated from display commands and coordinate data.

3.16 device coordinate (DC): A coordinate expressed in a coordinate system that is device dependent. In GKS, DC units are metres on a device capable of producing a precisely scaled image and appropriate workstation dependent units otherwise.

3.17 device driver: The device dependent part of a GKS implementation intended to support a graphics device. The device driver generates device dependent output and handles device dependent interaction.

3.18 device space: The space defined by the addressable points of a display device.

3.19 display device; graphics device: A device (for example refresh display, storage tube display, plotter) on which display images can be represented.

3.20 display image; picture: A collection of output primitives or segments that are represented together at any one time on a display surface.

3.21 display space: (1) That portion of the device space corresponding to the area available for displaying images. (2) The working space of an input device such as a digitiser.

3.22 display surface; view surface: In a display device, that medium on which display images may appear.

3.23 echo: The immediate notification of the current value provided by an input device to the operator at the display console.

3.24 escape: A function in GKS used to access implementation or device dependent features, other than for the generation of graphical output, that are not otherwise addressed by GKS.

3.25 feedback: Output indicating to the operator the application program's interpretation of a logical input value.

3.26 fill area: A GKS output primitive consisting of a polygon (closed boundary) which may be hollow or may be filled with a uniform colour, a pattern, or a hatch style.

3.27 fill area bundle table: A table associating specific values for all workstation dependent aspects of a fill area primitive with a fill area bundle index. In GKS, this table contains entries consisting of interior style, style index, and colour index.

3.28 Generalized Drawing Primitive (GDP): An output primitive used to address special geometrical workstation capabilities such as curve drawing.

3.29 GKS level: Two values from the sets (m,0,1,2) and (a,b,c) which together define the minimal functional capabilities provided by a specific GKS implementation.

3.30 GKS Metafile (GKSM): A sequential file that can be written or read by GKS and is used for long-term storage (and for transmittal and transferral) of graphical information.

3.31 halfline: A horizontal line between the capline and the baseline within the character body (see figure 3), about which a horizontal string of characters in a font would appear centrally placed in the vertical direction. All halflines in a font are in the same position in the character bodies.

3.32 hatch: One possible method of filling the interior of a polygon specified by a fill area primitive. The interior is filled with an arrangement of one or more sets of parallel lines.

3.33 highlighting: A device independent way of emphasizing a segment by modifying its visual attributes. For example, blinking.

3.34 implementation mandatory: Implementation mandatory describes a property that is required to be realized identically on all workstations of all implementations of GKS.

3.35 input class: A set of input devices that are logically equivalent with respect to their function. In GKS, the input classes are: LOCATOR, STROKE, VALUATOR, CHOICE, PICK and STRING.

3.36 inquiry function: A GKS function whose purpose is to return values depending on the current state of GKS or on some fixed property of the GKS implementation. There is no effect on the state of GKS or on the display image.

3.37 locator device: A GKS logical input device providing a position in world coordinates and a normalization transformation number.

3.38 logical input device: A logical input device is an abstraction of one or more physical devices that delivers logical input values to the program. Logical input devices in GKS can be of type LOCATOR, STROKE, VALUATOR, CHOICE, PICK and STRING.

3.39 logical input value: A value delivered by a logical input device.

3.40 marker: A glyph with a specified appearance which is used to identify a particular location.

3.41 measure: A value (associated with a logical input device), which is determined by one or more physical input devices, and a mapping from the values delivered by the physical devices. The logical input value delivered by a logical input device is the current value of the measure.

3.42 MI: An abbreviation for GKS metafile input, a category of workstation.

3.43 MO: An abbreviation for GKS metafile output, a category of workstation.

3.44 normalization transformation; viewing transformation; window-to-viewport transformation: A transformation that maps the boundary and interior of a window to the boundary and interior of a viewport. In GKS, this transformation maps positions in world coordinates to normalized device coordinates.

3.45 normalized device coordinates (NDC): A coordinate specified in a device independent intermediate coordinate system, normalized to some range, typically 0 to 1. In GKS, during an intermediate state the coordinates may lie outside the defined range, but associated clipping information ensures that the output does not exceed the coordinate range $[0,1] \times [0,1]$.

3.46 operator: Person manipulating physical input devices so as to change the measures of logical input devices and cause their triggers to fire.

3.47 output primitive; graphic primitive; display element: A basic graphic element that can be used to construct a display image. Output primitives in GKS are polyline, polymarker, text, fill area, cell array, and generalized drawing primitive.

3.48 pick device: A GKS logical input device providing the pick identifier attached to an output primitive and the associated segment name.

3.49 pick identifier: A name, attached to individual output primitives within a segment, and returned by the pick device. The same pick identifier can be assigned to different output primitives.

3.50 pixel; picture element: The smallest element of a display surface that can be independently assigned a colour or intensity.

3.51 polyline: A GKS output primitive consisting of a set of connected lines.

3.52 polyline bundle table: A table associating specific values for all workstation dependent aspects of a polyline primitive with a polyline bundle index. In GKS, this table contains entries consisting of linetype, linewidth scale factor, and colour index.

3.53 polymarker: A GKS output primitive consisting of a set of locations, each to be indicated by the same type of marker.

3.54 polymarker bundle table: A table associating specific values for all workstation dependent aspects of a polymarker primitive with a polymarker bundle index. In GKS, this table contains entries consisting of marker type, marker size scale factor, and colour index.

3.55 primitive attribute: An attribute that applies to output primitives as opposed to attributes that apply to other aspects of the graphical system such as segments. Primitive attribute values (for output primitives) are selected by the application in a workstation independent manner, but can have workstation dependent effects.

3.56 prompt: Output to the operator indicating that a specific logical input device is available.

3.57 raster graphics: Computer graphics in which a display image is composed of an array of pixels arranged in rows and columns.

3.58 rotation: Turning all or part of a display image about an axis. In GKS, this capability is restricted to segments.

3.59 scaling; zooming: Enlarging or reducing all or part of a display image by multiplying the coordinates of display elements by a constant value. In GKS, this capability is restricted to segments.

NOTE. For different scaling in two orthogonal directions two constant values are required.

3.60 segment: A collection of display elements that can be manipulated as a unit.

3.61 segment attributes: Attributes that apply only to segments. In GKS, segment attributes are visibility, highlighting, detectability, segment priority, and segment transformation.

3.62 segment priority: A segment attribute used to determine which of several overlapping segments takes precedence for graphic output and input.

3.63 segment transformation: A transformation that causes the display elements defined by a segment to appear with varying position (translation), size (scale), and/or orientation (rotation) on the display surface.

3.64 string device: A GKS logical input device providing a character string as its result.

3.65 stroke device: A GKS logical input device providing a sequence of points in world coordinates, and a normalization transformation number.

3.66 text: A GKS output primitive consisting of a character string.

3.67 text bundle table: A table associating specific values for all workstation dependent aspects of a text primitive with a text bundle index. In GKS, this table contains entries consisting of text font and precision, character expansion factor, character spacing and colour index.

3.68 text font and precision: An aspect of text in GKS, having two components, font and precision, which together determine the shape of the characters being output, on a particular workstation. In addition, the precision describes the fidelity with which the other text aspects match those requested by an application program. In order of increasing fidelity, the precisions are: STRING, CHAR and STROKE.

3.69 translation; shift: The application of a constant displacement to the position of all or part of a display image. In GKS, this capability is restricted to segments.

3.70 trigger: A physical input device or set of devices that an operator can use to indicate significant moments in time.

3.71 valuator device: A GKS logical input device providing a real number.

3.72 viewport: An application program specified part of normalized device coordinate space. In GKS, this definition is restricted to a rectangular region of normalized device coordinate space used in the definition of the normalization transformation.

3.73 window: A predefined part of a virtual space. In GKS, this definition is restricted to a rectangular region of the world coordinate space used for the definition of the normalization transformation.

3.74 workstation: GKS is based on the concept of abstract graphical workstations, which provide the logical interface through which the application program controls physical devices.

3.75 Workstation Dependent Segment Storage (WDSS): Segment storage on a workstation that is used for graphical output. Segments cannot be transferred from WDSS to another workstation.

3.76 Workstation Independent Segment Storage (WISS): A special workstation type, where segments can be stored and later transferred to other workstations.

3.77 workstation mandatory: Workstation mandatory describes a property that is required to be realized identically on all workstations of a GKS implementation.

3.78 workstation transformation: A transformation that maps the boundary and interior of a workstation window into the boundary and interior of a workstation viewport (part of display space), preserving aspect ratio. In GKS, this transformation maps positions in normalized device coordinates to device coordinates. The effect of preserving aspect ratio is that the interior of the workstation window may not map to the whole of the workstation viewport.

3.79 workstation viewport: A portion of display space currently selected for output of graphics.

3.80 workstation window: A rectangular region within the normalized device coordinate system which is represented on a display space.

3.81 world coordinate (WC): A device independent Cartesian coordinate system used by the application program for specifying graphical input and output.

4 The Graphical Kernel System

4.1 The Standard

4.1.1 Specification

The set of functions known as the Graphical Kernel System shall be as described in sections **4**, **5** and **6**. These functions are organized in twelve upward compatible levels with increasing capabilities as described in **4.10**.

4.1.2 Registration

For certain parameters of the functions, GKS defines value ranges as being reserved for registration or future standardization. The meanings of these values will be defined using the procedures established in an International Standard under development (Procedures for registration of graphical items). These procedures do not apply to values and value ranges defined as being workstation or implementation dependent; these values and ranges are not standardized.

4.2 Introduction

The Graphical Kernel System (GKS) provides a functional interface between an application program and a configuration of graphical input and output devices. The functional interface contains all basic functions for interactive and non-interactive graphics on a wide variety of graphics equipment.

The interface is at such a level of abstraction that hardware peculiarities are shielded from the application program. As a result a simplified interface presenting uniform output primitives (POLYLINE, POLYMARKER, TEXT, FILL AREA, CELL ARRAY, GENERALIZED DRAWING PRIMITIVE), and uniform input classes (LOCATOR, STROKE, VALUATOR, CHOICE, PICK, STRING) is obtained.

In **4.3** the concepts of basic output, input and the organization of input and output sequences are outlined. A central concept both for structuring GKS and for realizing device independence is introduced, called the workstation.

The facilities for picture manipulation and change are introduced via the segment facilities, the dynamic attributes and the transformations. The integral control over all these methods for change is further explained in **4.5.3** on workstations.

The concept of multiple workstations allows simultaneous output to and input from various display systems. Facilities for internal and external storage are provided by special workstations together with the possibility of transferring graphical entities directly from the special workstation for internal storage to other workstations.

Not every GKS implementation needs to support the full set of functions. Twelve levels are defined to meet the different requirements of graphics systems. Each GKS implementation provides at least the functions of one level. The levels are upward compatible.

Part 1 of GKS defines only a language independent nucleus of a graphics system. For integration into a language, GKS is embedded in a language dependent layer containing the language conventions, for example, parameter and name assignment. Language bindings are contained in Part 2.

The layer model represented in figure 1 illustrates the role of GKS in a graphics system. Each layer may call the functions of the adjoining lower layers. In general the application program uses the application oriented layer, the language dependent layer, other application dependent layers, and operating system resources. All workstation capabilities that can be addressed by GKS functions are used only via GKS.

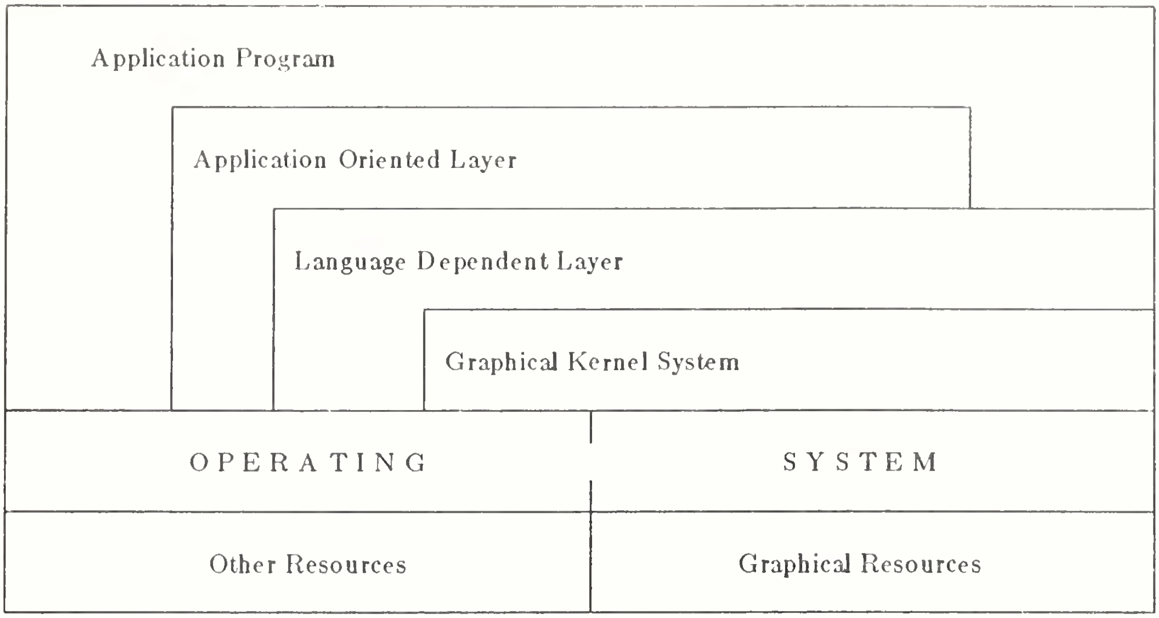


Figure 1. Layer model of GKS

4.3 Concepts

The graphical output that is generated by GKS is built up from two groups of basic elements called output primitives and primitive attributes. The output primitives are abstractions of basic actions a device can perform, such as drawing lines, and printing character strings. The attributes control the aspects of the output primitives on a device, such as linestyle, colour, character height and pick identifier. Non-geometric aspects, such as colour but not character height, can be controlled for each workstation individually, to make best use of its capabilities.

The graphical information that is input from a device, as a result of operator actions, is mapped by GKS onto six classes of input each represented by a data type referred to as a logical input value. An instance of such a device representation is called a logical input device. The effect of input actions on the display surface, such as prompts and echoes, is controlled by GKS for each logical input device individually.

The two abstract concepts (abstract output and abstract input) are the building blocks of a so-called abstract workstation. A workstation of GKS represents a unit consisting of zero or one display surfaces and zero or more input devices, such as keyboard, tablet and lightpen. The workstation presents these devices to the application program as a configuration of abstract devices thereby shielding the hardware peculiarities.

The geometrical information (coordinates) contained in output primitives, attributes and logical input values (locators and strokes) can be subjected to transformations. These transformations perform mappings between three coordinate systems, namely:

a) World Coordinates (WC), used by the application programmer;

b) Normalized Device Coordinates (NDC), used to define a uniform coordinate system for all workstations;

c) Device Coordinates (DC), one coordinate system per workstation, representing its display space coordinates.

Output primitives and attributes are mapped from WC to NDC by normalization transformations, from NDC to NDC by segment transformations (see next paragraph), and from NDC to DC by workstation transformations. Locator input is mapped by an inverse workstation transformation from DC to NDC and by one of the inverse normalization transformations from NDC to WC.

Output primitives and primitive attributes may be grouped together in a segment. Segments are the units for manipulation and change. Manipulation includes creation, deletion, and renaming. Change includes transforming a segment, making a segment visible or invisible, and highlighting a segment. Segments also form the basis for workstation independent storage of pictures at run time. Via this storage, which is set up as a special workstation called workstation independent segment storage, segments can be inserted and transferred to other workstations.

The attributes which control the appearance of parts of the picture (output primitives, segments, prompt and echo types of input devices) on the display surface are organized in a uniform manner. Two groups of attributes apply to the appearance of each output primitive: primitive attributes (that are workstation independent) and workstation attributes. Primitive attributes are specified modally and are bound to a primitive when it is created. The primitive attributes include all geometric aspects of primitives, such as character height for text and pattern size for fill area. In addition, the non-geometric aspects of primitives are controlled by the primitive attributes in one of two ways. Either a single attribute is used to specify all the non-geometric aspects of the primitive by an index which points to a workstation dependent representation (set of values) or one attribute is used to specify each of the non-geometric aspects of the primitive in a workstation independent way. The former is referred to as bundled specification and the latter is referred to as individual specification.

Workstation attributes include the actual representations on a workstation pointed to by indices used in bundled specification of non-geometric aspects. For example, the representations (or bundles) for polyline each contain values of linetype, linewidth scale factor and colour index. Workstation attributes also specify the colour and pattern tables and the control over deferral of picture change. Workstation attributes can be reset dynamically.

The appearance of segments is controlled by segment attributes, which are segment transformation, visibility, highlighting, segment priority, and detectability. These may be reset dynamically. Segment attributes can be a basis for feedback during manipulations (for example, highlighting).

The attributes which control the operation of logical input devices can be specified either upon initialisation or as part of input device setting, depending upon the attributes. Through initialisation, an initial value, a prompt and echo technique, and an area on the screen for echoing can be specified. A data record may further provide device specific attributes. Through input device setting, the operating mode may be selected and the echo may be switched on or off. The operating modes of logical input devices specify who (operator or application program) has the initiative: SAMPLE input is acquired directly by the application program; REQUEST input is produced by the operator in direct response to the application program; EVENT input is generated asynchronously by the operator and is collected in a queue for the application program.

At run time GKS can be in one of five different operating states. Associated with each state are the set of GKS functions allowed in this state, and a set of state variables. The operating state concept and the state variables allow for proper specification of initialisations (for example, at OPEN WORKSTATION) and the effect of various functions, especially with respect to the maintenance of device independence. One special set of functions called inquiry functions is allowed in all states. They give read-only access to the state lists. In this way useful information can be provided when errors occur. Other inquiry functions allow read-only access to the workstation descriptions, to allow the application program to adapt to particular workstation capabilities. Inquiry functions never cause errors. Instead they return information specifying whether a valid inquiry was made.

GKS provides an interface to a system for filing graphical information for the purpose of external long term storage and exchange. The interface consists of a GKS Metafile output workstation, which writes to a so-called graphics metafile (which is sequential), and a GKS Metafile input workstation, which reads from the metafile. In addition to the normal functions for output to workstations, a GKS Metafile output workstation may accept items containing non-graphical information. Input from a metafile is controlled by read and interpret functions which have the same effect as invoking the corresponding functions directly from the application program.

4.4 Graphical output

4.4.1 Output primitives

The graphical information that is generated by GKS and routed to all active workstations is built up of basic pieces called output primitives. GKS provides six output primitives:

a)	POLYLINE:	GKS generates a set of connected lines defined by a point sequence.
b)	POLYMARKER:	GKS generates symbols of one type centred at given positions.
c)	TEXT:	GKS generates a character string at a given position.
d)	FILL AREA:	GKS generates a polygonal area which may be hollow or filled with a uniform colour, a pattern, or a hatch style.
e)	CELL ARRAY:	GKS generates an array of pixels with individual colours.
f)	GENERALIZED DRAWING PRIMITIVE(GDP):	GKS addresses special geometrical output capabilities of a workstation such as the drawing of spline curves, circular arcs, and elliptic arcs. The objects are characterized by an identifier, a set of points and additional data. GKS applies all transformations to the points but leaves the interpretation to the workstation.

4.4.2 Output primitive attributes

Each output primitive potentially has three types of attribute (geometric, non-geometric and identification). The first two attribute types determine the exact appearance of the output primitive while the third attribute type is used in connection with input. The values of these attributes are set modally and are recorded in the GKS state list. A separate GKS function is provided for each primitive attribute (except the ASFs: see later in this subsection), to allow the application program to specify the value of an attribute without unnecessarily specifying the values of other attributes. During creation of an output primitive (that is, when one of the GKS output primitive functions is invoked) these values are bound to the primitive and cannot be changed afterwards.

Attributes of the first type control the geometric aspects of primitives; these are aspects which affect the shape or size of the whole primitive (for example, CHARACTER HEIGHT for TEXT). Hence, they are sometimes referred to as geometric attributes. Attributes of this type are workstation independent and, if they represent coordinate data (points or displacements), are expressed in world coordinates (for example, CHARACTER HEIGHT is expressed in world coordinates but TEXT PATH takes one of a set of enumerated values). They are defined separately for each primitive and a primitive may have zero, one or many geometric attributes.

Current values of (workstation independent) geometric attributes, which are expressed in world coordinates, are stored in world coordinates. When they are bound to their respective primitives, the values are subject to the same transformations as the geometric data contained in the definition of the primitive. Hence, current values are unaffected by changes in the normalization transformation and the workstation transformation.

Attributes of the second type control the non-geometric aspects of primitives; these are aspects which merely affect a primitive's appearance (for example, linetype for POLYLINE, or colour index for all primitives except CELL ARRAY) or the shape or size of the component parts of the primitive (for example, marker size scale factor for POLYMARKER). Non-geometric aspects do not represent coordinate data. The non-geometric aspects of a primitive may be specified in one of two ways, namely via a bundle or individually.

For specification of aspects via a bundle, there is one attribute per primitive, called the <primitive> INDEX. This attribute is an index into a bundle table, each entry of which contains all the non-geometric aspects of the primitive. There is a separate bundle table for each primitive with the exception of GENERALIZED DRAWING PRIMITIVE and CELL ARRAY (see later in this subsection). The non-geometric aspects are workstation dependent in this method of specification and each workstation has its own set of bundle tables (stored in the workstation state list). The values in a particular bundle (or entry in the bundle table) may be different for different workstations.

For individual specification of aspects, there is a separate attribute for each non-geometric aspect. As with the attributes controlling the geometric aspects, these attributes are workstation independent and are stored in the GKS state list. Since each non-geometric aspect only occurs in one primitive bundle type, each of these attributes applies to only one primitive type.

For a given non-geometric aspect, the values that can be assigned to the appropriate bundle component are the same as the values that can be assigned to the corresponding attribute for individual specification. Since the bundles are set separately for each workstation, the values of their components are restricted to the valid values for that workstation. In the case of individual attribute specification, such restrictions are not imposed. Default actions for the display of a primitive are defined to occur if it is created with a value of an individually specified attribute that is invalid on a particular workstation.

As indicated above, GENERALIZED DRAWING PRIMITIVE (GDP) and CELL ARRAY do not have associated bundle tables nor corresponding individually specified attributes. The GDP may use the most appropriate bundle tables or sets of individually specified attributes for each GDP function. For example, if one GDP function is essentially a FILL AREA, then the fill area bundle table or the set of individually specified fill area attributes would be used. CELL ARRAY contains colour index information as part of its definition but has no other non-geometric aspects and so does not use a bundle table nor does it have a set of individually specified attributes.

The method of specification of the non-geometric aspects of a primitive may be chosen separately for each aspect. A further group of primitive attributes, called ASPECT SOURCE FLAGS (ASFs), take the values INDIVIDUAL and BUNDLED to specify the choice. As with the other primitive attributes, these attributes are workstation independent and are stored in the GKS state list. There is one ASF for each non-geometric aspect of each primitive. The initial values of all the ASFs are the individual. The flags may be set at any time when GKS is open by the function SET ASPECT SOURCE FLAGS. This enables some non-geometric aspects of a primitive to be specified individually and others via a bundle.

When a primitive is displayed, the values of the non-geometric aspects with which it is displayed are determined as follows.

a) If the ASF for an aspect is INDIVIDUAL, the value used on all workstations is the value of the corresponding individually specified attribute of that primitive.

b) If the ASF for an aspect is BUNDLED, the value used on a workstation is obtained via the bundle table for that primitive on the workstation; the corresponding component of the bundle, pointed to by the bundle index, is used.

Colour is specified as an index into a separate colour table. There is only one colour table per workstation into which all the colour indices point. Similarly, other entries in a bundle, or corresponding individually specified attributes, may be indices either into another workstation table (for example, style index when interior style PATTERN is used) or into a fixed list (for example, linetypes for polyline).

There is precisely one attribute of the third type per primitive, namely PICK IDENTIFIER. This is used for identifying a primitive, or a group of primitives, in a segment when that segment is picked.

The attributes which apply to each output primitive (attributes controlling non-geometric aspects, geometric attributes and PICK IDENTIFIER) are:

c)	POLYLINE:	POLYLINE INDEX LINETYPE LINEWIDTH SCALE FACTOR POLYLINE COLOUR INDEX LINETYPE ASF LINEWIDTH SCALE FACTOR ASF POLYLINE COLOUR INDEX ASF PICK IDENTIFIER
d)	POLYMARKER:	POLYMARKER INDEX MARKER TYPE MARKER SIZE SCALE FACTOR POLYMARKER COLOUR INDEX MARKER TYPE ASF MARKER SIZE FACTOR ASF POLYMARKER COLOUR INDEX ASF PICK IDENTIFIER
e)	TEXT:	TEXT INDEX TEXT FONT AND PRECISION CHARACTER EXPANSION FACTOR CHARACTER SPACING TEXT COLOUR INDEX TEXT FONT AND PRECISION ASF CHARACTER EXPANSION FACTOR ASF CHARACTER SPACING ASF TEXT COLOUR INDEX ASF CHARACTER HEIGHT CHARACTER UP VECTOR TEXT PATH TEXT ALIGNMENT PICK IDENTIFIER
f)	FILL AREA:	FILL AREA INDEX FILL AREA INTERIOR STYLE FILL AREA STYLE INDEX FILL AREA COLOUR INDEX FILL AREA INTERIOR STYLE ASF FILL AREA STYLE INDEX ASF FILL AREA COLOUR INDEX ASF PATTERN SIZE

PATTERN REFERENCE POINT
PICK IDENTIFIER

g)	CELL ARRAY:	PICK IDENTIFIER
h)	GENERALIZED DRAWING PRIMITIVE:	Zero or more of the sets e) to i) except that PICK IDENTIFIER is always an attribute

Figure 2 shows the binding of the attributes.

The attributes for each primitive, other than PICK IDENTIFIER, are described in **4.4.3** to **4.4.8**. PICK IDENTIFIER is described in more detail in **4.7.1**. In the descriptions, attributes appear in upper case (for example, the attributes CHARACTER HEIGHT and PICK IDENTIFIER); aspects appear in both upper and lower case, according to their context. Geometric aspects are always controlled by geometric attributes and so appear in upper case (for example, the aspect CHARACTER HEIGHT). Non-geometric aspects may be controlled via a <primitive> INDEX or by individually specified attributes. Non-geometric aspects appear in lower case unless the corresponding individually specified attributes are being used which appear in upper case (for example, the aspect linetype but the individually specified attribute LINETYPE).

The entries in the bundle, pattern, and colour tables may be set separately for each workstation. Some standard definitions for table entries are contained in the workstation description table and are used as initial values. The application program may select a standard definition or may define the values of a specific entry explicitly. Only the most commonly used (or anticipated) combinations of values need be predefined for each output type workstation. At least those predefined entries with indices up to the minimum number of predefined entries at a given level (see **4.10.3**) are distinguishable from each other. Other combinations of values can be specified by the SET <primitive |PATTERN |COLOUR> REPRESENTATION function, possibly after inquiring the workstation capabilities. The tables, which are on every workstation of category OUTPUT, OUTIN or MO (i.e. they are workstation attributes), are:

polyline bundle table
polymarker bundle table
text bundle table
fill area bundle table
pattern table
colour table

The values in these tables may be (dynamically) changed. In fact, the only way of changing the aspects of a primitive which are stored in a bundle table is by changing that table. However, note that a change in a bundle table entry can only be reflected in a displayed primitive if the values of the corresponding ASFs (of that primitive) for the aspects in the bundle table are BUNDLED. The entry 'dynamic modification accepted' in the workstation description table indicates which changes:

i) lead to an implicit regeneration (may be deferred) (IRG);

j) can be performed immediately (IMM).

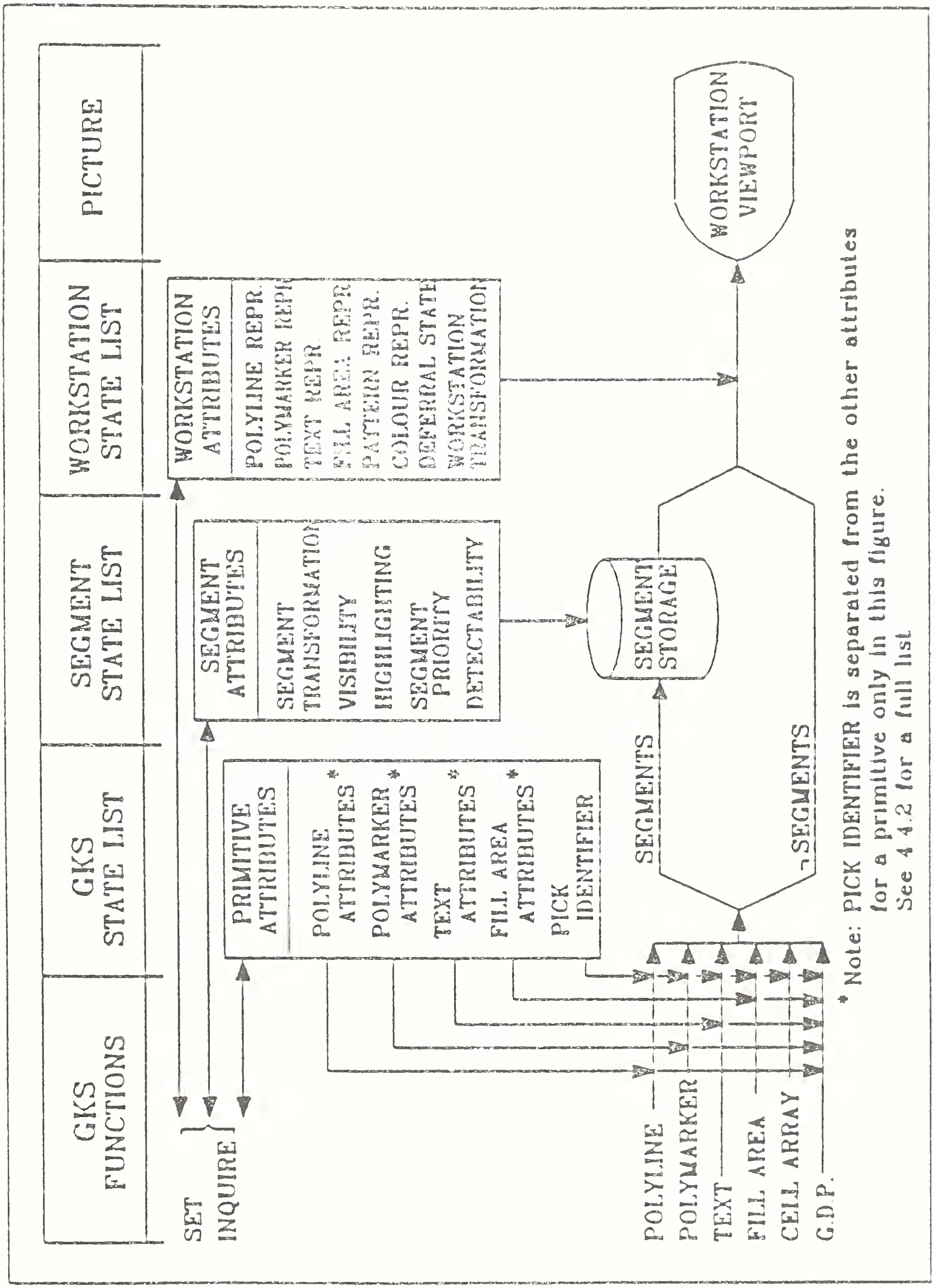
The deferral state is explained in more detail in **4.5.3**. If changes can be performed immediately, those changes may affect primitives outside segments in addition to those inside segments.

4.4.3 Polyline attributes

Polyline has no geometric attributes. The representation of polyline on the workstation is controlled by the POLYLINE INDEX, or the set of individually specified polyline attributes (LINETYPE, LINEWIDTH SCALE FACTOR, and POLYLINE COLOUR INDEX) or some combination of the two, depending upon the values of the ASFs for linetype, linewidth scale factor and polyline colour index. The POLYLINE INDEX is a pointer into the polyline bundle table, each entry of which contains values for linetype, linewidth scale factor and polyline colour index.

Linetypes 1 to 4 are solid, dashed, dotted and dashed-dotted. Every workstation of category OUTPUT or OUTIN realizes linetypes 1 to 4 with recognizable styles. Linetypes greater than 4 are reserved for registration or future standardization. Linetypes less than 0 may be available but their styles are implementation dependent. The linetype specifies a sequence of line segments and gaps which are repeated to draw a polyline. It is workstation dependent whether this sequence is restarted or continued at the start of the polyline, at the start of a clipped piece of a polyline, and at each vertex of a polyline.

Figure 2 - Binding of attributes



The linewidth is calculated as a nominal linewidth multiplied by the linewidth scale factor. This value is mapped by the workstation to the nearest available linewidth.

4.4.4 Polymarker attributes

Polymarker has no geometric attributes. The representation of polymarker at the workstation is controlled by the POLYMARKER INDEX, or the set of individually specified polymarker attributes (MARKER TYPE, MARKER SIZE SCALE FACTOR, and POLYMARKER COLOUR INDEX) or some combination of the two, depending upon the values of the ASFs for marker type, marker size scale factor, and polymarker colour index. The POLYMARKER INDEX is a pointer into the polymarker bundle table, each entry of which contains values for marker type, marker size scale factor and polymarker colour index.

Marker types 1 to 5 are dot, plus sign, asterisk, circle, and diagonal cross each centred on the positions they are identifying. Every workstation of category OUTPUT or OUTIN realizes marker types 1 to 5 with recognizable shapes at the given positions. Marker types greater than 5 are reserved for registration or future standardization. Marker types less than 0 may be available but their forms are implementation dependent.

The marker size is calculated as a nominal size multiplied by the marker size scale factor. This size is mapped by the workstation to the nearest available size. Marker type 1 is always displayed as the smallest displayable dot.

The marker is visible if, and only if, the marker position is within the clipping rectangle. The clipping of partially visible markers is workstation dependent.

4.4.5 Text attributes

Text has the geometric attributes CHARACTER HEIGHT, CHARACTER UP VECTOR, TEXT PATH, and TEXT ALIGNMENT which are specified and used as described in this subsection.

Text also has two implicitly specified geometric attributes CHARACTER WIDTH and CHARACTER BASE VECTOR. These are implicitly specified by the functions SET CHARACTER HEIGHT and SET CHARACTER UP VECTOR respectively. They otherwise behave like ordinary geometric attributes (their values are bound to TEXT primitives when the primitives are created and cannot be changed afterwards and these values are subject to the same transformations as the geometric data contained in the definition of the primitive).

The representation of text at the workstation is controlled by the TEXT INDEX, or the set of individually specified text attributes (TEXT FONT AND PRECISION, CHARACTER EXPANSION FACTOR, CHARACTER SPACING, and TEXT COLOUR INDEX) or some combination of the two, depending upon the values of the ASFs for text font and precision, character expansion factor, character spacing and text colour index. The TEXT INDEX is a pointer into the text bundle table, each entry of which contains values for text font and precision, character expansion factor, character spacing and text colour index.

Precise control of the appearance of TEXT on a workstation is provided by the following aspects: CHARACTER HEIGHT, CHARACTER WIDTH, character expansion factor, TEXT PATH, CHARACTER UP VECTOR, CHARACTER BASE VECTOR, character spacing and TEXT ALIGNMENT. However, the use of these values in displaying text is determined by the setting of the text font and precision aspect (font and precision are two components of the same aspect). The CHARACTER HEIGHT specifies the nominal height of a capital letter character. The CHARACTER WIDTH specifies the nominal width of a character; the actual width depends upon the width to height ratio of the character indicated by the font designer and may vary from character to character. The character expansion factor specifies the deviation of the width to height ratio of the character from the ratio indicated by the font designer. The CHARACTER UP VECTOR gives the up direction of a character. The CHARACTER BASE VECTOR gives the direction of the baseline of a character. Only the directions, not the lengths, of these vectors are relevant. TEXT PATH has the possible values RIGHT, LEFT, UP and DOWN. It specifies the writing direction of the text string. For RIGHT, the text string is written along a baseline in the direction of the CHARACTER BASE VECTOR. For LEFT, the baseline direction is the opposite direction of the CHARACTER BASE VECTOR. For UP, the character path coincides with the direction of the CHARACTER UP VECTOR. For DOWN, it is the opposite direction of the CHARACTER UP VECTOR. For the UP and DOWN text path directions the characters are arranged so that the centres of the character bodies are on a straight line in the direction of the CHARACTER UP VECTOR.

The character spacing value specifies how much additional space is to be inserted between two adjacent character bodies. If the value of character spacing is zero, the character bodies are arranged one after the other along the TEXT PATH, without any additional space between. A positive value of character spacing will insert additional space between character bodies. A negative value of character spacing will cause adjacent character bodies to overlap. Character spacing is specified as a fraction of the font nominal character height.

The effect of the aspects CHARACTER HEIGHT, CHARACTER WIDTH, character expansion factor, TEXT PATH, character spacing and text font is to define an (imaginary) rectangle with its sides parallel to the x and y axes, enclosing the text. The bounds of this enclosing rectangle are as follows. For TEXT PATH = LEFT or RIGHT, the height of the rectangle is the height of the character body of the specified font; the left side of the rectangle is the left side of the character body of the leftmost character and the right side of the rectangle is the right side of the character body of the rightmost character. For TEXT PATH = UP or DOWN, the top of the rectangle is the top of the character body of the topmost character and similarly, the bottom of the rectangle is the bottom of the bottommost character; the width of the rectangle is the width of the widest character in the specified font.

The effect of the CHARACTER UP VECTOR and CHARACTER BASE VECTOR attributes is to transform the enclosing rectangle, thus defining an enclosing parallelogram, the text extent parallelogram (the rectangle has been rotated and sheared).

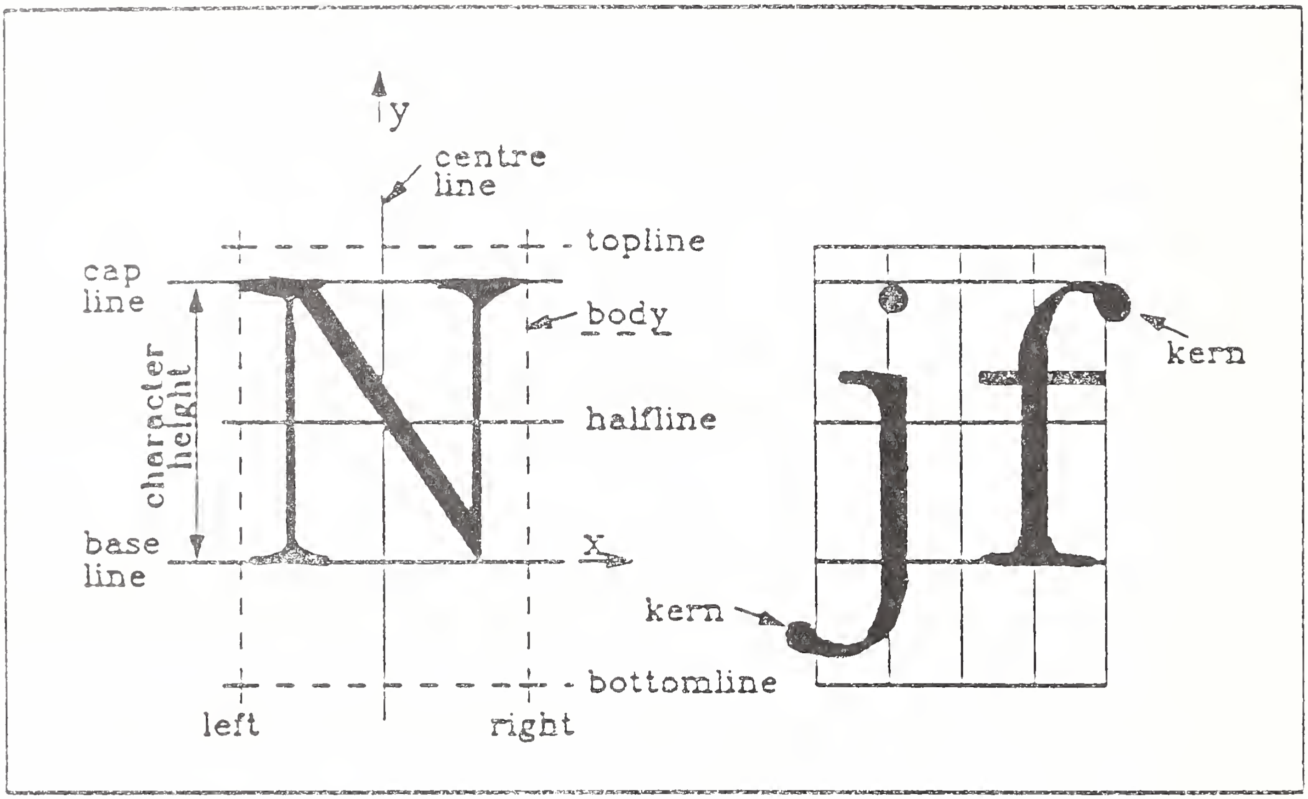


Figure 3. Font description coordinate system

The TEXT ALIGNMENT attribute controls the positioning of this text extent parallelogram in relation to the text position. For simplicity the TEXT ALIGNMENT is described in terms of the default CHARACTER UP VECTOR and CHARACTER BASE VECTOR, when the text extent parallelogram is actually a rectangle. The horizontal component of TEXT ALIGNMENT has four values: LEFT, CENTRE, RIGHT and NORMAL. If the horizontal component is LEFT, the left side of the text extent parallelogram passes through the text position. Similarly, if the value is RIGHT, the right side of the text extent parallelogram passes through the text position. If the horizontal component is CENTRE, the text position lies midway between the left and right sides of the text extent parallelogram. Thus, if TEXT PATH = UP or DOWN, the straight line passing through the centrelines of the characters also passes through the text position. The vertical component of TEXT ALIGNMENT has six values: TOP, CAP, HALF, BASE, BOTTOM and NORMAL. These each correspond to one of the font specific horizontal lines in the definition of a character (see figure 3). A value of TOP causes the top of the text extent parallelogram to pass through the text position. A value of CAP causes the text position to lie on the capline of the whole string (TEXT PATH = LEFT or RIGHT) or on the capline of the topmost character in the string (TEXT PATH = UP or DOWN). A value of HALF causes the text position to lie on the halfline of the whole string (TEXT PATH = LEFT or RIGHT) or on a line halfway between the halflines of the top and bottom characters (TEXT PATH = UP or DOWN). A value of BASE causes the text position to lie on the baseline of the whole string (TEXT PATH = LEFT or RIGHT) or on the baseline of the bottom character in the string (TEXT PATH = UP or DOWN). A value of BOTTOM causes the bottom of the text extent parallelogram to pass through the text position.

In the general case, the orientation referred to as horizontal is that of the CHARACTER BASE VECTOR with RIGHT representing direction of that vector and LEFT being opposite to it. Similarly the orientation referred to as vertical is that of the CHARACTER UP VECTOR with UP representing the direction of that vector and DOWN being opposite to it.

Either component of TEXT ALIGNMENT can take the value NORMAL. For each value of TEXT PATH, the effect of a particular component being NORMAL is equivalent to one of the other values of that component. In each case, the equivalent alignment value is chosen to achieve a natural alignment for that TEXT PATH value. The complete list of equivalent values is:

TEXT PATH	NORMAL Horizontal and Vertical Alignments
RIGHT	(LEFT, BASE)
LEFT	(RIGHT, BASE)
UP	(CENTRE, BASE)
DOWN	(CENTRE, TOP)

The initial values of the geometric text attributes are:

CHARACTER HEIGHT	WC	0.01 (ie 1% of the height of the default window)
CHARACTER UP VECTOR	WC	(0,1)
TEXT PATH		RIGHT
TEXT ALIGNMENT		(NORMAL, NORMAL)

and the initial values of the implicitly specified geometric text attributes are:

CHARACTER WIDTH	WC	0.01 (ie the same value as the initial value of CHARACTER HEIGHT)
CHARACTER BASE VECTOR	WC	(1,0)

Text font and precision together constitute one aspect. The text font value is used to select a particular font on the workstation. Every workstation supports at least one font that is able to generate a graphical representation of the characters defined in ANSI X3.4-1977 (commonly referred to as ASCII). This is font number 1. Font numbers greater than 1 are reserved for registration or future standardization. Font numbers less than 0 may be supported but are implementation dependent.

The text precision value is used to select the 'closeness' of the text representation at the workstation in relation to that defined by the workstation independent text attributes and the transformation and clipping currently applicable. The text precision value has the following possible values:

a) STRING: The TEXT character string is generated in the requested text font and is positioned by aligning the TEXT output primitive at the given text position. CHARACTER HEIGHT, CHARACTER WIDTH and character expansion factor are evaluated as closely as reasonable, given the capabilities of the workstation. CHARACTER UP VECTOR, CHARACTER BASE VECTOR, TEXT PATH, TEXT ALIGNMENT and character spacing, need not be used. Clipping is done in an implementation and workstation dependent way.

b) CHAR: The TEXT character string is generated in the requested text font. For the representation of each individual character, the aspects CHARACTER HEIGHT, CHARACTER WIDTH, the up direction of the CHARACTER UP VECTOR, the baseline direction of the CHARACTER BASE VECTOR, and character expansion factor are evaluated as closely as possible, in a workstation dependent way. The spacing used between character bodies is evaluated exactly; the character body, for this purpose, is an ideal character body, calculated precisely from the text aspects and the font dimensions. The position of the resulting text extent parallelogram is determined by the TEXT ALIGNMENT and the text position. Clipping is performed at least on a character by character basis.

c) STROKE: The text character string in the requested text font is displayed at the text position by applying all text aspects. The character string is clipped exactly at the clipping rectangle.

STROKE precision does not necessarily mean vector strokes; as long as the representation adheres to the rules governing STROKE precision, the font may be realized in any form, for example by raster fonts.

A GKS output level m implementation need only support STRING text precision, and level 0 need only support text precisions STRING and CHAR. All text precisions must be supported above output level 0. A workstation may use a higher precision than the one requested for this purpose, i.e., if STROKE precision is supported in a particular font, the implication is that both STRING and CHAR precision are available in that font. However, it is not necessary for a workstation to support all precisions for a given font (i.e. for a given font, STROKE can be missing or both STROKE and CHAR can be missing). Text font and precision are workstation mandatory. That is, for any GKS level supporting a STROKE precision font, every workstation of a particular installation supports at least one STROKE precision text font. This is font number 1, containing the character set defined by ANSI X3.4-1977. This implies that, for STROKE precision text, some sort of software character generator is required for those implementations that have inadequate hardware. Not all workstations need to support all fonts, but for those that do, the same font number is used to select that font on all workstations of a particular installation.

Fonts are defined only within the GKS implementation. The font designer specifies the shape of the symbol representing each character in a local 2D cartesian font coordinate system. Fonts are either monospaced or proportionally spaced. Each character in a font coordinate system has an associated character body, a font baseline, a font halfline, a capline and a centreline (see figure 3). For monospaced fonts, the character bodies of all characters have the same size. For proportionally spaced fonts, the width of the bodies may differ from character to character. The character body edges are parallel to the axes of the font coordinate system. The font baseline, the font halfline and the capline are parallel to the x-axis of the font coordinate system, and within the vertical extent of the body. The position of the font halfline is defined by the font designer for use in aligning text strings. The centreline is parallel to the y-axis and bisects the body. Their exact positions are specified by the font designer.

The height of a character in the font coordinate system is given by the height from the font baseline to the capline. The width of a character is given by the width of the character body. The width of a character may include space on either side of the character and this space is generally evenly split between the left and right sides of the character. It is assumed that the characters lie within their body, except that kerned characters may exceed the side limits of the character body.

In general, the top limits of the bodies for a font are identical with, or very close to, the typographical capline or ascender line, and the bottom limit to the descender line. The space, if any, between the topline and the capline may be used for an additional mark over the character, for example an accent. However, these and other details are purely for the use of the font designer. The intention is only that characters placed with their bodies touching in the horizontal direction should give an appearance of good normal spacing, and characters touching in the vertical direction will avoid clashes between ascenders and descenders (typographically 'set solid').

Since the values of CHARACTER HEIGHT, CHARACTER WIDTH, CHARACTER UP VECTOR and CHARACTER BASE VECTOR are given in world coordinate units, but the characters are generated on the workstation in device coordinates, using the workstation dependent font and precision, the geometric attributes need to be transformed in such a way that the workstation can generate the characters in the way intended.

The effect to be achieved is now described. Together with the text coding, a height vector parallel to the CHARACTER UP VECTOR with length equal to CHARACTER HEIGHT, and a width vector parallel to the CHARACTER BASE VECTOR with length equal to CHARACTER WIDTH, are passed down the viewing pipeline. These vectors are transformed by the normalization transformation, by a segment transformation if within a segment, and by the workstation transformation. They are also stored in segments. Then the vectors can be used by the workstation character generator. Thus, the shape of individual characters can be transformed by a normalization transformation that is unequal in x and y and by a segment transformation.

On the workstation, the height of a character is given by the length of the transformed height vector; the character up direction is given by the direction of the transformed height vector; the width of a character is given by the length of the transformed width vector multiplied by the font width to height ratio for the character and by the character expansion factor; the character base direction is given by the direction of the transformed width vector. The characters are arranged together in a text extent parallelogram, depending on the values of TEXT PATH and character spacing. The text extent parallelogram is then positioned according to the value of TEXT ALIGNMENT and the text position, contained in the definition of the TEXT primitive.

Figures 4 to 7 give examples of the effects of different values of text aspects. Figure 8 gives examples of the effect of different normalization transformations on the displayed form of the text.

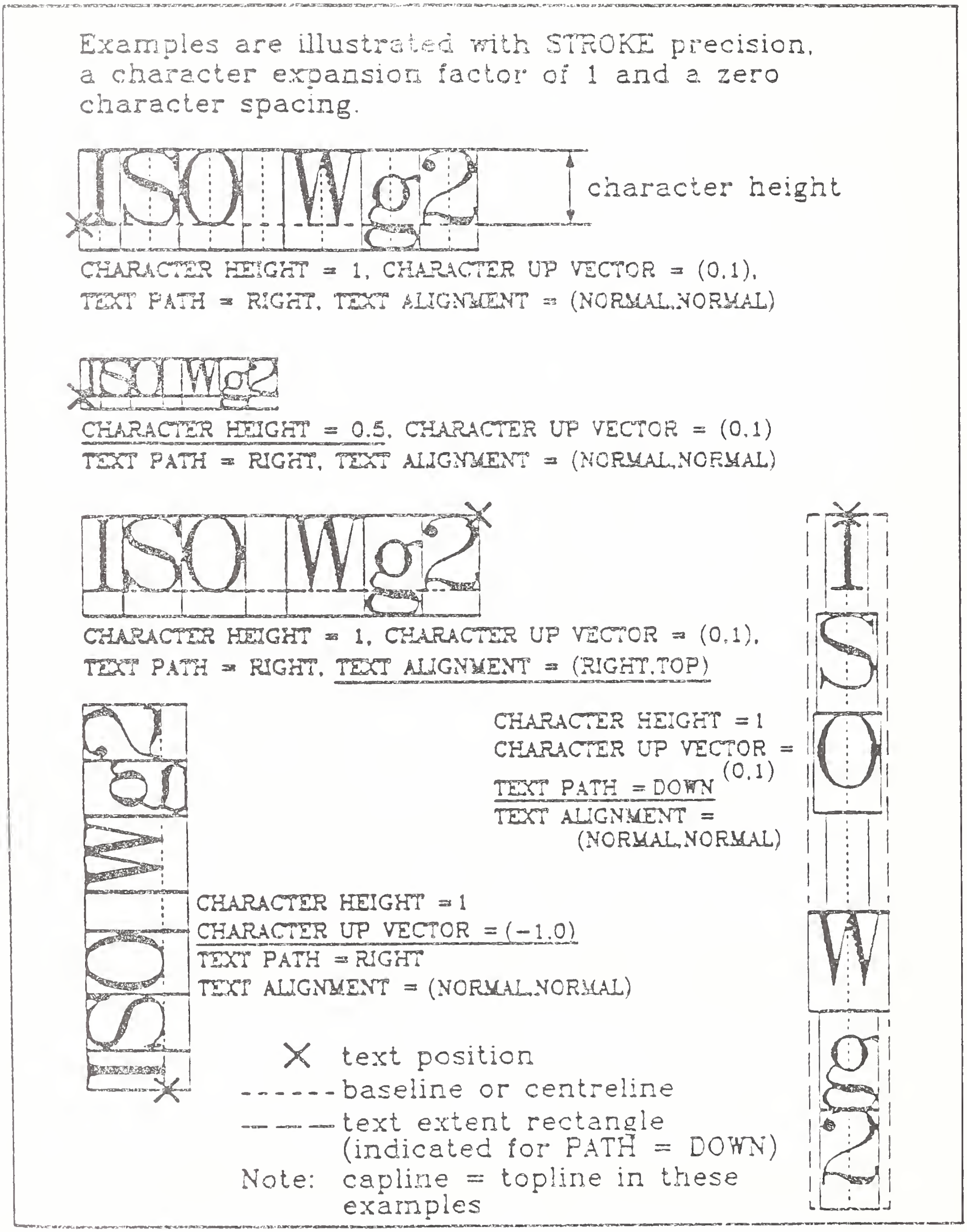


Figure 4. Effects of changes in geometric text attributes

NOTE. Changed attributes are underlined

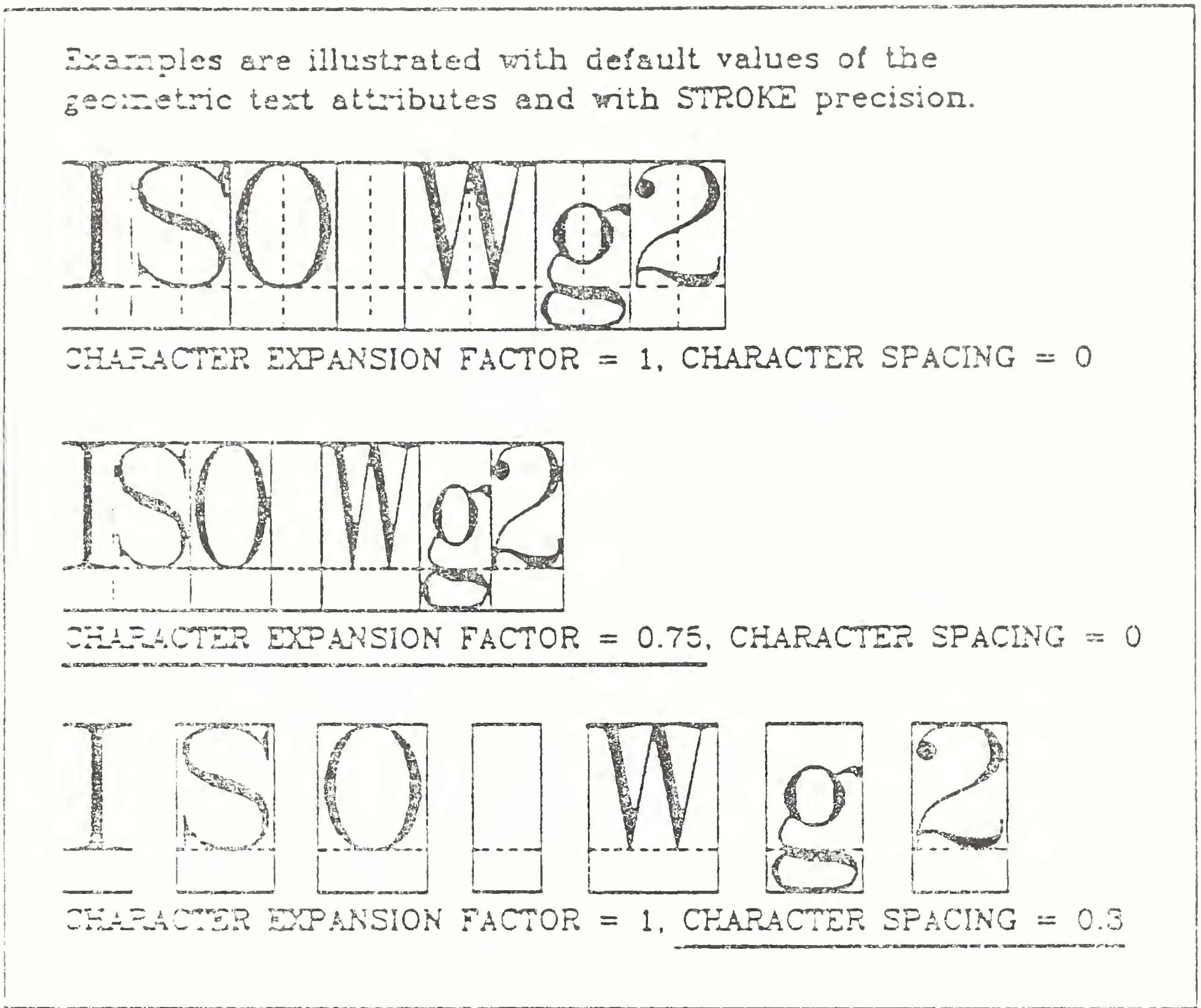


Figure 5. Effects of changes in non-geometric text aspects

NOTE. Changed aspects are underlined.

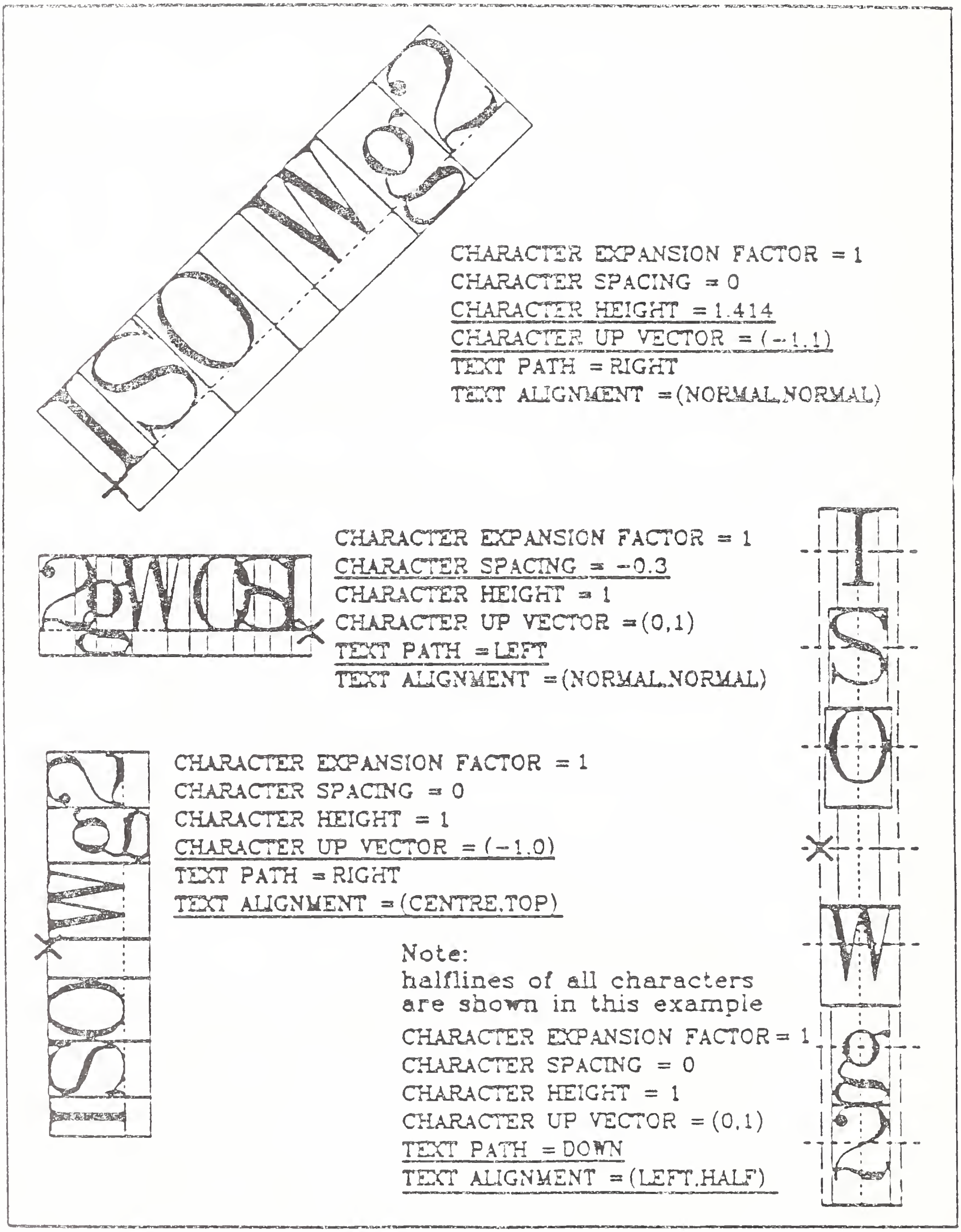


Figure 6. Effects of combined changes in text aspects

NOTE. Changes from the top example of figures 4 and 5 are underlined.

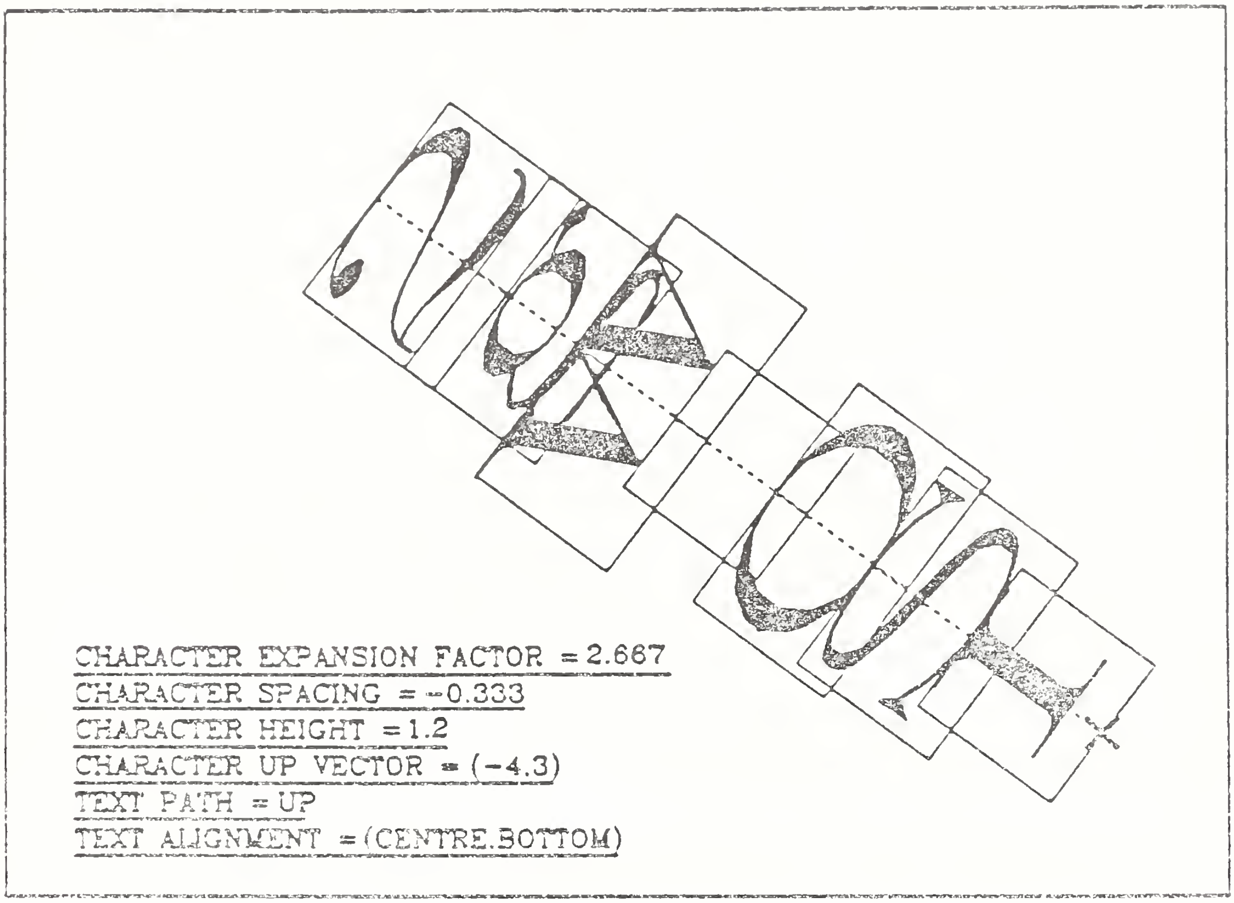


Figure 7. Effects of several changes in text aspects

NOTE Changes from the top example of figures 4 and 5 are underlined.

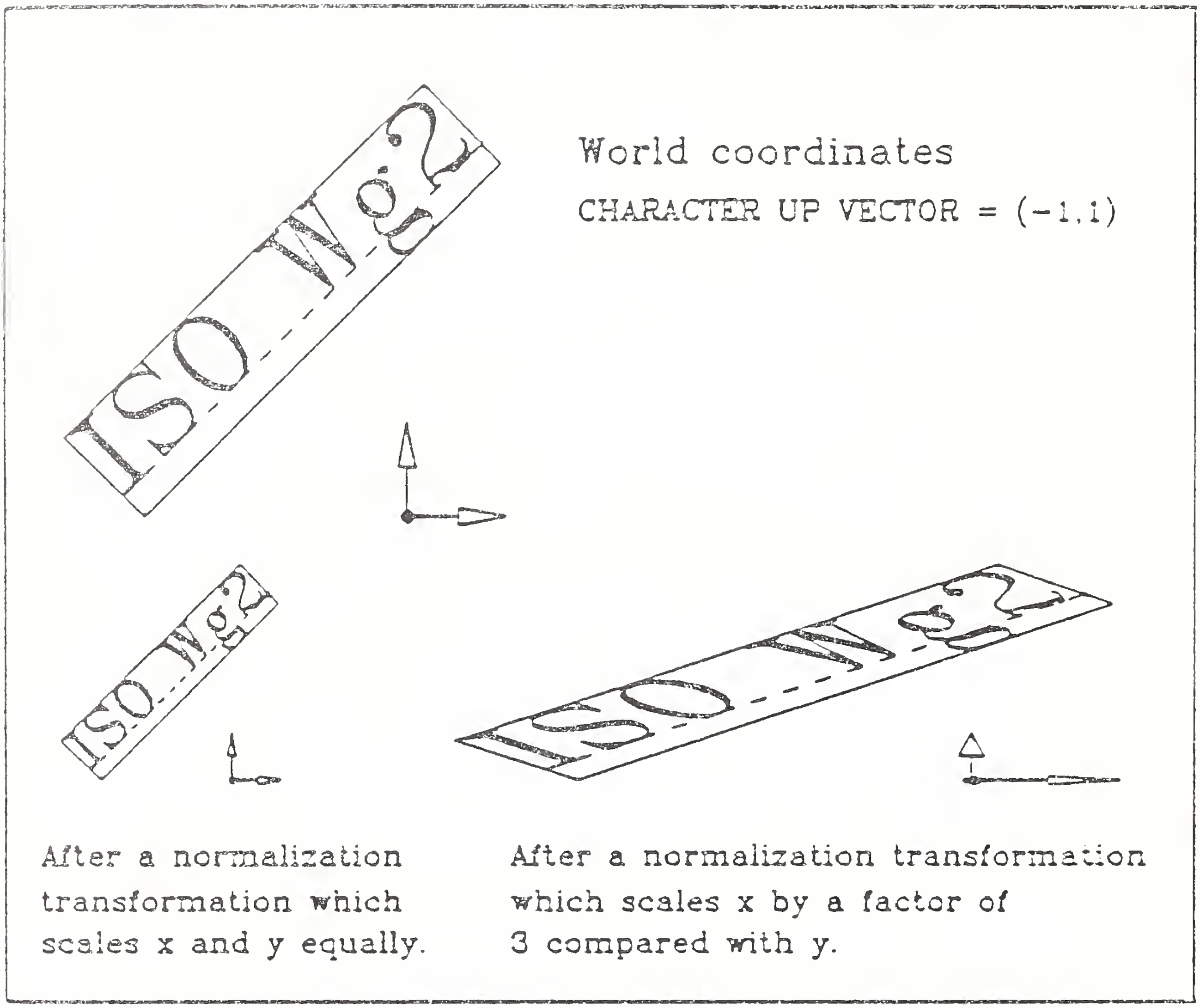


Figure 8. Effects of different normalization transformations on text in STROKE precision

4.4.6 Fill area attributes

Fill area has the geometric attribute PATTERN REFERENCE POINT. It also has two implicitly specified geometric attributes PATTERN WIDTH VECTOR and PATTERN HEIGHT VECTOR. These are implicitly specified by the function SET PATTERN SIZE. Like ordinary geometric attributes, their values are bound to FILL AREA primitives when the primitives are created and cannot be changed afterwards and these values are subject to the same transformations as the geometric data contained in the definition of the primitive. The usage of the fill area geometric attributes is described later in this subsection.

The representation of fill area at the workstation is controlled by the FILL AREA INDEX, or the set of individually specified fill area attributes (FILL AREA INTERIOR STYLE, FILL AREA STYLE INDEX, and FILL AREA COLOUR INDEX) or some combination of the two, depending upon the values of the ASFs for fill area interior style, fill area style index, and fill area colour index. The FILL AREA INDEX is a pointer into the fill area bundle table, each entry of which contains values for the fill area interior style, fill area style index and fill area colour index.

The fill area interior style is used to determine in what style the area should be filled. It has the following values:

a) HOLLOW: No filling, but draw the bounding polyline, using the fill area colour index currently selected (either via the fill area bundle or individually, depending upon the corresponding ASF). The linetype and linewidth are implementation dependent.

b) SOLID: Fill the interior of the polygon using the fill area colour index currently selected (either via the fill area bundle or individually, depending upon the corresponding ASF).

c) PATTERN: Fill the interior of the polygon using the fill area style index currently selected (either via the fill area bundle or individually, depending upon the corresponding ASF) as an index into the pattern table. In this context, the fill area style index is sometimes referred to as the pattern index.

d) HATCH: Fill the interior of the polygon using the fill area colour index and the fill area style index currently selected (either via the fill area bundle or individually, depending upon the corresponding ASFs). The fill area style index is used as a pointer into the list of hatch styles, in which case it is sometimes referred to as the hatch index.

For interior style PATTERN, the pattern is defined by the pattern representation, which specifies an array ($DX \times DY$) of colour indices, that are pointers into the colour table. The size and position of the start of the pattern are determined by a pattern box. The pattern box, which is a parallelogram, is defined by the PATTERN WIDTH VECTOR and the PATTERN HEIGHT VECTOR located relative to the PATTERN REFERENCE POINT. The pattern box is conceptually divided into a grid of $DX \times DY$ cells. The colour index array is associated with the cells as follows: the element (1,DY) is associated with the cell having the PATTERN REFERENCE POINT at one corner; elements with increasing first dimension are associated with successive cells in the direction of the PATTERN WIDTH VECTOR; elements with decreasing second dimension are associated with successive cells in the direction of the PATTERN HEIGHT VECTOR. The attributes defining the pattern box are subject to all the transformations producing a transformed pattern box. The pattern is mapped onto the polygon by conceptually replicating the transformed pattern box in directions parallel to its sides until the interior of the complete polygon is covered.

Mapping the transformed pattern cells to the pixels of a raster display is performed by the following rules:

e) If the centre of a pixel lies inside the parallelogram defined by the transformed cell, its colour is set;

f) The pixel is assigned the colour of the cell corresponding to the pixel's centre.

For a workstation which can implement patterns but not transformable patterns, a suitable action is to generate non-transformed patterns to fill a polygon.

For interior style HATCH, the hatch index selects among hatch styles: hatch styles greater than 0 are reserved for registration or future standardization; hatch styles less than 0 are workstation dependent. Whether hatching is affected by transformations or not is workstation dependent.

Interior style HOLLOW is available on every workstation of category OUTPUT or OUTIN. It is workstation dependent which of the interior styles SOLID, PATTERN and HATCH are available.

4.4.7 Cell array attributes

Cell array has no attributes other than PICK IDENTIFIER. However, an array of colour indices, which are pointers into the colour table, is part of the definition of a cell array.

4.4.8 Generalized Drawing Primitive attributes

Generalized Drawing Primitive(GDP) has no explicit geometric attributes. Such information may be specified in the GDP data record. The representation of the GDP at the workstation is controlled by zero or more of the sets of polyline, polymarker, text and fill area attributes (see **4.4.2**). Whether bundle indices or associated individually specified attributes are used depends upon the values of the appropriate ASFs. The sets of attributes most appropriate for the specified GDP function are selected for the GDP as part of the definition of the GDP and are recorded in the workstation description table. Consiequently, if a GDP is essentially a cell array, then an array of colour indices would be specified in the GDP data record.

4.4.9 Colour

In GKS, colour is specified in a number of different situations. It may be an aspect of a primitive, in which case it is specified either in the bundle for that primitive or by the individual colour attribute for that primitive. It may be part of a pattern for FILL AREA, in which case an array of colours is specified, or it may be part of a primitive itself, namely CELL ARRAY, when an array of colours is also specified. In each case, the colour is specified as an index into a colour table on the workstation. On each workstation, there is one colour table into which all the colour indices point.

The size of the colour table is workstation dependent but entries 0 and 1 always exist. Entry 0 corresponds to the background colour. The background colour is the colour of the display surface after it has been cleared. Entry 1 is the default foreground colour and entries higher than 1 correspond to alternative foreground colours. Entries in the table may be set by the function SET COLOUR REPRESENTATION which specifies the colour as a combination of red, green, and blue intensities. The specified colour is mapped to the nearest available by the workstation. On some workstations it may not be possible to change the background colour, and in this case the mapping of a specific colour to the nearest available for the background colour may be different from the mapping of the same colour for the foreground colours.

Some workstations are not capable of displaying colours (for example, workstations only capable of displaying colours with equal red, green, and blue intensities or workstations only capable of displaying colours which are different intensities of the same colour); these are referred to as monochrome workstations. Whether a workstation is capable of colour is recorded in the 'colour available' entry in the workstation description table. On monochrome workstations, the intensity is computed from the colour values in a workstation dependent way. See Appendix D for a recommended algorithm.

4.5 Workstations

4.5.1 Workstation characteristics

GKS is based on the concept of abstract graphical workstations. These provide the logical interface through which the application program controls physical devices. Certain special workstations provide facilities for the storage and exchange of graphical information.

For every type of workstation present in a GKS implementation (except for the special workstations), there exists a workstation description table which describes the capabilities and characteristics of the workstation. The application program can inquire which capabilities are available and adapt its behaviour accordingly. If a capability is requested that a particular workstation does not provide, a standard error reaction is defined. Certain minimal capabilities of a workstation are detailed in **4.10**.

An abstract graphical workstation with maximum capabilities:

a) has one addressable display surface of fixed resolution;

b) allows only rectangular display spaces (the display space does not consist of a number of separate parts);

c) permits the specification and use of smaller display spaces than the maximum while guaranteeing that no display image is generated outside the specified display space;

d) supports several linetypes, text fonts, character sizes, etc, to allow output primitives to be drawn with different aspects;

e) has one or more logical input devices for each input class;

f) permits REQUEST, SAMPLE and EVENT type input;

g) allows logical input devices to be set in REQUEST, SAMPLE or EVENT mode independently of each other;

h) stores segments and provides facilities for changing and manipulating them.

In practice, the workstation is not necessarily equipped with all of these capabilities.

Each workstation has a type. Each workstation type falls into one of six categories:

OUTPUT	Output
INPUT	Input
OUTIN	Output and input
WISS	Workstation Independent Segment Storage(WISS)
MO	GKS Metafile (GKSM) output
MI	GKSM input

A workstation of category OUTPUT has only output capabilities. It can display all output primitives, with the possible exception of the GENERALIZED DRAWING PRIMITIVE which is optional. Minimal requirements for displaying TEXT and FILL AREA primitives are listed in **4.4**, and for CELL ARRAY in **5.3**.

GKS allows the appearance of output primitives to vary between workstations, thus allowing advantage to be taken of their differing capabilities. The facilities which allow this variation are:

polyline representation (see **4.4**)
polymarker representation (see **4.4**)
text representation (see **4.4**)
fill area representation (see **4.4**)
pattern representation (see **4.4**)
colour representation (see **4.4**)
deferral state (see **4.5.3**)
workstation transformation (see **4.6.3**)

Figure 2 (see **4.4**) illustrates the binding of the workstation attributes.

A workstation of category INPUT has at least one logical input device, but no output capability.

A workstation of category OUTIN has the characteristics of both an OUTPUT and INPUT workstation. In addition, the existence of a workstation in this category in a GKS implementation gives rise to additional requirements regarding logical input devices (see **4.8.1**).

The last three categories WISS, MO and MI are special GKS facilities that provide a means for temporarily or permanently storing graphical information. They are treated as workstations for the purposes of control, but otherwise have quite different characteristics (see **4.7.5** and **4.9**).

Section **A.5** of appendix A gives a complete listing of all GKS functions which apply directly or indirectly to each category of workstation.

Actual workstations may provide more capabilities than those listed in the workstation description table. These cannot be used by GKS. However, if the workstation itself provides sufficient intelligence, the additional capabilities may be accessed via the GENERALIZED DRAWING PRIMITIVE or ESCAPE functions, or used locally by the workstation operator. As an example, if a workstation has two display surfaces, the operator may switch locally from one to the other without notifying GKS or the application program. More than one display surface can be controlled by GKS only by defining a separate workstation for each display surface.

4.5.2 Selecting a workstation

The application program references a workstation by means of a workstation identifier. Connection to a particular workstation is established by the function OPEN WORKSTATION, which associates the workstation identifier with a workstation type and a connection identifier. The current state of each open workstation is kept in a workstation state list. Segment manipulation and input can be performed on all open workstations. Output primitives are sent to, and segments are stored on, all active workstations and no others; an open workstation is made active by the function ACTIVATE WORKSTATION.

An active workstation is made inactive by the function DEACTIVATE WORKSTATION; an open workstation is closed by the function CLOSE WORKSTATION.

The following sequence of functions illustrates workstation selection:

```
OPEN WORKSTATION (N1,conid1,workstation type A);
OPEN WORKSTATION (N2,conid2,workstation type B);
ACTIVATE WORKSTATION (N1);

   Output functions;                 {generated only on N1}
   Input functions;                  {possible on N1,N2}

ACTIVATE WORKSTATION (N2);

   Output functions;                 {generated on N1,N2}

DEACTIVATE WORKSTATION (N1);

   Output functions;                 {generated only on N2}
   Input functions;                  {possible on N1,N2}

CLOSE WORKSTATION (N1);
DEACTIVATE WORKSTATION (N2);
CLOSE WORKSTATION (N2);
```

4.5.3 Deferring picture changes

It is desirable that the display of a workstation reflects, as far as possible, the actual state of the picture as defined by the application program. However, to use the capabilities of a workstation efficiently, GKS allows a workstation to delay, for a certain period of time, the actions requested by the application program. During this period, the state of the display may be undefined.

The function SET DEFERRAL STATE allows the application program to choose that deferral state which takes into account the capabilities of the workstation and the requirements of the application program. Two attributes are defined for this purpose. Deferral mode controls the time at which output functions have their visual effects. Implicit regeneration controls the time at which picture changes have their visual effects: picture changes in general imply an alteration not just an addition to the picture.

The concept of deferral refers only to visible effects of GKS functions. Effects on the segment storage or on the state of the workstation are (conceptually) not deferred.

Deferral mode controls the possible delaying of output functions: for example, data sent to a device may be buffered to optimize data transfer. The values of deferral mode (in increasing order of delay) are:

a) ASAP: The visual effect of each function will be achieved on the workstation As Soon As Possible (ASAP). GKS ensures that the actions necessary to achieve this visual effect are initiated before control is returned to the application program, but, owing to possible delays not under the influence of GKS, the actions are not necessarily completed before control is returned.

b) BNIG: The visual effect of each function will be achieved on the workstation Before the Next Interaction Globally (BNIG), i.e. before the next interaction with a logical input device gets underway on any workstation (see **4.8.2**). If an interaction on any workstation is already underway, the visual effect will be achieved as soon as possible.

c) BNIL: The visual effect of each function will be achieved on the workstation Before the Next Interaction Locally (BNIL), i.e. before the next interaction with a logical input device gets underway on that workstation (see **4.8.2**). If an interaction on that workstation is already underway, the visual effect will be achieved as soon as possible.

d) ASTI: The visual effect of each function will be achieved on the workstation At Some TIme (ASTI).

Deferral applies to the following functions that generate output:

POLYLINE
POLYMARKER
TEXT
FILL AREA
CELL ARRAY
GENERALIZED DRAWING PRIMITIVE
INSERT SEGMENT
ASSOCIATE SEGMENT WITH WORKSTATION
COPY SEGMENT TO WORKSTATION
INTERPRET ITEM

For none of the possible values of deferral mode is it mandatory for an implementation to delay the visual effect of output functions. If the application program requires a delay, it can achieve this using the segment storage facility and the visibility attribute. This restriction means that the buffer for deferred actions can be chosen in an implementation dependent manner.

Certain functions can be performed immediately on some workstations, but on other workstations imply a regeneration of the whole picture to achieve their effect. For example, an implicit regeneration is necessary when picture changes require new paper to be put on a plotter. The entries 'dynamic modification accepted' in the workstation description table indicate which changes:

e) lead to an implicit regeneration (IRG);

f) can be performed immediately (IMM).

If changes can be performed immediately, those changes may affect primitives outside segments in addition to those inside segments. If regeneration occurs, all primitives outside segments will be deleted from the display surface.

An implicit regeneration is equivalent to an invocation of the function REDRAW ALL SEGMENTS. Its possible delay is controlled by the implicit regeneration mode, a single entry in the workstation state list. The values of implicit regeneration mode are:

g) SUPPRESSED: Implicit regeneration of the picture is suppressed, until it is explicitly requested: the entry 'new frame necessary at update' is set to YES.

h) ALLOWED: Implicit regeneration of the picture is allowed.

An implicit regeneration is made necessary, if any of the following occur:

i) if the functions listed below have a visible effect on the display image of the respective workstation:

1) if the 'dynamic modification accepted' entry in the workstation description table is IRG (implicit regeneration necessary) for the specified representation:

SET POLYLINE REPRESENTATION
SET POLYMARKER REPRESENTATION
SET TEXT REPRESENTATION
SET FILL AREA REPRESENTATION
SET PATTERN REPRESENTATION
SET COLOUR REPRESENTATION

2) if the 'dynamic modification accepted' entry in the workstation description table is IRG for the workstation transformation:

SET WORKSTATION WINDOW
SET WORKSTATION VIEWPORT

3) if the 'dynamic modification accepted' entry in the workstation description table is IRG for segment priority and this workstation supports segment priority:

i) if primitives are added to open segment overlapping a segment of higher priority:

POLYLINE
POLYMARKER
TEXT
FILL AREA
CELL ARRAY
GENERALIZED DRAWING PRIMITIVE
INSERT SEGMENT

(since only segments have priority, primitives outside segments do not make an implicit regeneration necessary.)

ii) if the complete execution of one of the following actions would be affected by segment priority:

DELETE SEGMENT
DELETE SEGMENT FROM WORKSTATION
ASSOCIATE SEGMENT WITH WORKSTATION
SET SEGMENT TRANSFORMATION
SET VISIBILITY
SET SEGMENT PRIORITY

4) if the 'dynamic modification accepted' entry in the workstation description table is IRG for segment transformation:

SET SEGMENT TRANSFORMATION

5) if the 'dynamic modification accepted' entry in the workstation description table is IRG for 'visibility (visible → invisible)':

SET VISIBILITY (INVISIBLE)

6) if the 'dynamic modification accepted' entry in the workstation description table is IRG for 'visibility (invisible → visible)':

SET VISIBILITY (VISIBLE)

7) if the 'dynamic modification accepted' entry in the workstation description table is IRG for highlighting:

SET HIGHLIGHTING

8) if the 'dynamic modification accepted' entry in the workstation description table is IRG for delete segment:

DELETE SEGMENT
DELETE SEGMENT FROM WORKSTATION

j) if any of the above situations occurs as a result of INTERPRET ITEM.

An implicit regeneration has to be done (including deletion of primitives outside segments) only if one of the functions listed causes a visible effect on the display; for example, if an invisible segment is deleted, a regeneration need not be done. However, an implementation is allowed to perform an implicit regeneration in any of the cases listed above.

Deferred actions can be made visible at any time by the use of the UPDATE WORKSTATION function or by an appropriate change of the deferral state.

4.5.4 Clearing the display surface

Two capabilities for clearing the display surface are recognized, namely:

a) clear the display surface even if it is empty;

b) ensure that the display surface is clear without clearing the display surface needlessly.

The second capability means that the display surface is only cleared when needed: this would normally be when the display surface is not clear (i.e. when the 'display surface empty' entry in the workstation state list is NOTEMPTY). The entry 'display surface empty' in the workstation state list is set to NOTEMPTY if output is sent to the device. It may be set to NOTEMPTY even if output does not appear on the display surface (for example, a GDP primitive which has been clipped at the device to non-existence).

Both capabilities for clearing the display surface are available to the user through the function CLEAR WORKSTATION. The second capability is also used in UPDATE WORKSTATION and REDRAW ALL SEGMENTS ON WORKSTATION.

4.5.5 Elimination of primitives outside segments

Elimination of primitives outside segments occurs in the following situations:

a) if the following GKS functions are invoked:

CLEAR WORKSTATION

REDRAW ALL SEGMENTS ON WORKSTATION

UPDATE WORKSTATION
if the parameter update regeneration flag is PERFORM and if 'new frame action necessary at update' in the workstation state list is YES;

SET DEFERRAL STATE
if 'implicit regeneration mode' is ALLOWED and 'new frame action necessary at update' is YES;

b) if an implicit regeneration is made necessary (see **4.5.3**) and 'implicit regeneration mode' is ALLOWED;

c) if any of the above situations occurs as a result of INTERPRET ITEM.

4.5.6 Sending messages to a workstation

The MESSAGE function allows a character string to be sent to a workstation. The application program has no control over the position and appearance of the character string and an implementation is allowed to place the string on a device distinct from, but associated with, the workstation. The rules to be followed by an implementation are stated in **5.2**.

4.6 Coordinate systems and transformations

4.6.1 Normalization transformations

In GKS, the application programmer can compose his graphical picture from separate parts each of which, conceptually, is defined with its own world coordinate system (WC). The relative positioning of the separate parts is defined by having a single normalized device coordinate space (NDC) onto which all the defined world coordinate systems are mapped. A set of normalization transformations define the mappings from the world coordinate systems onto the single normalized device coordinate space, which can be regarded as a workstation independent abstract viewing surface. This normalized picture can be stored and manipulated via the segment mechanism; it can also be stored on a metafile.

For output, a single normalization transformation is current at any one time and this is used to transform world coordinates specified, for example in output primitives and geometric attributes, into normalized device coordinates.

A normalization transformation is specified by defining the limits of an area in the world coordinate system (window) which is to be mapped onto a specified area of the normalized device coordinate space (viewport). Window and viewport limits specify rectangles parallel to the coordinate axes in WC and NDC. The rectangles include their boundaries. The normalization transformation performs a mapping from WC onto NDC that includes translation and differential scaling with positive scale factors for the two axes.

Although NDC space conceptually extends to infinity, the part of NDC space in which the viewport needs to be located and that can be viewed at a workstation is the closed range $[0,1] \times [0,1]$. In addition, an implementation may support only a restricted range of NDCs. However, this range is always sufficiently greater than the $[0,1] \times [0,1]$ square that useful effects of INSERT SEGMENT can be achieved. In particular, NDCs in the range $[-7,7] \times [-7,7]$ are always handled.

Each normalization transformation is identified by a transformation number which is an integer between 0 and an implementation dependent value n which can be inquired from the GKS state list. The normalization transformation with transformation number 0 is the unity transformation which maps $[0,1] \times [0,1]$ in world coordinates to $[0,1] \times [0,1]$ in normalized device coordinates. It cannot be changed.

Initially, all other normalization transformations are set to a default transformation which is the same as transformation number 0. Different transformations can be specified at any time when GKS is open. Since GKS provides a number of different normalization transformations, it is possible for the application program to specify them prior to outputting the graphical picture. The separate parts of the picture are output by selecting a particular normalization transformation before outputting the associated graphical primitives. However, specifying a normalization transformation, while the graphical output is taking place, is allowed.

A normalization transformation may be selected by SELECT NORMALIZATION TRANSFORMATION, and it will be used for all output until another is selected. By default, normalization transformation 0 is selected.

4.6.2 Clipping

The viewport of a particular normalization transformation is used to define a clipping rectangle, as well as, with the window, specifying the normalization transformation. When the viewport of the current normalization transformation is set or when a normalization transformation is selected, the 'clipping rectangle' entry in the GKS state list is set to the resulting viewport of the current normalization transformation. Clipping to this clipping rectangle can either be enabled or disabled. There is a single global switch (the clipping indicator) which defines whether or not the clipping rectangle is to be used for clipping.

Clipping does not take place when the normalization transformation is performed but is delayed until the output primitives are to be displayed on the display surface of a workstation. Output primitives stored in segments have their coordinates transformed to NDC and the associated clipping rectangle is stored with the primitives. The INSERT SEGMENT function allows the clipping rectangle in the GKS state list to replace the clipping rectangle, stored with an output primitive when the segment was defined.

Primitives sent to a workstation of category MO are not clipped.

4.6.3 Workstation transformations

The normalized device coordinate space can be regarded as a workstation independent abstract viewing surface. Each open workstation can select independently some part of the NDC space in the range $[0,1] \times [0,1]$ to be displayed somewhere on the workstation display surface. A particular workstation transformation is a mapping from NDC space onto the device coordinates (DC) for that workstation.

The units of device coordinates are metres on a device capable of producing a precisely scaled image (for example, on most plotters) and appropriate workstation dependent units otherwise (for example, on a display unit with unknown monitor size). In either case the device coordinate system maps onto the display space in the following way:

a) the DC origin is at the bottom left corner of the display space;

b) the device coordinate units are related to the display space in such a way that a square in device coordinates appears as a square on the display surface (this is trivially true if device coordinate units are metres);

c) x and y increase to the right and upwards respectively.

On some devices, device coordinate units do not coincide with addressable units, for example if the addressable units do not satisfy the above conditions.

The size of the display space in device coordinate units is recorded in the workstation description table.

The workstation transformation is a uniform mapping from NDC onto DC and thus performs translation and *equal* scaling with a positive scale factor for the two axes. Thus picture composition can be achieved using the normalization transformations whereas the workstation transformation allows different aspects of the composed picture to be viewed on different workstations. For example, a drawing could be output to a plotter at the correct scale and simultaneously some part of the drawing could be displayed on the full display surface of an interactive terminal.

The workstation transformation can be specified at any time after the workstation has been opened. However, actually changing the workstation transformation may cause an implicit regeneration of the picture.

A workstation transformation is specified by defining the limits of an area in the normalized device coordinate system within the range $[0,1] \times [0,1]$ (workstation window) which is to be mapped onto a specified area of the device coordinate space (workstation viewport). Workstation window and workstation viewport limits specify rectangles parallel to the coordinate axes in NDC and DC. The rectangles include their boundaries. To ensure that no output outside the workstation window is displayed, GKS clips at the workstation window boundaries, and this clipping cannot be disabled. As the workstation window is defined somewhere in the NDC range $[0,1] \times [0,1]$, this ensures that the only part of NDC space that can be viewed on any workstation lies in the range $[0,1] \times [0,1]$. If the workstation window and workstation viewport have different aspect ratios, the scaling specified would be different on each axis if the workstation window was mapped onto the workstation viewport in its entirety. To ensure equal scaling on each axis, the workstation transformation maps the workstation window onto the largest rectangle that can fit within the workstation viewport such that:

d) aspect ratio is preserved;

e) the lower left-hand corner of the workstation window is mapped to the lower left-hand corner of the workstation viewport.

Thus, space is left unused at the top or right side of the workstation viewport if the aspect ratios of the workstation window and workstation viewport are different.

All workstation transformations are set by default to map NDC space $[0,1] \times [0,1]$ onto the whole of the workstation display space. If the display space is not square, the same rules as above apply to achieve equal scaling on each axis.

Workstation transformations can be changed by SET WORKSTATION WINDOW or SET WORKSTATION VIEWPORT. As a specification of the workstation transformation may be deferred (see **4.5.3**), these two functions only set the 'requested workstation window' and 'requested workstation viewport' entries in the workstation state list. The 'current workstation window' and 'current workstation viewport' entries continue to hold the previously set transformation parameters. When the display is updated, the current values are set to the requested values.

A complete data flow chart for graphical output is given in figure 9. It should be noted that all three coordinate systems (WC, NDC and DC) are two dimensional Cartesian coordinate systems.

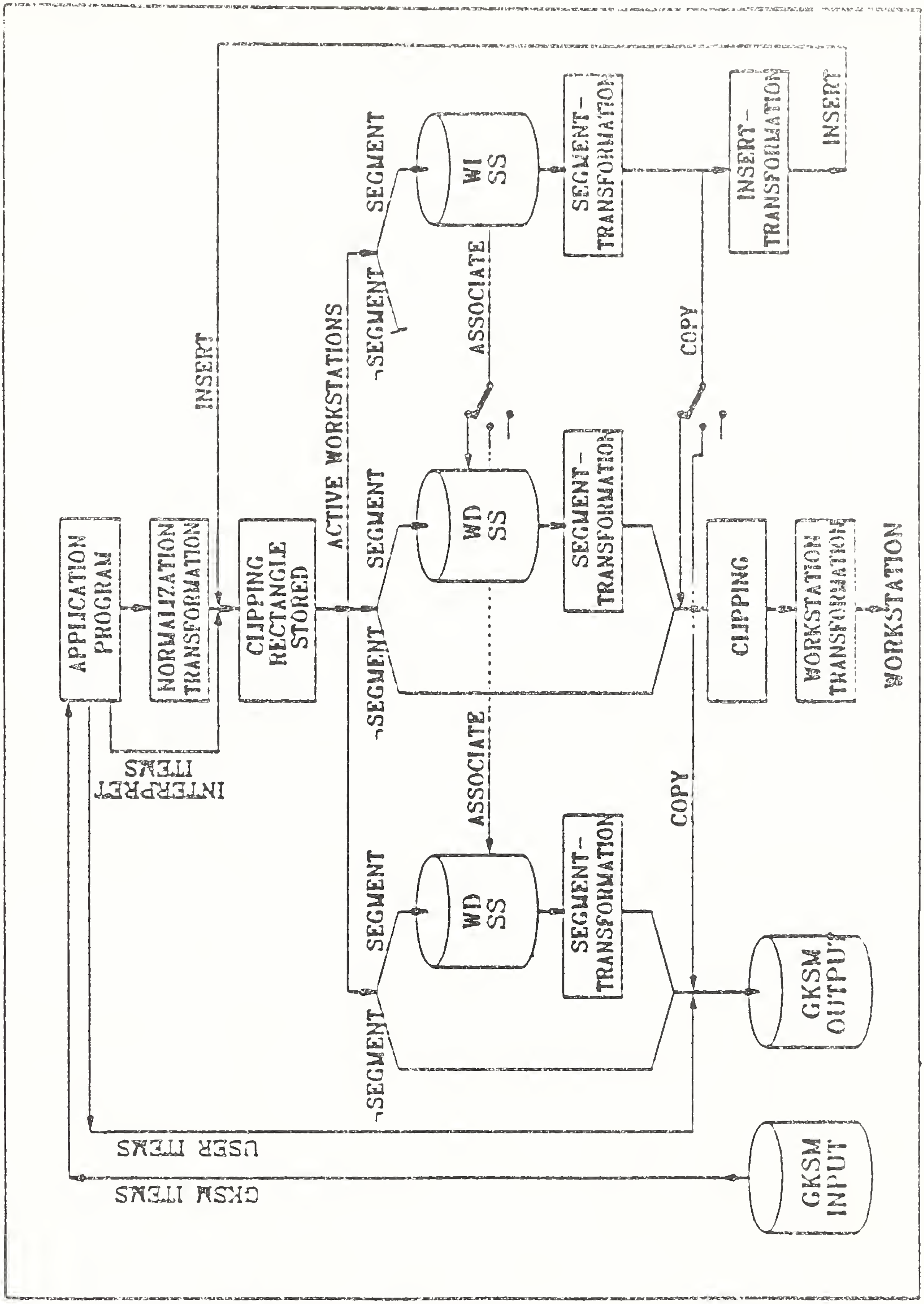


Figure 9. Data flow chart for graphical output in GKS

4.6.4 Transformation of locator input

The application programmer requires LOCATOR input to define a position in the most appropriate world coordinate system currently defined by the set of normalization transformations.

This is achieved by first transforming the input data from DC to NDC by the inverse workstation transformation which is in effect when LOCATOR input is generated. LOCATOR input can only be obtained from positions within the part of the current workstation viewport into which the current workstation window is mapped (note that this is a subset of the workstation viewport whenever the aspect ratio of the workstation viewport and workstation window differ). Thus, LOCATOR input always defines a position in the NDC range $[0,1] \times [0,1]$.

To return to the application program a position in world coordinates, the position in NDC space needs to be transformed from NDC to WC by the inverse of one of the normalization transformations. Each normalization transformation has associated with it a viewport input priority which is only relevant to LOCATOR and STROKE input. Normalization transformations are ordered in a list defined by the viewport input priority. At GKS initialisation, an implementation defined number of normalization transformations are initialised to have window and viewport set to the unit square and their viewport input priorities are set relative to the transformation number with transformation number 0 given the highest priority, transformation number 1 the next highest and so on. Changing the viewport input priority of any normalization transformation is allowed at any time.

The LOCATOR input position in NDC space is compared with the viewports of the normalization transformations, to find the normalization transformation with the viewport which has the highest viewport input priority and contains the LOCATOR position. The LOCATOR position is transformed by the inverse of this normalization transformation to the associated WC. This LOCATOR position is returned to the application program in WC together with the number of the normalization transformation used.

As transformation number 0 is the unity transformation with viewport $[0,1] \times [0,1]$ and cannot be changed, this ensures that LOCATOR input is always within at least one viewport. A data flow chart for LOCATOR input is given in figure 10.

As transformation number 0 is given the highest viewport input priority initially, LOCATOR input is effectively returned in WC equivalent to NDC until a normalization transformation is defined with a viewport input priority greater than that of transformation number 0. If a normalization transformation is no longer required for mapping LOCATOR input back to WC, it can effectively be hidden by reassigning it a viewport input priority lower than transformation number 0.

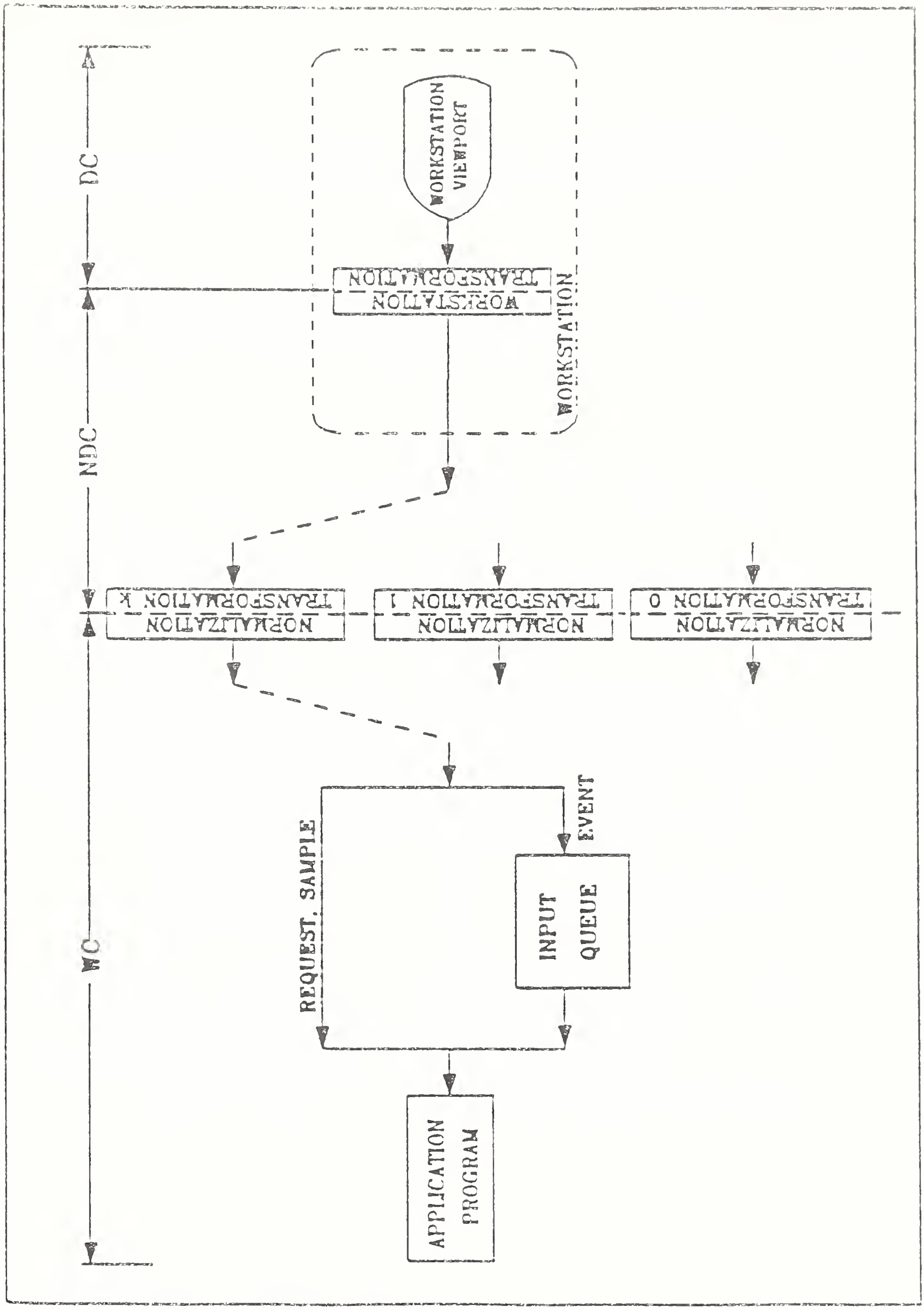


Figure 10. Data flow chart for locator input

Changing the viewport input priority of transformation number 0 is allowed.

In an event report, generated by a LOCATOR device in EVENT mode, the DC position is transformed to the appropriate WC position before the event report is placed on the input queue. These transformations may be performed while the normalization and workstation transformations are being changed; thus, there is a race condition. The implementation has therefore to treat the transformations as resources to be allocated and deallocated between the competing processes.

Between placing on the input queue and the execution of AWAIT EVENT which removes the LOCATOR position from the queue, it is possible for the normalization transformation and the workstation transformation to be changed by the application program. To ensure that the DC position located is equivalent to the WC position retrieved from the input queue, it is advisable for the application program not to change a transformation while a LOCATOR is in EVENT mode.

4.6.5 Transformation of stroke input

Similar considerations apply to transformation of STROKE input as apply to LOCATOR input, with the complication that more than one point is involved.

When each point of a stroke is generated, the coordinates of the point are transformed from DC to NDC by the inverse workstation transformation then in effect. STROKE input can only be obtained from positions within the part of the current workstation viewport into which the current workstation window is mapped (analogous to LOCATOR input). Thus STROKE input always consists of points in the NDC range $[0,1] \times [0,1]$.

To return to the application program points in world coordinates, the points in NDC space need to be transformed from NDC to WC by the inverse of one of the normalization transformations. The STROKE points in NDC space are compared with the viewports of the normalization transformations, to find the normalization transformation with the viewport which has the highest viewport input priority and contains all of the points. The STROKE points are then transformed by the inverse of this normalization transformation and returned to the application program in WC together with the number of the normalization transformation used.

If the STROKE device is in SAMPLE mode, the normalization transformation used may vary between successive samples.

In EVENT mode, there is a similar race condition to that applying to LOCATOR input. Between placing an event report on the input queue and the execution of AWAIT EVENT which removes the STROKE event from the queue, it is possible for the normalization transformation and the workstation transformation to be changed by the application program. To ensure that the DC points input by the operator are equivalent to the WC points retrieved from the input queue, it is advisable for the application program not to change transformations while a STROKE device is in EVENT mode.

4.7 Segments

4.7.1 Introduction to segments

In GKS, graphical output primitives may be grouped in segments as well as being created outside segments. Each segment is identified by a unique, application specified segment name. Segments may be:

a) transformed;

b) made visible or invisible;

c) highlighted;

d) ordered front to back, which impacts overlapping primitives;

e) made detectable or undetectable;

f) deleted;

g) renamed;

h) inserted into the open segment or into the stream of primitives outside segments (see **4.7.6**).

Only primitives contained inside segments are affected by these operations. The application program has no access to primitives outside segments once they have been created.

Every primitive within a segment has an attribute PICK IDENTIFIER which establishes a second level of naming. The sole function of the PICK IDENTIFIER is the identification of primitives; it cannot be used for manipulations. This level of naming is provided in GKS to reduce the segment overhead for applications where a great number of picture parts need to be distinguished for input but the need for manipulation is less important.

Whereas segment names are unique, the same value for PICK IDENTIFIER can be assigned arbitrarily to single output primitives or groups of output primitives within segments, as illustrated in the following sequence of functions:

```
SET PICK IDENTIFIER(4);
CREATE SEGMENT (1);
  Output functions;          {segment=1, PICK IDENTIFIER=4}
SET PICK IDENTIFIER (2);
  Output functions;          {segment=1, PICK IDENTIFIER=2}
CLOSE SEGMENT;
  Output functions;          {primitives not pickable}
                             {PICK IDENTIFIER=2}
SET PICK IDENTIFIER (5);
  Output functions;          {primitives not pickable}
                             {PICK IDENTIFIER=5}
CREATE SEGMENT (2);
  Output functions;          {segment=2, PICK IDENTIFIER=5}
SET PICK IDENTIFIER (3);
  Output functions;          {segment=2,PICK IDENTIFIER=3}
CLOSE SEGMENT;
```

After a segment is closed, primitives in it cannot be modified nor can primitives be added to or deleted from the segment. No function is provided to extend a segment after it has been closed. Clipping rectangles and primitive attributes (geometric attributes, attributes controlling non-geometric aspects, and PICK IDENTIFIER) are stored along with primitives in segment storage. Geometrical transformations, changes of the segment attributes and changes of the workstation specific bundle and colour tables referenced from within a segment are possible.

All values describing the state of a segment (i.e. name, segment attributes, and workstations active at creation time) are stored in a segment state list that GKS keeps during a segment's lifetime.

Each segment is stored on all workstations active at the time the segment is created (CREATE SEGMENT). It can be deleted on all workstations by the DELETE SEGMENT function. It can be deleted on a specific workstation by the DELETE SEGMENT FROM WORKSTATION function. All segments stored on a specific workstation can be deleted from it by the CLEAR WORKSTATION function.

Segment storage on an OUTPUT or OUTIN workstation is referred to as Workstation Dependent Segment Storage (WDSS). GKS provides a second segment storage system for workstation independent storage of pictures at run time, Workstation Independent Segment Storage (WISS: see **4.7.5** and **4.7.6**). Segments cannot be moved from WDSS to another workstation, but from WISS they can.

Segments have a unique name across all segment storage. A GKS implementation provides a large number of available segment names (for example 32 000).

4.7.2 Segment attributes

Segment attributes affect all the primitives in a segment. The segment attributes are:

a)	SEGMENT TRANSFORMATION:	(see **4.7.3**);
b)	VISIBILITY:	a segment is either displayed or not;
c)	HIGHLIGHTING:	a visible segment is either highlighted or not;
d)	SEGMENT PRIORITY:	if parts of segments (for example, FILL AREA, CELL ARRAY) overlap, the segment with the higher priority will be preferred, both when the segments are displayed and when they are picked;
e)	DETECTABILITY:	a segment can either be selected by a pick input device or it cannot.

The segment attributes are unique for each segment and do not vary on different workstations. The default segment attributes (identity transformation, visible, not highlighted, priority 0, undetectable) are assigned to a segment when it is opened. The segment attributes of any segment in existence, including the open segment, may be changed. The binding of segment attributes is shown in figure 2 (see **4.4**).

Segment priority affects segments being displayed (i.e. performing segment and workstation transformations, including clipping, for each primitive of the segment). If parts of primitives overlap with others of a visible segment with higher priority, these parts may be invisible. Whether a workstation supports this feature is indicated in the workstation description table. This feature is intended to address appropriate hardware capabilities only. It is not intended to mandate shielding on non-raster displays. When primitives within a segment overlap, the implementation determines the appearance of the overlapped parts. The actual effect is listed in the documentation accompanying an implementation.

When primitives of segments overlapping each other are picked, the segment with higher priority is selected. When primitives of the same segment or of segments with equal priority overlap, the results are implementation dependent.

4.7.3 Segment transformations

Segment transformations are a mapping from NDC onto NDC. They perform translation, scaling and rotation.

Segment transformations are characterized by:

a) segment name;

b) transformation matrix.

The transformation matrix is a 2×3 matrix, consisting of a 2×2 scaling and rotation portion and a 2×1 translation portion. Utility functions (EVALUATE TRANSFORMATION MATRIX, ACCUMULATE TRANSFORMATION MATRIX) are available to the application program for setting up the transformation matrices. A fixed point for scaling and rotation, and a shift vector in either WC or NDC may be specified. In the former case, the WC values of the fixed point and shift vector are first transformed using the current normalization transformation.

The segment transformation takes place after the normalization transformation, but before any clipping.

A segment transformation, specified by the SET SEGMENT TRANSFORMATION function, is not actually performed in the segment storage but only saved in the segment state list. Every time the segment is redrawn this segment transformation is applied before clipping. Successive SET SEGMENT TRANSFORMATION function calls for the same segment are not accumulated; each succeeding transformation matrix replaces its predecessor. By calling SET SEGMENT TRANSFORMATION with an identity transformation matrix, the original segment can be obtained without loss of information.

Locator input data is not affected by any segment transformation.

4.7.4 Clipping and WDSS

Clipping takes place after the normalization and segment transformations have been applied. Each primitive is clipped against the clipping rectangle associated with the primitive when it was put into the segment. If the 'clipping indicator' entry in the GKS state list was CLIP when this occurred, the clipping rectangle associated with the primitive is the clipping rectangle in the GKS state list at that time, otherwise it is $[0,1] \times [0,1]$ in NDC.

Clipping rectangles are not transformed by the segment transformation and thus clipping is always performed against a rectangle whose edges are parallel to the NDC space coordinate axes.

4.7.5 Workstation Independent Segment Storage

One Workstation Independent Segment Storage (WISS) is defined, where segments can be stored for use by the COPY SEGMENT TO WORKSTATION, ASSOCIATE SEGMENT WITH WORKSTATION, and INSERT SEGMENT functions, as described in **4.7.6**. None of these functions modify the contents of the segments to which they are applied. Only one WISS is permitted in a GKS implementation.

The ability to manipulate segments requires the storage of all segments so that they can be reused on whatever workstations are active when they are created. By contrast, primitives outside segments cannot be reused. GKS does not define the manner and format of the storage of segments as long as all segment operations can be performed and as long as the correct clipping is applied to each primitive.

The point in the viewing pipeline at which primitives are recorded in the WISS immediately follows the point at which data are distributed to workstations, as shown in figure 9 (see **4.6**). For this reason the WISS is treated like a workstation (of category WISS), as far as control functions are concerned. Primitives are transformed from world coordinates to NDC before they are distributed to workstations.

Whether the WISS is realized within the GKS nucleus or by utilizing the capabilities of an appropriate physical workstation or other input/output device is left to the implementor.

4.7.6 WISS functions and clipping

Just as in other workstations, a segment is stored in WISS if WISS is active when the segment is created and a clipping rectangle is associated with each primitive. If the 'clipping indicator' entry in the GKS state list is CLIP when this occurs, the clipping rectangle associated with the primitive is the clipping rectangle in the GKS state list; otherwise it is $[0,1] \times [0,1]$ in NDC.

COPY SEGMENT TO WORKSTATION copies primitives from a segment in WISS to be output on the specified workstation. The function takes a copy of each primitive and its associated clipping rectangle from a segment in the WISS, transforms the primitives by the segment transformation and puts the clipping rectangles and the transformed primitives into the viewing pipeline at the place equivalent to the one where the information left (but it is sent only to the workstation specified in the invocation), as shown in figure 9 (see **4.6**). This function cannot be invoked when a segment is open. By contrast with ASSOCIATE SEGMENT WITH WORKSTATION, this function does not cause a segment to exist on the specified workstation.

ASSOCIATE SEGMENT WITH WORKSTATION copies the segment to the WDSS of the specified workstation in the same way as if the workstation were active when the segment was created. Clipping rectangles are copied unchanged. This function cannot be invoked when a segment is open.

INSERT SEGMENT allows previously stored primitives (in segments in WISS) to be transformed and again placed into the stream of output primitives. INSERT SEGMENT reads the primitives from a segment in the WISS, applies the segment transformation followed by the insert transformation and then inserts them into the viewing pipeline at the point before data are distributed to the workstations. All clipping rectangles in the inserted segment are ignored. Each primitive processed is assigned a new clipping rectangle, which is the clipping rectangle in the GKS state list if the 'clipping indicator' entry in the GKS state list is CLIP and is $[0,1] \times [0,1]$ if the 'clipping indicator' entry in the GKS state list is NOCLIP. In other words, inserted primitives are assigned clipping rectangles in the same manner as directly created primitives. Thus, all primitives processed by a single invocation of INSERT SEGMENT receive the same clipping rectangle. Inserted information may re-enter the WISS, if the WISS is active and a segment is open.

An invocation of INSERT SEGMENT has no effect on output primitives passing through the pipeline before or after the invocation. The INSERT SEGMENT function can be used when a segment is open but the open segment cannot, itself, be inserted.

4.8 Graphical Input

4.8.1 Introduction to logical input devices

An application program obtains graphical input from an operator by controlling the activity of one or more logical input devices, which deliver logical input values to the program.

A logical input device is identified by a workstation identifier, an input class and a device number.

The workstation identifier identifies an open workstation, belonging to category INPUT or OUTIN, of which the logical input device is a part. The logical input device is implemented in terms of a physical input device or devices present on the workstation.

The input class determines the type of logical input value that the logical input device delivers. The six input classes and the logical input values they provide are:

a) LOCATOR: a position in world coordinates and a normalization transformation number.

b) STROKE: a sequence of points in world coordinates and a normalization transformation number.

c) VALUATOR: a real number.

d) CHOICE: a CHOICE status and a non-negative integer which represents a selection from a number of choices.

e) PICK: a PICK status, a segment name and a pick identifier. Primitives outside segments cannot be picked.

f) STRING: a character string.

The device number distinguishes different logical input devices of the same class on the same workstation.

A workstation of category INPUT or OUTIN contains at least one logical input device. A GKS implementation providing at least one OUTIN workstation always provides an operator with at least one logical input device in each class defined at the level (see **4.10.3**) of the implementation.

Each logical input device can be operated in three modes, called operating modes. At any time a logical input device is in one, and only one, of the modes set by the invocation of a function in the group SET <input class> MODE. The three operating modes are REQUEST, SAMPLE and EVENT. Input from devices is obtained in different ways depending on the mode as follows.

g) REQUEST: A specific invocation of REQUEST <input class> causes an attempt to read a logical input value from a specified logical input device. This can only occur when the logical input device is in REQUEST mode. GKS waits until the input is entered by the operator or a break action is performed by the operator. The break action is dependent on the logical input device and on the implementation. If a break occurs, the logical input value is not valid.

h) SAMPLE: A specific invocation of SAMPLE <input class> causes GKS, without waiting for an operator action, to return the current logical input value of a specified logical input device. This can only occur when the logical input device is in SAMPLE mode.

i) EVENT: GKS maintains one input queue containing temporally ordered event reports. An event report contains the identification of a logical input device and a logical input value from that device. Event reports are generated asynchronously, by operator action only, from input devices in EVENT mode.

The application program can remove the oldest event report from the queue and examine its contents. The application can also flush from the queue all event reports from a specified logical input device.

A specific logical input device is said to be taking part in an interaction during the whole time that it is in SAMPLE or EVENT mode, but, when it is in REQUEST mode, only during the execution of a REQUEST <input class> function for that device. Alternatively, an interaction with the device may be said to be underway during that time. Many devices on many workstations may be taking part in interactions simultaneously.

4.8.2 Logical input device model

To describe the precise actions of the logical input devices, it is first necessary to describe their relationship with physical input devices, using the concept of measures and triggers.

A logical input device contains a measure, a trigger, an initial value, a prompt and echo type, an echo area and a data record containing details about the prompt and echo type. A logical input device's measure and trigger are parts of the implementation of the workstation containing the logical input device. Initial value, prompt and echo type, echo area, and data record can be supplied by the application program.

The measure of a logical input device is a value determined by one or more physical input devices together with a 'measure mapping'. More than one measure can simultaneously be determined by a single physical device; a separate measure mapping applies for each measure. A measure can be seen as the state of an independent, active process (a measure process). Each state corresponds exactly with a logical input value.

The current state of the measure process (i.e. the device's measure) is available to GKS as a logical input value. Whenever the device is taking part in an interaction, the measure process is in existence. Under other conditions, this process does not exist.

When a measure process comes into existence, the data in the workstation state list entry for the logical input device are examined. The initial value is checked for legality according to input class dependent rules explained in **4.8.4**. If the check succeeds, the initial value is used as the current state of the process; otherwise a value dependent on the logical input device is used. Next, a prompt is output to indicate that the device is ready for use. (The prompt technique used by a device is determined by its prompt and echo type, which may be selected by calling the appropriate INITIALISE function.) Creation of the measure process is then complete.

While the measure process is in existence, if echoing is required, output indicating the current state of the measure process is provided to the operator.

The trigger of a logical input device is a physical input device or a set of them together with a 'trigger mapping'. The operator can use a trigger to indicate significant moments in time. At these moments, the trigger is said to 'fire'. A single operator action (for example, pressing a button or a light pen tip switch) causes the firing of not more than one trigger. Several logical input devices can refer to the same trigger.

A trigger can be seen as an independent, active process (a trigger process) that sends a message to one or more recipients when it fires. A logical input device is a recipient of its trigger if there is a pending REQUEST for it or if it is in EVENT mode. Both of these conditions can be true simultaneously for different logical input devices. If there is at least one recipient for a trigger, the trigger process is in existence. Under other conditions this process does not exist.

If a REQUEST for a logical input device is pending when the device's trigger fires, the measure of that device is used to satisfy the REQUEST. If one or more devices containing a given trigger are in EVENT mode when the trigger fires, the identifications of those devices and their measure values are passed to the input queue mechanism as separate event reports. The input queue mechanism is described in detail in **4.8.5**.

When a trigger firing succeeds in satisfying a REQUEST, or adding event records to the input queue, GKS provides to the operator an acknowledgement the form of which depends on the implementation of the logical input device. The acknowledgement is not controllable by a GKS function.

4.8.3 Operating modes of logical input devices

The mode of a logical input device may be changed by invoking the appropriate SET <input class> MODE function.

After an invocation of SET <input class> MODE with the parameter REQUEST, no measure process exists for the specified device and the device's identifier is not on its trigger's list of recipients. After an invocation with the parameter EVENT, a newly initiated measure process is in existence for the specified device and the device's identifier is on its trigger's list of recipients.

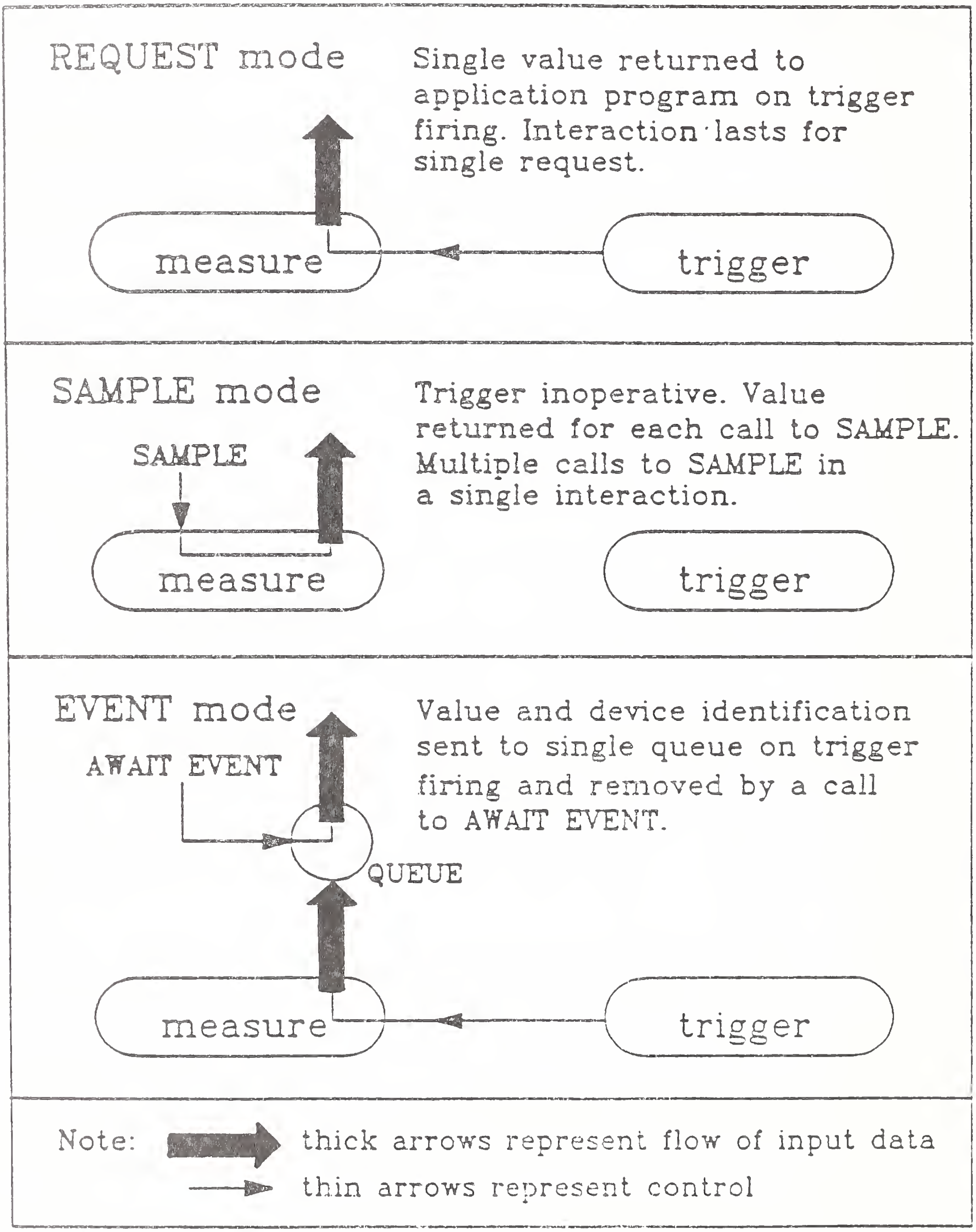


Figure 11. The relationship between the measure and trigger for different operating modes, illustrated for a single logical input device

After an invocation with the parameter SAMPLE, a newly initiated measure process is in existence for the specified device, but the device's identifier is not on its trigger's list of recipients.

Initially a logical input device is in REQUEST mode.

While a device is in REQUEST mode, a logical input value may be obtained by invoking the appropriate REQUEST <device class> function. The effects of doing so are as follows.

a) To create a measure process for the specified device and to set its value to the initial value from the workstation state list as described in **4.8.4**. Echoing is performed by the measure process if echoing is on for the specified device.

b) To add the device's identifier to its trigger's list of recipients. If the list was previously empty, the trigger process is started.

c) To suspend GKS until the trigger of the specified device fires, or the operator invokes the break facility.

d) If the trigger fired, to set the logical input value to the current state of the measure process.

e) To destroy the measure process.

f) To remove the device's identifier from its trigger's list of recipients. If this list becomes empty, the trigger process is destroyed.

g) If the trigger fired, to return the logical input value and the status OK, otherwise to return the status NONE.

While a logical input device is in SAMPLE mode, a logical input value may be obtained by invoking the appropriate SAMPLE <input class> function. The effect of doing so is to set the logical input value to the current state of the measure process without waiting for a trigger firing.

While a logical input device is in EVENT mode, logical input values are added as event reports to the input queue, and may be obtained in sequence by invoking AWAIT EVENT, and then invoking the appropriate GET <device class> function. (More details of the input queue are given in **4.8.5**.)

Figure 11 shows the effect of every operating mode on the measure and trigger of a logical input device.

4.8.4 Measures of each input class

Details of the measures of logical input devices of different classes are as follows.

A LOCATOR measure consists of a position in world coordinates and a normalization transformation number. Let P and N denote these values.

Then P transformed to NDC by N lies within the workstation window. Also P lies within the window specified by N and, in addition, P transformed to NDC by N lies outside all viewports of higher priority than N.

A STROKE measure consists of a sequence of points in world coordinates and a normalization transformation number. Let $P_1 \ldots P_m$ be the points and N be the transformation number.

Then P_i $(1 \leq i \leq m)$ transformed to NDC by N lie within the workstation window. Also P_i $(1 \leq i \leq m)$ lie within the window specified by N and, in addition, there is no viewport of higher priority than N containing all the points P_i transformed to NDC by N. Thus, N may change as points are added to the stroke.

Any invocation of SET WINDOW, SET VIEWPORT or SET VIEWPORT INPUT PRIORITY can cause a change in P (any P_i for STROKE) or N or both, but the above conditions hold for the new values.

The rules imply that no normalization transformation having priority less than that of transformation 0 can appear in the state of a LOCATOR or STROKE measure process (with the default settings of the viewport input priorities, normalization transformation 0 has the highest).

A VALUATOR measure provides logical input values that are real numbers. Each value lies between (possibly including) minimum and maximum values, which are in the data record in the workstation state list.

A CHOICE measure provides logical input values whose components are OK or NOCHOICE and an integer in the range 1 to a device dependent maximum specified in the workstation description table. If the first component is OK, then the integer is valid. CHOICE input typically occurs when an operator presses a button (the numeric identifier of the button determines the measure) or combination of buttons (the measure is derived from the combination of buttons pressed).

A PICK measure provides logical input values whose components are OK or NOPICK, segment name and a pick identifier. If the first component is OK, then the segment name and pick identifier obey the following rules:

a) The segment exists and has VISIBILITY on and DETECTABILITY on.

b) The segment is present on the workstation containing the PICK device.

c) The pick identifier is the pick identifier attribute of at least one output primitive in the segment. This is tested using the clipping parameters in effect when the primitive arrived at the workstation. Part of the primitive lies within the workstation window and, if clipping was on, part also lies within the primitive's (normalization) clipping rectangle. Further, the primitive is not completely overlapped by primitives in a segment of higher priority.

The PICK initial value is tested against the above rules whenever the PICK measure process is initiated. If the rules are not satisfied, the process state is set to NOPICK.

For certain workstations, testing rule c) when the PICK measure process is initiated, may be very expensive. In such cases, only rules a) and b) need be tested.

The PICK measure is defined using the properties of output primitives and segments. PICK devices exist only on workstations of category OUTIN.

A STRING measure provides logical input values which are character strings up to a device dependent maximum length specified by the buffer size value in the data record in the workstation state list.

4.8.5 Input queue and current event report

The input queue contains zero or more event reports. Event reports contain pairs of values (device identifier, logical input value) resulting from trigger firings. Event reports can be added to the input queue when logical input devices in EVENT mode are triggered by the operator. Events can be removed from the input queue by invocations of AWAIT EVENT, FLUSH DEVICE EVENTS and CLOSE WORKSTATION.

When a trigger that is part of one or more logical input devices in EVENT mode fires, the resulting event reports are entered into the queue and marked as a group of simultaneous event reports. An event report for each device is added to the input queue, if and only if there is room for the whole group of simultaneous event reports.

The order of reports within a group of simultaneous event reports is undefined.

If there is not room in the queue for all event reports when a trigger fires, input queue overflow has occurred. Input queue overflow is not reported to the application program immediately. It is reported via the error mechanism during the next invocation of any GKS function that can remove event reports from the input queue (AWAIT EVENT, FLUSH DEVICE EVENTS, and CLOSE WORKSTATION). The input queue has to be emptied before further event reports will be added. Between the detection of input queue overflow and the next time AWAIT EVENT is invoked with the input queue empty, no events are generated by trigger firings and thus no acknowledgements are provided. (This permits the application program to determine how many events were in the queue when overflow occurred by calling AWAIT EVENT with zero timeout.)

When the 'input queue overflow' error is reported, the trigger causing the overflow is indicated by placing into the error state list the identification of any one of the logical input devices using that trigger which was in EVENT mode at the time the overflow was detected.

AWAIT EVENT, if the queue is not empty, removes the first event report after copying the logical input value into the current event report in the GKS state list. The workstation identifier, input class and device number are returned to the application program directly by AWAIT EVENT. If the queue is empty, AWAIT EVENT suspends execution until an event report is queued or until the specified timeout period has elapsed.

The application program may obtain the contents of the current event report by calling the appropriate GET <input class> function.

If, after removing the event report there remain in the queue other reports in the same group of simultaneous events as the removed report, the 'more simultaneous events' entry in the GKS state list is set to MORE. Otherwise it is set to NOMORE.

FLUSH DEVICE EVENTS removes all event reports for a specific device from the input queue. CLOSE WORKSTATION removes from the input queue all event reports for all logical input devices on that workstation.

If the 'more simultaneous events' entry has the value MORE, when either FLUSH DEVICE EVENTS or CLOSE WORKSTATION is invoked, and they remove all the remaining reports in the group of simultaneous event reports at the head of the queue, then the entry is set to NOMORE.

4.8.6 Initialisation of input devices

For each input class, there is an INITIALISE function which can only be called if the logical input device it specifies is in REQUEST mode. These functions provide the following information to a device via the workstation state list (if the INITIALISE function is not called, then default values apply):

a) An initial value appropriate to the class. If the initial value violates the rules, an error occurs and the workstation state list is unchanged.

b) A prompt and echo type that selects the prompting technique and, if echoing is on, the echoing technique for a logical input device. An implementation dependent prompt and echo type (type 1) is required for all logical input devices. Further prompt and echo types appropriate to each class are defined but not required. These further types are listed with the appropriate INITIALISE function. Prompt and echo types above those are reserved for registration or future standardization. Prompt and echo types less than 0 are device dependent.

c) An echo area (xmin,xmax,ymin,ymax) in device coordinates. Input device implementations may use the echo area for certain prompt and echo types to display prompts or echoes.

d) A data record. Some input classes have mandatory control values in the data record. Some prompt and echo types within an input class also have mandatory control values in the data record. These values occupy well defined places in the data record. In any data record used in initialising an input device, values mandatory to the input class, if any, appear first followed by values mandatory to the prompt and echo type if any. Depending on the device and prompt and echo type, the data record may contain other (additional) information.

When a logical input device is REQUESTed, or when it is set to EVENT or SAMPLE mode, its measure is set to the initial value from the workstation state list, unless this is not a valid measure for the device. If it is not a valid measure for the device, the measure is set to a device dependent value, except for PICK devices, for which the measure is set to NOPICK.

Prompt and echo types describe both the prompt, which informs the operator that the device is available, and the echo, which informs the operator of the state of the measure. The functions provided to control input device mode, SET <input class> MODE, also control whether echo is on or off. In addition, an implementation dependent acknowledgement of successful trigger firings is provided.

The items in data records mandatory for each class are: in a STROKE data record, input buffer size in number of points; in a VALUATOR data record, low value and high value; in a STRING data record, input buffer size and initial cursor position. Prompt and echo types which have mandatory values are types 2, 3, 4 and 5 for CHOICE.

4.9 GKS Metafile Interface

For the purpose of long-term filing of graphical information, GKS provides an interface to sequential files called GKS Metafiles (GKSMs). They can be used for:

a) transporting graphical information between systems;

b) transporting graphical information from one place to another (for example, by means of magnetic tapes);

c) transporting graphical information from one GKS application to another;

d) storing accompanying non-graphical information.

The GKSMs behave like workstations. For output and input, several different workstations of the categories MO and MI can be used concurrently. However, some workstation control and inquiry functions are not applicable to these workstations (they are not meaningful). Section **A.5** of appendix A gives a complete listing of all GKS functions which affect workstations of category MO and MI.

The application program may write data in a metafile using WRITE ITEM TO GKSM. After closing an MO workstation the metafile may be opened as an MI workstation.

Three functions, GET ITEM TYPE FROM GKSM, READ ITEM FROM GKSM and INTERPRET ITEM are provided to read and interpret metafiles. These functions assume that a metafile consists of a sequence of items. Each item comprises an item type, an item data record length and an item data record. The item type indicates either that the item contains information that can be interpreted by GKS or that it contains information that was written by an application program (using WRITE ITEM TO GKSM). When an MI workstation is opened, the first item in the metafile becomes the 'current item'.

GET ITEM FROM GKSM delivers the item type and item data record length of the current item.

READ ITEM FROM GKSM copies the contents of the item data record of the current item into a data area supplied by the application program and then makes the next item in the metafile the current item.

INTERPRET ITEM takes the contents of a GKSM item data record supplied by the application program (as delivered by READ ITEM FROM GKSM) and causes appropriate changes in the set of GKS state variables and generates appropriate graphical output as determined by the metafile specification. The information in metafile item data records can be regarded as falling into classes corresponding to the classes of GKS functions. The interpretation of primitive attribute, clipping rectangle or clipping indicator information causes appropriate changes to entries in the GKS state list. The geometric primitive attribute information, which is expressed in NDC, is transformed by the inverse of the currently selected normalization transformation before being used to set the appropriate entries in the GKS state list. Information corresponding to GKS functions which control a single workstation, but where a workstation is not specified, may be interpreted on all active workstations.

4.10 GKS levels

4.10.1 Introduction

The GKS system is designed to be usable by a wide range of applications, from static plotting to dynamic motion and real time interaction. In addition, many display devices lack features (such as picking) that would require considerable implementation effort to simulate with software. It is therefore desirable to permit GKS implementations that do not include all of the functional capabilities defined in this standard.

4.10.2 The level structure

The functional capabilities of GKS can be grouped into the major areas:

a) output (minimal performance, full performance);

b) input (no input, REQUEST input, full input);

c) number of workstations (one workstation, multiple workstations);

d) attributes (only predefined bundles and individual attribute specifications possible, full bundle concept);

e) segmentation (none, basic segmentation (without Workstation Independent Segment Storage), full segmentation).

If an arbitrary combination of capabilities were to be considered a valid GKS implementation, an almost unlimited number of different standard dialects would result and program portability, one of the major goals of this standard, would not be achieved. Therefore, twelve valid levels of the GKS system are defined, in order to address the most common classes of equipment and applications. Each GKS implementation provides at least the functions of one level.

The level structure has two independent axes: input and ''all the other functions'', summarized as output.

The output level axis has the four possibilities:

m: Minimal output;

0: All primitives and attributes;

1: Basic segmentation with full output;

2: Workstation Independent Segment Storage.

The input level axis has the three possibilities:

a: No input;

b: REQUEST input;

c: Full input.

In GKS, capabilities are expressed by functions and by ranges of parameters.

There are three different types of capability at each level:

f) An explicitly defined and required capability. Every GKS implementation at a specific level supports the capability at that level.

g) An explicitly defined and non-required capability. A GKS implementation may support the capability and, if it does, it is implemented according to the explicit function definitions.

h) A conceptually defined and non-required capability. A GKS implementation may provide the capability. Its implementation follows general rules given by the GKS concepts and functional definitions.

The set of explicitly defined and required capabilities includes:

i) predefined bundle numbers up to the required minimum;(output levels 0,1,and2);

j) linetypes 1 to 4,

k) marker types 1 to 5;

l) text precision STROKE (output levels 1 and 2);

m) interior style HOLLOW;

n) one input device for each input class defined at that level (input levels b and c);

o) prompt and echo type 1 (input levels b and c).

The set of explicitly defined and non-required capabilities includes:

p) text precision STROKE (output levels m and 0);

q) interior style SOLID, PATTERN, HATCH;

r) transformable patterns;

s) segment priority (output levels 1 and 2);

t) prompt and echo types above 1 that are defined (input levels b and c).

The set of conceptually defined and non-required capabilities includes:

u) linetypes above 4;

v) marker types above 5;

w) specific generalized drawing primitives;

x) prompt and echo types above the defined set (input levels b and c);

y) specific escape functions.

Explicitly defined and non-required capabilities of a specific level can become explicitly defined and required capabilities in a higher level of GKS, through variations in the ranges of parameters, for example text precision STROKE and metafile workstations. Each GKS level contains precisely those functions that are explicitly defined and required in that level. However, ranges of parameters may contain additional explicitly defined and non-required capabilities and conceptually defined and non-required capabilities.

4.10.3 Level functionality

The facilities making up each of the components of a level are as follows:

Output level m: Minimal output

a) subset of control available;

b) subset of primitives available;

c) subset of attributes controllable;

d) there are no bundles for attributes;

e) colour representation modification possible;

f) only one workstation with output capabilities available at a time;

g) normalization transformation 0 and only one settable normalization transformation available;

h) subset of inquiries available.

Output level 0: All primitives and attributes

a) all output level m capabilities;

b) basic control;

c) all primitives available at least in minimal performance;

d) use of predefined bundles only (no modification to bundles);

e) only one workstation without output capabilities required at a time;

f) metafile workstations not required; if provided, then both input and output are available; if not provided, then metafile functions return appropriate errors;

g) multiple normalization transformations (but a system with normalization 0 and only one settable normalization transformation is allowable);

h) suitable basic inquiries;

i) pixel readback provided (non-pixel devices may report non-processing).

Output level 1: Basic segmentation with full output

a) all output level 0 capabilities;

b) full workstation control;

c) full output features;

d) full bundle concept;

e) multiple workstation concept;

f) metafile workstation required;

g) multiple settable normalization transformations;

h) basic segmentation (no Workstation Independent Segment Storage);

i) suitable inquiries.

Output level 2: Workstation Independent Segment Storage

a) all output level 1 capabilities;

b) Workstation Independent Segment Storage.

Input level a: No input

a) no facilities.

Input level b: REQUEST input

a) input device initialization and mode setting functions;

b) REQUEST functions on all appropriate devices;

c) appropriate logical input devices include PICK if and only if combined with output level 1 capabilities;

d) function to set viewport input priority.

Input level c: Full input

a) all input level b capabilities;

b) SAMPLE and EVENT mode input.

Table 1 gives a summary of the functionality of each valid GKS level. Each box contains only those functions added to the previous boxes of the same row and column.

Output Level	Input Level a	b	c
m	No input, minimal control, only individually set attributes, 1 settable normalization transformation, and subset of output functions and attributes.	REQUEST input, mode setting and initialise functions for logical input devices, no PICK.	SAMPLE and EVENT input, no PICK.
0	Basic control, predefined bundles, multiple normalization transformation facilities but minimum settable required is 1, and all output functions; metafile workstations optional	Set viewport input priority.	
1	Full output including full bundle concept, multiple workstation concept, basic segmentation (everything except Workstation Independent Segment Storage); metafile workstations required.	REQUEST PICK, mode setting and initialise for PICK.	SAMPLE and EVENT input for PICK.
2	Workstation Independent Segment Storage.		

Table 1 - GKS level concept

Embedded in the levels summarized above are variations in the number of possibilities required in the set of explicitly defined and required capabilities. Table 2 exactly identifies the minimum support which is always provided at each level.

	Level											
CAPABILITY	ma	mb	mc	0a	0b	0c	1a	1b	1c	2a	2b	2c
Foreground Colours (intensity)	1	1	1	1	1	1	1	1	1	1	1	1
Linetypes	4	4	4	4	4	4	4	4	4	4	4	4
Linewidths	-	-	-	1	1	1	1	1	1	1	1	1
Predefined polyline bundles	-	-	-	5	5	5	5	5	5	5	5	5
Settable polyline bundles	-	-	-	-	-	-	20	20	20	20	20	20
Marker types	5	5	5	5	5	5	5	5	5	5	5	5
Marker sizes	-	-	-	1	1	1	1	1	1	1	1	1
Predefined polymarker bundles	-	-	-	5	5	5	5	5	5	5	5	5
Settable polymarker bundles	-	-	-	-	-	-	20	20	20	20	20	20
Character heights (see note a)	1	1	1	1	1	1	1	1	1	1	1	1
Character expansion factors (see note a)	-	-	-	1	1	1	1	1	1	1	1	1
String precision fonts	1	1	1	1	1	1	1	1	1	1	1	1
Character precision fonts	-	-	-	1	1	1	1	1	1	1	1	1
Stroke precision fonts	-	-	-	0	0	0	2	2	2	2	2	2
Predefined text bundles	-	-	-	2	2	2	6	6	6	6	6	6
Settable text bundles	-	-	-	-	-	-	20	20	20	20	20	20
Predefined patterns (see note b)	-	-	-	1	1	1	1	1	1	1	1	1
Settable patterns (see notes b and e)	-	-	-	-	-	-	10	10	10	10	10	10
Hatch styles (see note c)	-	-	-	3	3	3	3	3	3	3	3	3
Predefined fill area bundles	-	-	-	5	5	5	5	5	5	5	5	5
Settable fill area bundles	-	-	-	-	-	-	10	10	10	10	10	10
Settable normalization transformations	1	1	1	1	1	1	10	10	10	10	10	10
Segment priorities (see note d)	-	-	-	-	-	-	2	2	2	2	2	2
Input classes	-	5	5	-	5	5	-	6	6	-	6	6
Prompt and echo types per device	-	1	1	-	1	1	-	1	1	-	1	1
Length of input queue (see note e)	-	-	20	-	-	20	-	-	20	-	-	20
Maximum string buffer size (characters)	-	72	72	-	72	72	-	72	72	-	72	72
Maximum stroke buffer size (points)	-	64	64	-	64	64	-	64	64	-	64	64
Workstations of category OUTPUT or OUTIN	1	1	1	1	1	1	1	1	1	1	1	1
Workstations of category INPUT or OUTIN	-	1	1	-	1	1	-	1	1	-	1	1
Workstation Independent Segment Storage	-	-	-	-	-	-	-	-	-	1	1	1
MO workstations	-	-	-	0	0	0	1	1	1	1	1	1
MI workstations	-	-	-	0	0	0	1	1	1	1	1	1

0 indicates explicitly defined and non-required at that level
- indicates not defined at that level

Notes:

a) relevant only for character and string precision text

b) relevant only for workstation supporting pattern interior style

c) relevant only for workstation supporting hatch interior style

d) relevant only for workstation supporting segment priorities

e) since available resources are finite and entries have variable size, it may not always be possible to achieve the minimal values in a particular application

Table 2 - Minimal Support Required at Each Level

4.11 States of GKS and inquiry functions

4.11.1 Description of states

GKS exists in one of five different operating states (see figure 12):

GKCL = GKS closed;
GKOP = GKS open;
WSOP = At least one workstation open;
WSAC = At least one workstation active;
SGOP = Segment open.

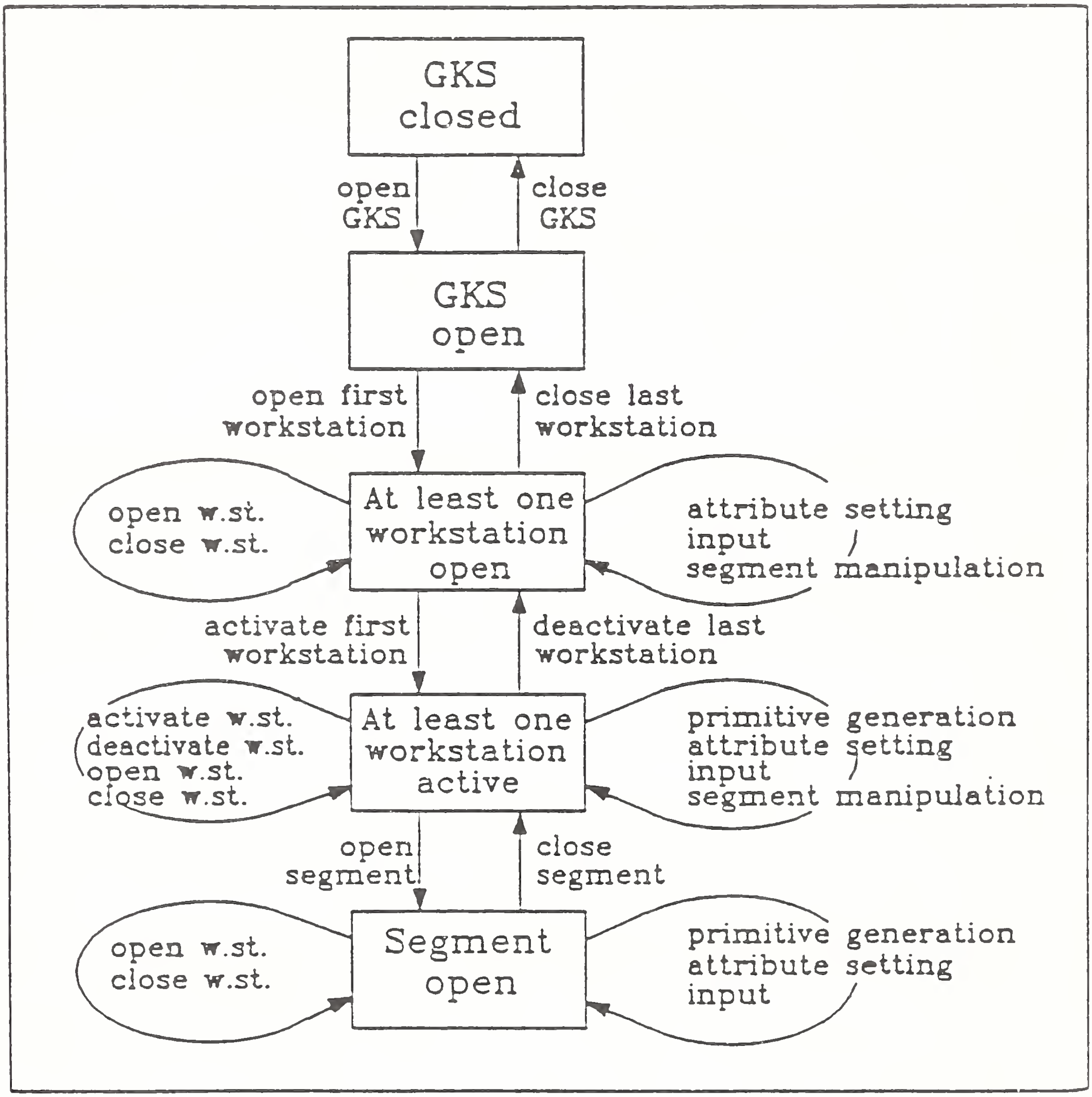


Figure 12. Some transitions between operating states

The operating state value is contained in a global static variable that is initialised, before the first invocation of GKS, to the value GKCL. The operating states differ in so far as individual calls to GKS are allowed only in certain operating states, as indicated in the functional description in section **5**.

The overall state of GKS is defined by a set of state variables having specific values. These state variables are characterized by the fact that they allow a complete description of the effects of the functions. The total set of GKS state variables contains the following subsets:

a) operating state;

b) GKS state list;

c) segment state list for every existing segment;

d) input queue;

e) workstation state list for every open workstation;

f) GKS error state list.

Certain functions cause these state subsets to be allocated, made available and cancelled. When these state subsets are allocated, they are initialised with default values. When initialising a workstation state list, some of the default values are taken from the workstation description table for that workstation type. There is a workstation description table for each workstation type supported by the GKS implementation. The variables of the state subsets are modified and inquired by invocations of GKS functions.

When an error condition is detected during execution of a GKS function, GKS calls the ERROR HANDLING procedure. During execution of the ERROR HANDLING procedure, GKS is in an error state. In this error state, GKS allows only inquiry functions, the ERROR LOGGING procedure and the EMERGENCY CLOSE GKS procedure to be executed and no modifications to any of the state lists except the error state list.

4.11.2 Inquiry functions

Inquiry functions return values directly from or derived from the various state lists and workstation description tables. The data types of the values and the default values of the entries are summarized in section 6.

The inquiry functions of GKS are designed in such a way that they do not cause any errors to be generated. Inquiry functions for values that may be logically unavailable have an output parameter, 'error indicator', that determines whether or not the other returned values are valid. The availability parameter is of type integer and, in the event of the other values not being available, returns an error number, which identifies the appropriate GKS error condition. The same error numbers are used as for non-inquiry functions and thus the standard list of error messages should be consulted. If GKS is not in the proper state, then the error number appropriate to this condition is the one returned, even if there are other reasons for the values being unavailable. If the values are available, zero is returned in the error indicator parameter.

For all values except zero the returned output values are implementation dependent. The description of each inquiry function lists the error indicator values that the function can return.

Some inquiry functions that retrieve values from the workstation state lists have an input parameter of type 'enumeration' that can take the following values :

a) SET: the values returned are those provided by the application program;

b) REALIZED: the values returned are those used by the workstation when the actual values are mapped to the available values in the workstation.

4.12 Error handling

For level m, only the default actions of error handling are supported; that is, errors are printed on the error file specified in OPEN GKS. For other levels for each GKS function, a finite number of error situations is specified, any of which will cause the ERROR HANDLING procedure to be called. Every GKS implementation supports this error checking. The ERROR HANDLING procedure provides an interface between GKS and the application program. The ERROR HANDLING procedure, if provided by the application program, may interpret the information about the error and may store data in a data area for subsequent interpretation by the application program after return from the GKS function that caused the error.

The GKS error handling strategy is derived from the following classification of errors:

- I errors resulting in a precisely defined reaction;
- II errors resulting in an attempt to save the results of previous operations;
- III errors which cause unpredictable results including the loss of information.

GKS recognizes three situations in which errors are detected:

- A error detected in GKS procedures;
- B error detected in procedures called from GKS (driver procedures, operating system procedures);
- C error detected in other areas of the application program.

If errors are detected outside GKS (situation C), either the application program may regain control over the execution or program execution will be terminated abnormally. In the latter case, results are unpredictable (class III), and in the worst situation, all graphical information produced so far in this job may be lost. If, however, the application program obtains control, it may attempt to close GKS properly or at least attempt an emergency closure by calling the EMERGENCY CLOSE GKS procedure. Similarly, if the error occurs in procedures called by GKS and control is not returned properly to GKS, the effects are unpredictable.

The EMERGENCY CLOSE GKS procedure is an implementation dependent facility. Its purpose is to save as much of the graphical information produced as possible. The effects of this procedure on the workstations are left undefined in this standard. The EMERGENCY CLOSE GKS procedure may be called directly from the application program. It is also called from GKS itself as a standard error reaction to class II errors.

Finally, all errors that are listed explicitly as part of the definition of GKS functions belong to class I. Either they are detected within GKS itself (situation A) or a procedure called from GKS has returned control, to the corresponding GKS procedure, with the appropriate error information (situation B). In all these class I cases, GKS calls the ERROR HANDLING procedure. If a GKS function is called with more than one error condition applicable, at least one error is reported.

The application program may either provide its own ERROR HANDLING procedure or may use that provided as part of GKS. Any ERROR HANDLING procedure accepts the following information from GKS:

a) the identification of the error condition;

b) the identification of the GKS function that called the ERROR HANDLING procedure;

c) the error file.

The ERROR HANDLING procedure provided by GKS just calls the ERROR LOGGING procedure, using the same set of parameters. The latter performs the following actions:

d) prints an error message and GKS function identification on the error file;

e) returns to the calling procedure.

This two-stage calling of the error procedures allows the application program to supply its own ERROR HANDLING procedure, while still having access to services provided by the ERROR LOGGING procedure, as shown in the following example of an application program supplied ERROR HANDLING procedure.

Example

```
PROCEDURE ERROR HANDLING (error number, identification of GKS function, error file);
  Interpret GKS function and error identification
  in order to select the following cases:
CASE 'special treatment':
  Interpret error parameters as passed from GKS;
  Store information for application program in application supplied data area;
  Return to calling GKS procedure;
CASE 'standard treatment':
  Call ERROR LOGGING procedure with all the above parameters;
  Return to calling GKS procedure;
END.
```

All GKS procedures perform the following actions after detecting an error condition:

f) set error state to ON;

g) call ERROR HANDLING procedure with appropriate parameters;

h) set error state to OFF;

i) Perform built-in error reaction (normally, a function causing an error has no effect; to accomplish this in some cases requires clean-up operations).

All GKS procedures check on entry (in the following order):

j) that GKS is in the correct state;

k) that the values of input parameters are valid.

At least the first error detected is reported except that, in the case of inquiry functions, the first error detected is returned via the error indicator.

The application program supplied ERROR HANDLING procedure has access to the set of GKS state variables. However, no modification of GKS state is possible during error handling, i.e. only GKS inquiry functions, the ERROR LOGGING procedure and the EMERGENCY CLOSE GKS procedure may be called by the application program supplied ERROR HANDLING procedure. This is achieved by setting the error state to ON prior to calling the ERROR HANDLING procedure from GKS and setting the error state to OFF afterwards. An inquiry function cannot generate an error.

Error numbers for errors originating in GKS functions can be found in section 5 under each GKS function.

4.12.1 Reserved errors

Unused error numbers less than 2000 are reserved for future standardization.

Error numbers 2000-3999 are reserved for language bindings.

Error numbers greater than or equal to 4000 are reserved for registration or future standardization.

NOTE. Error numbers are registered in the the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When an error has been approved by the ISO Working Group on Computer Graphics [1], the error number will be assigned by the Registration Authority.

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

4.13 Special interfaces between GKS and the application program

A uniform escape mechanism for allowing access to installation and hardware specific features (a 'standard way of being non-standard') is provided by means of the ESCAPE function. Although the use of this mechanism reduces the portability of the application program, it does so in an easily identifiable manner.

The ESCAPE function does not generate geometrical output; by contrast, the GENERALIZED DRAWING PRIMITIVE can generate geometrical output not otherwise generated by GKS.

5 GKS Functions

5.1 Notational Conventions

The heading of each function specifies:

a) the function's name;

b) the GKS states in which the function may be used except that, for inquiry functions (see **5.9**), only those states in which the inquiry function can return valid values is specified;

c) the GKS lowest level L at which the function is explicitly defined and required.

More information about levels and states can be found in **4.10** and **4.11** respectively. Appendices **A.3** and **A.4** contain lists of all functions according to levels and states respectively. The GKS functional capabilities are summarized in Appendix F.

The parameter lists indicate for each entry:

a) whether the entry is an input (In) or output (Out) parameter;

b) the name of the parameter;

c) for coordinate data, the coordinate system (WC, NDC, DC) used in the function call (coordinate systems are explained in **4.6**);

d) either, for enumeration type data, the permitted values, or, for real and integer data, any restriction on their value range (for example, '>0'): the notation is explained in **6.1**;

e) the data type, which is either of simple form (I, R, S, P, N, E) representing:

   I integer
   R real
   S string
   P point
   N name
   E enumeration type

   or is a compound based on one or more of the simple forms (for example: $n \times P$) or is a compound, the content and structure of which are defined for some uses:

   D data record

   The data types are explained in **6.1**.

5.2 Control Functions

OPEN GKS — GKCL — Lma

Parameters:

In	error file	F
In	amount of memory units for buffer area	I

Effect: GKS is set into the operating state GKOP = "GKS open". The GKS state list is allocated and initialised as indicated in **6.4**. The GKS description table and the workstation description tables are made available.

The entry 'error file' in the GKS error state list is set to the value specified by the first parameter. The permitted buffer area which can be used by GKS for internal purposes is limited.

NOTE. Certain environments might not permit dynamic memory management. In this case, the buffer area may be limited in a static way to be described in the installation documentation.

References:

4.11
4.12

Errors:

1 *GKS not in proper state: GKS shall be in the state GKCL*
200 *Specified error file is invalid*

CLOSE GKS — GKOP — Lma

Parameters:

none

Effect: GKS is set into the operating state GKCL = "GKS closed". The GKS description table, GKS state list and the workstation description tables become unavailable. All GKS buffers are released and all GKS files are closed.

NOTE. GKS can be reopened by invoking the function OPEN GKS.

References:

4.11
4.12

Errors:

2 *GKS not in proper state: GKS shall be in the state GKOP*

OPEN WORKSTATION — GKOP,WSOP,WSAC,SGOP — Lma

Parameters:

In	workstation identifier	N
In	connection identifier	C
In	workstation type	W

Effect: If GKS is in operating state GKOP, it is set into the state WSOP = 'at least one workstation open'. GKS requests the operating system to establish the specified connection for a workstation characterized in the workstation description table by the 'workstation type'. The workstation state list is allocated and initialised as indicated in **6.5**. The workstation identifier is added to the set of open workstations in the GKS state list.

OPEN WORKSTATION ensures that the display surface is clear, but does not clear the surface needlessly.

NOTE. The connection identifier is given in a form suitable for the application program language.

An attempt to open a workstation with the same connection identifier and workstation type as one already open causes error 26 to occur.

References:

4.5.2
4.11

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
21 *Specified connection identifier is invalid*
22 *Specified workstation type is invalid*
23 *Specified workstation type does not exist*
24 *Specified workstation is open*
26 *Specified workstation cannot be opened*
28 *Workstation Independent Segment Storage is already open*
42 *Maximum number of simultaneously open workstations would be exceeded*

CLOSE WORKSTATION — WSOP,WSAC,SGOP — Lma

Parameters:

In workstation identifier N

Effect: An implicit UPDATE WORKSTATION (with the parameter update regeneration flag set to PERFORM) is performed for the specified workstation. The workstation state list is deallocated. The workstation identifier is deleted from the set of open workstations in the GKS state list and from the set of associated workstations in the segment state list of every segment containing it. If the set of associated workstations of a segment becomes empty, the segment is deleted. The input queue is flushed of all events from all devices on the workstation being closed. If the 'identification of one of the logical input devices that caused an input queue overflow' entry in the GKS error state list refers to this workstation identifier, then all the contents of that entry become undefined.

The connection to the workstation is released. GKS is set into operating state GKOP if no workstations remain open. The display surface need not be cleared when CLOSE WORKSTATION is invoked, but it may be cleared.

References:

4.5.2
4.8.5
4.11

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
29 *Specified workstation is active*
147 *Input queue has overflowed*

ACTIVATE WORKSTATION — WSOP,WSAC — Lma

Parameters:

In	workstation identifier	N

Effect: GKS is set into the operating state WSAC = "At least one workstation active". The specified workstation is marked active in the workstation state list. The workstation identifier is added to the set of active workstations in the GKS state list.

NOTE. Output primitives are sent to and segments are stored on all active workstations.

References:

4.5.2
4.11

Errors:

6 *GKS not in proper state: GKS shall be either in the state WSOP or in the state WSAC*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
29 *Specified workstation is active*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
43 *Maximum number of simultaneously active workstations would be exceeded*

DEACTIVATE WORKSTATION — WSAC — Lma

Parameters:

In	workstation identifier	N

Effect: The specified workstation is marked inactive in the workstation state list. The workstation identifier is deleted from the set of active workstations in the GKS state list. GKS is set into the operating state WSOP = "At least one workstation open" if no workstation remains active.

NOTE. While a workstation is inactive, primitives are not sent to it nor does it store new segments. Segments already stored on this workstation are retained.

References:

4.5.2
4.11

Errors:

3 *GKS not in proper state: GKS shall be in the state WSAC*
20 *Specified workstation identifier is invalid*
30 *Specified workstation is not active*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*

CLEAR WORKSTATION — WSOP,WSAC — Lma

Parameters:

In	workstation identifier		N
In	control flag	(CONDITIONALLY, ALWAYS)	E

Effect: All of the following actions are executed in the given sequence:

a) All deferred actions for the specified workstation are executed (without intermediate clearing of the display surface).

b) The display surface is set to a clear state according to the control flag as follows:

CONDITIONALLY:
the display surface is cleared only if the 'display surface empty' entry in the workstation state list is NOTEMPTY.

ALWAYS:
the display surface is cleared.

c) If the 'workstation transformation update state' entry in the workstation state list is PENDING, the 'current workstation window' and 'current workstation viewport' entries in the workstation state list are assigned the values of the 'requested workstation window' and 'requested workstation viewport' entries; the 'workstation transformation update state' entry is set to NOTPENDING.

d) For all segments stored on the specified workstation, the workstation identifier is deleted from the 'set of associated workstations' in the segment state list. If the 'set of associated workstations' of a segment becomes 'empty', the segment is deleted. The 'set of stored segments for this workstation' in the workstation state list is set to 'empty'.

e) The 'new frame action necessary at update' entry in the workstation state list is set to NO.

f) The 'display surface empty' entry in the workstation state list is set to EMPTY.

References:

4.5.3
4.5.4
4.5.5
4.7.1

Errors:

6 *GKS not in proper state: GKS shall be either in the state WSOP or in the state WSAC*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*

REDRAW ALL SEGMENTS ON WORKSTATION WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier	N

Effect: All of the following actions are executed in the given sequence:

a) All deferred actions for the specified workstation are executed (without intermediate clearing of the display surface).

b) The display surface is cleared only if the 'display surface empty' entry in the workstation state list is NOTEMPTY. The entry is set to EMPTY.

c) If the 'workstation transformation update state' entry in the workstation state list is PENDING, the 'current workstation window' and 'current workstation viewport' entries in the workstation state list are assigned the values of the 'requested workstation window' and 'requested workstation viewport' entries; the 'workstation transformation update state' entry is set to NOTPENDING.

d) All visible segments stored for this workstation (i.e. contained in the 'set of stored segments for this workstation' in the workstation state list) are redisplayed. This action typically causes the 'display surface empty' entry in the workstation state list to be set to NOTEMPTY.

e) The 'new frame action necessary at update' entry in the workstation state list is set to NO.

References:

4.5.3
4.5.4
4.5.5
4.7

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*

UPDATE WORKSTATION — WSOP,WSAC,SGOP — Lma

Parameters:

In	workstation identifier		N
In	update regeneration flag	(PERFORM,POSTPONE)	E

Effect: All deferred actions for the specified workstation are executed (without intermediate clearing of the display surface). If the update regeneration flag is set to PERFORM and the 'new frame action necessary at update' entry in the workstation state list is YES, then the following actions are executed in the given sequence:

a) The display surface is cleared only if the 'display surface empty' entry in the workstation state list is NOTEMPTY. The entry is set to EMPTY.

b) If the 'workstation transformation update state' entry in the workstation state list is PENDING, the 'current workstation window' and 'current workstation viewport' entries in the workstation state list are assigned the values of the 'requested workstation window' and 'requested workstation viewport' entries; the 'workstation transformation update state' entry is set to NOTPENDING.

c) All visible segments stored on this workstation (i.e. contained in the 'set of stored segments for this workstation' in the workstation state list) are redisplayed. This action typically causes the 'display surface empty' entry in the workstation state list to be set to NOTEMPTY.

d) The 'new frame action necessary at update' entry in the workstation state list is set to NO.

NOTE. If the update regeneration flag is PERFORM, UPDATE WORKSTATION suspends the effect of SET DEFERRAL STATE. In that case, it is equivalent to the following sequence of functions.

INQUIRE WORKSTATION STATE;
save deferral state;
SET DEFERRAL STATE (ASAP,ALLOWED);
set deferral state to saved value;

If the value of the 'new frame action necessary at update' entry is NO or the update regeneration flag is

POSTPONE, UPDATE WORKSTATION merely initiates the transmission of blocked data. If the value of the entry 'new frame action necessary at update' is YES and the regeneration flag is PERFORM, UPDATE WORKSTATION behaves as REDRAW ALL SEGMENTS ON WORKSTATION.

The 'new frame action necessary at update' entry in a workstation state list is set to YES during deferred action generation if both of the following are true (see **4.5**):

a) an action causing modification of the picture is actually deferred on that workstation;

b) the workstation display surface does not allow modification of the image without redrawing the whole picture (for example, plotter, storage tube display).

References:

4.5.3
4.5.4
4.5.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*

SET DEFERRAL STATE — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier		N
In	deferral mode	(ASAP,BNIG,BNIL,ASTI)	E
In	implicit regeneration mode	(SUPPRESSED,ALLOWED)	E

Effect: The entries 'deferral mode' and 'implicit regeneration mode' for the specified workstation are set in the workstation state list. Depending on the new value of 'deferral mode', deferred output may be unblocked. If in the workstation state list, the new value of 'implicit regeneration mode' is ALLOWED and 'new frame action necessary at update' is YES, then an action equivalent to REDRAW ALL SEGMENTS is performed.

References:

4.5.3
4.5.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*

MESSAGE — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier	N
In	message	S

Effect: The message function:

a) may display a message at an implementation dependent location on the workstation viewport or on some separate device associated with the workstation.

b) does not alter the GKS state list.

c) may affect the workstation in a purely local way (for example, requesting the operator to change paper). Possible effects on the execution of the application program or on subsequent commands sent to the workstation by GKS are stated explicitly in the implementation dependencies manual.

References:

4.5.6

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
36 *Specified workstation is Workstation Independent Segment Storage*

ESCAPE — GKOP,WSOP,WSAC,SGOP — Lma

Parameters:

In	specific escape function identification	N
In	escape input data record	D
Out	escape output data record	D

Effect: The specified non-standard specific escape function is invoked. The form of the escape data record and which of them are used may vary for different functions. Also the GKS states allowing the invocation of a specific escape function may be restricted. The following rules govern the definition of a new specific escape function:

a) the GKS design concept (see Section 0 - Introduction)

b) the GKS state lists are not altered;

c) the function does not generate geometrical output;

d) any side effects are well documented.

Specific escape functions may apply to more than one workstation, for example all open workstations or all active workstations. The escape input data record can include a workstation identifier where this is required.

NOTE. Examples of specific escape functions anticipated at present are:

a) support of raster devices allowing the display of more than one frame buffer;

b) use of rasterop hardware to manipulate data previously output by cell array.

Where the specific escape function identification is bound to an integer in a programming language, specific escape function identifications greater than 0 are reserved for registration or future standardization and specific escape function identifications less than 0 are implementation dependent.

Specific escape function identifications are registered in the the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a specific escape function has been approved by the ISO Working Group on Computer Graphics [1], the specific escape function identification will be assigned by the Registration Authority.

References:

4.13

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
180 *Specified escape function is not supported*
181 *Specified escape function identification is invalid*
182 *Contents of escape data record are invalid*

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

5.3 Output Functions

POLYLINE — WSAC,SGOP — Lma

Parameters:

In	number of points		(2..n)	I
In	points	WC		$n \times P$

Effect: A sequence of connected straight lines is generated, starting from the first point and ending at the last point. The current values of the polyline attributes, as given by the GKS state list (see **6.4**), are bound to the primitive. The polyline attributes are listed in **4.4.2**.

If, after the workstation transformation, all points coincide, no error is generated and whether anything is drawn is workstation dependent.

References:

4.4.1
4.4.2
4.4.3
4.5.3

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
100 *Number of points is invalid*

POLYMARKER — WSAC,SGOP — Lma

Parameters:

In	number of points		(1..n)	I
In	points	WC		$n \times P$

Effect: A sequence of markers is generated to identify all the given positions. The current values of the polymarker attributes, as given by the GKS state list (see **6.4**), are bound to the primitive. The polymarker attributes are listed in **4.4.2**.

NOTE. A marker is visible if and only if the marker position is within the clipping rectangle. The clipping of partially visible markers is workstation dependent.

References:

4.4.1
4.4.2
4.4.4
4.5.3

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
100 *Number of points is invalid*

TEXT

WSAC,SGOP Lma

Parameters:

In	text position	WC	P
In	character string		S

Effect: A character string is generated. The current values of the text attributes, as given by the GKS state list (see **6.4**), are bound to the primitive. The text attributes are listed in **4.4.2**.

The text position is given in WC and transformed by the current normalization transformation.

If, after the workstation transformation, the height or width of a character is zero, no error is generated and whether anything is drawn is workstation dependent.

If the character string contains a control character (for example, characters outside the range 2/0 to 7/14 inclusive in ISO 646), the effect is workstation dependent. Either error 101 is generated or some visual effect may be generated or the character may be ignored. Even if error 101 occurs, the character string is displayed on all active workstations which do not generate error 101.

NOTE. Text is clipped in a way that depends on the text precision as defined by the text font and precision currently selected (either via the text bundle or individually, depending upon the corresponding ASF).

References:

4.4.1
4.4.2
4.4.5
4.5.3

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
101 *Invalid code in string*

FILL AREA

WSAC,SGOP Lma

Parameters:

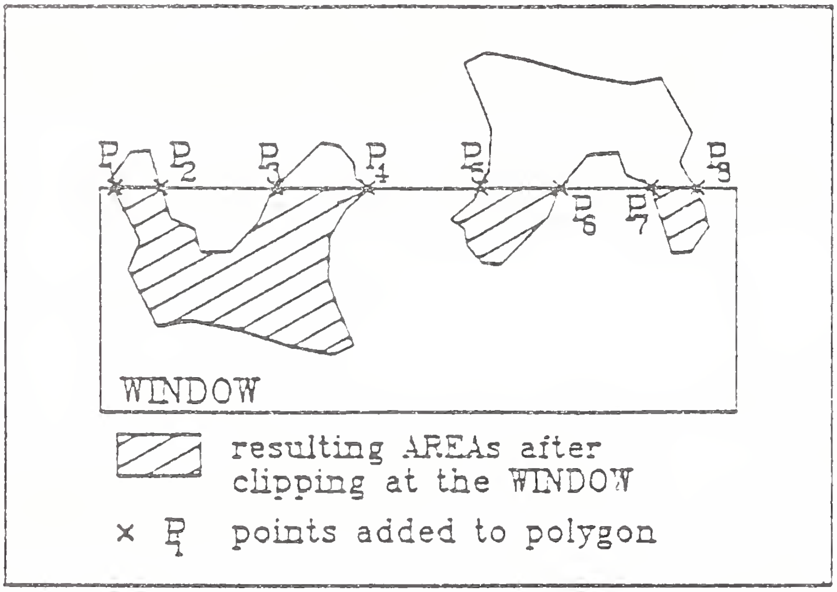
In	number of points	(3..n)	I
In	points	WC	n×P

Effect: A FILL AREA primitive is generated. The current values of the fill area attributes, as given by the GKS state list (see **6.4**), are bound to the primitive. The fill area attributes are listed in **4.4.2**.

The polygon defined by the points is filled according to the fill area interior style currently selected (either via the fill area bundle or individually, depending upon the corresponding ASF). The boundary is drawn for interior style HOLLOW, whereas, for other interior styles, the amount of the boundary that is drawn ensures that two regions which share a common edge appear without an apparent gap or overlap at that edge, to the extent that can reasonably be achieved.

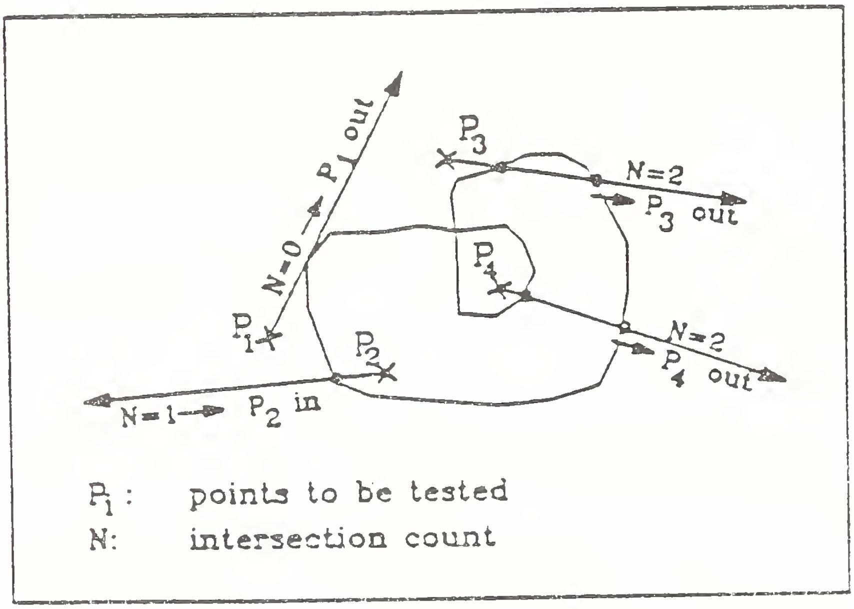
If parts of the area are clipped, the resulting new boundaries become part of the area boundaries. Multiple subareas may be generated (see figure 13).

Figure 13 - Examples of FILL AREA clipping



The interior of a polygon is defined in the following way (see figure 14).

Figure 14 - Area inside a polygon



For a given point, create a straight line starting at that point and going to infinity. If the number of intersections between the straight line and the polygon is odd, the point is within the polygon; otherwise it is outside. If the straight line passes a polygon vertex tangentially, the intersection count is not affected. If a point is within the polygon, it is included in the area to be filled subject to the rule for boundaries.

If, after the workstation transformation, all points coincide, no error is generated and whether anything is drawn is workstation dependent. If, after the workstation transformation, some or all lines in a bounding polygon have a line segment in common, no error is generated. Whether the resulting line segment is regarded as part of the boundary to be drawn or not is workstation dependent.

For PICK input, a FILL AREA primitive displayed with interior style HOLLOW may be picked by pointing at any point on the bounding polygon. A FILL AREA primitive displayed with interior style SOLID or PATTERN may be picked by pointing at any point inside the polygon. Pointing at a hole in the area does not identify that area. A FILL AREA primitive displayed with interior style HATCH may be picked by pointing at any point on any hatch line.

References:

4.4.1
4.4.2
4.4.6
4.5.3

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
100 *Number of points is invalid*

CELL ARRAY — WSAC,SGOP — L0a

Parameters:

In	cell rectangle (P,Q)	WC		2×P
In	dimensions of colour index array DX,DY		(1..n)	2×I
In	colour index array		(0..n)	n×n×I

Effect: A CELL ARRAY primitive is generated using the cell rectangle corners, the dimensions of the colour index array and the colour index array.

A rectangle, which is taken to be aligned with the world coordinate axes, is defined by the points P and Q. This rectangle is conceptually divided into a grid in DX×DY cells. Each cell has a width of |PX-QX|/DX and a height of |PY-QY|/DY, where (PX,PY) are the coordinates of the cornerpoint P and (QX,QY) are the coordinates of the cornerpoint Q. The colour index array is oriented with respect to the rectangle by associating the four corners as follows: the (1,1) element is associated with the cell having P at one corner; the (DX,DY) element with the cell having Q at one corner; the (1,DY) element with the cell having the point (PX,QY) at one corner; the (DX,1) element with the cell having the point (QX,PY) at one corner. The colour of each cell is specified by the index of the corresponding element of the colour index array. If an index is not present in the colour table on a workstation, a workstation dependent index is used on that workstation.

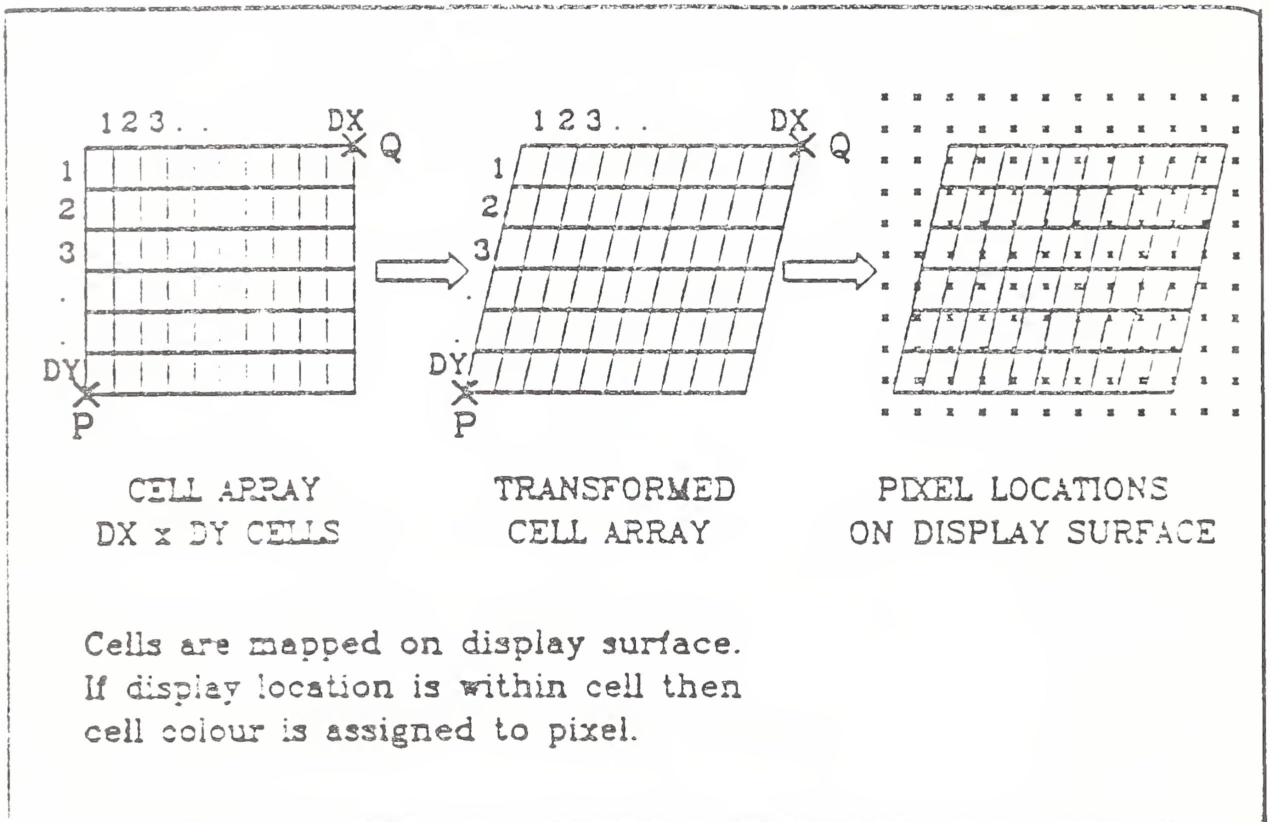
The rectangular grid defined by P,Q,DX and DY is subject to all transformations, potentially transforming the rectangular cells into parallelograms. If part of a transformed cell is outside the window, the transformed cell is partially clipped. Mapping the transformed cells onto the pixels of a raster display (see figure 15) is performed by the following rules:

a) If the centrepoint of a pixel lies inside the parallelogram defined by the transformed rectangle, its colour is set.

b) The pixel is assigned the colour of the cell which contains the pixel's centrepoint. Thus, the pixel colour is selected by point sampling the transformed rectangle at the pixel centrepoint, not by area sampling or filtering.

   If, after the workstation transformation, the four corner points are coincident or collinear, no error is generated and whether anything is drawn is workstation dependent.

Figure 15 - Mapping of CELL ARRAYs



The minimal simulation required is to draw the transformed boundaries of the cell rectangle, using implementation dependent colour, linewidth and linetype.

References:

4.4.1
4.4.2
4.4.7
4.5.3

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
91 *Dimensions of colour array are invalid*

GENERALIZED DRAWING PRIMITIVE (GDP) WSAC,SGOP L0a

Parameters:

In	number of points		(0..n)	I
In	points	WC		n×P
In	GDP identifier			N
In	GDP data record			D

Effect: A Generalized Drawing Primitive (GDP) of the type indicated by the GDP identifier is generated on the basis of the given points and the GDP data record. The current values of the entries in the GKS state list (see **6.4**) for the sets of polyline, polymarker, text or fill area attributes are bound to the primitive. These attributes are listed in **4.4.2**. When the GDP generates output at the workstation, zero or more of the sets of attributes are used. These are the sets of attributes most appropriate for the specified GDP function and are selected for the GDP as part of the definition of the GDP. (They are defined in the workstation description table.)

NOTE. The parameters are transmitted to the workstation and interpreted in a workstation dependent way. In this way special capabilities of the workstation can be addressed. Even if error 104 or error 105 occurs, the GDP is displayed on all active workstations capable of doing so. For example, some of the primitives anticipated at present are:

a) circle: points given are centre, peripheral point;

b) circular arc: points given are centre, start point, end point to be connected anticlockwise in world coordinates;

c) ellipse: points given are 2 focal points, peripheral point;

d) elliptic arc: points given are 2 focal points, start point, end point to be connected anticlockwise in world coordinates;

e) interpolating curve (for example, spline): points given are interpolated.

The recommended set of attributes to use for the above GDP examples would be the polyline attributes.

It should be emphasized that the points, specified as parameters, are transformed by GKS after the interpretation of the points (as defining, say, a spline curve or circle) is performed by the active workstations. For example, a GDP, which defines a circle, would appear as an ellipse when the transformation has differential scaling for the two axes. Each specific GDP definition defines how the transformation is applied to both the points and the shape of the GDP. Though the points cannot be clipped, the resulting output of the GDP is clipped against the clipping rectangle, if the 'clipping indicator' entry in the GKS state list is CLIP, and the workstation window. If a specific GDP is available on a workstation but is unable to be generated because the current transformations or clipping rectangle are such that the preceding conditions would be violated, error 105 occurs.

The GDP data record attribute list may contain additional data for each point (for example, vertex order for splines) which remain untransformed. These have to be defined for a specific GDP. In defining a new GDP, the GKS design concepts (see section 0) are not violated. The set of generalized drawing primitives implemented on a workstation may be empty.

Where the GDP identifier is bound to an integer in a programming language, GDP identifiers greater than 0 are reserved for registration or future standardization and GDP identifiers less than 0 are implementation dependent.

GDP identifiers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a GDP has been approved by the ISO Working Group on Computer Graphics [1], the GDP identifier will be assigned by the Registration Authority.

References:

4.4.1
4.4.2
4.4.8
4.5.3
4.13

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*

100 *Number of points is invalid*

102 *Generalized drawing primitive identifier is invalid*

103 *Content of generalized drawing primitive data record is invalid*

104 *At least one active workstation is not able to generate the specified generalized drawing primitive*

105 *At least one active workstation is not able to generate the specified generalized drawing primitive under the current transformations and clipping rectangle*

5.4 Output Attributes

5.4.1 Workstation Independent Primitive Attributes

SET POLYLINE INDEX **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	polyline index	(1..n)	I

Effect: The 'current polyline index' entry in the GKS state list is set to the value specified by the parameter. This value is used when creating subsequent POLYLINE output primitives.

References:

4.4.2
4.4.3

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
60 *Polyline index is invalid*

SET LINETYPE **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	linetype	(-n..-1,1..n)	I

Effect: The 'current linetype' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent POLYLINE output primitives, created when the 'current linetype ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent POLYLINE output primitives, created when the 'current linetype ASF' entry in the GKS state list is BUNDLED.

Linetype values produce linetypes as indicated:

<0	implementation dependent
1	solid line
2	dashed line
3	dotted line
4	dashed-dotted line
≥5	reserved for registration or future standardization

If the specified linetype is not available on a workstation, linetype 1 is used on that workstation.

NOTE. Linetype values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a linetype has been approved by the ISO Working Group on Computer Graphics [1], the linetype value will be assigned by the Registration Authority.

References:

4.4.2
4.4.3

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
63 Linetype is equal to zero

SET LINEWIDTH SCALE FACTOR **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	linewidth scale factor	≥ 0	R

Effect: The 'current linewidth scale factor' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent POLYLINE output primitives, created when the 'current linewidth scale factor ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent POLYLINE output primitives, created when the 'current linewidth scale factor ASF' entry in the GKS state list is BUNDLED.

The linewidth scale factor is applied to the nominal linewidth on a workstation; the result is mapped by the workstation to the nearest available linewidth.

References:

4.4.2
4.4.3

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
65 Linewidth scale factor is less than zero

SET POLYLINE COLOUR INDEX **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	polyline colour index	(0..n)	I

Effect: The 'current polyline colour index' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent POLYLINE output primitives, created when the 'current polyline colour index ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent POLYLINE output primitives, created when the 'current polyline colour index ASF' entry in the GKS state list is BUNDLED.

The colour index is a pointer into the colour tables of the workstations. If the specified colour index is not present in a workstation colour table, a workstation dependent colour index is used on that workstation.

References:

4.4.2
4.4.3

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
92 Colour index is less than zero

SET POLYMARKER INDEX **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	polymarker index	(1..n)	I

Effect: The 'current polymarker index' entry in the GKS state list is set to the value specified by the parameter. This value is used when creating subsequent POLYMARKER output primitives.

References:

4.4.2
4.4.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
66 *Polymarker index is invalid*

SET MARKER TYPE **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	marker type	(-n..-1,1..n)	I

Effect: The 'current marker type' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent POLYMARKER output primitives, created when the 'current marker type ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent POLYMARKER output primitives, created when the 'current marker type ASF' entry in the GKS state list is BUNDLED.

Marker type values produce centred symbols as indicated:

<0	implementation dependent
1	.
2	+
3	*
4	0
5	X
≥ 6	reserved for registration or future standardization

Marker type 1 is always displayed as the smallest displayable dot. If the specified marker type is not available on a workstation, marker type 3 (*) is used on that workstation.

NOTE. Marker type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a marker type has been approved by the ISO Working Group on Computer Graphics[1], the marker type value will be assigned by the Registration Authority.

References:

4.4.2
4.4.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
69 *Marker type is equal to zero*

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

SET MARKER SIZE SCALE FACTOR — GKOP,WSOP,WSAC,SGOP — L0a

Parameters:

In	marker size scale factor	≥ 0	R

Effect: The 'current marker size scale factor' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent POLYMARKER output primitives, created when the 'current marker size scale factor ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent POLYMARKER output primitives, created when the 'current marker size scale factor ASF' entry in the GKS state list is BUNDLED.

The marker size scale factor is applied to the nominal marker size on a workstation; the result is mapped by the workstation to the nearest available marker size.

References:

4.4.2
4.4.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
71 *Marker size scale factor is less than zero*

SET POLYMARKER COLOUR INDEX — GKOP,WSOP,WSAC,SGOP — Lma

Parameters:

In	polymarker colour index	(0..n)	I

Effect: The 'current polymarker colour index' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent POLYMARKER output primitives, created when the 'current polymarker colour index ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent POLYMARKER output primitives, created when the 'current polymarker colour index ASF' entry in the GKS state list is BUNDLED.

The colour index is a pointer into the colour tables of the workstations. If the specified colour index is not present in a workstation colour table, a workstation dependent colour index is used on that workstation.

References:

4.4.2
4.4.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
92 *Colour index is less than zero*

SET TEXT INDEX — GKOP,WSOP,WSAC,SGOP — L0a

Parameters:

In	text index	(1..n)	I

Effect: The 'current text index' entry in the GKS state list is set to the value specified by the parameter. This value is used when creating subsequent TEXT output primitives.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
72 *Text index is invalid*

SET TEXT FONT AND PRECISION **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	text font and precision	(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)

Effect: The 'current text font and precision' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent TEXT output primitives, created when the 'current text font and precision ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT output primitives, created when the 'current text font and precision ASF' entry in the GKS state list is BUNDLED.

Text font and precision is a single text aspect; a particular text font can be available at some, but not necessarily all, precisions. Text font 1 contains a graphical representation of the characters defined in ISO 646 (see **4.4.5**). Text fonts greater than 1 are reserved for registration or future standaradization. Text fonts less than 0 are implementation dependent. The text precision value determines the fidelity with which the other text aspects are used. The values of text precision, in order of increasing fidelity, are STRING, CHAR and STROKE (see **4.4.5**).

If the specified text font and precision is not available on a workstation, the value (1;STRING) is used on that workstation.

NOTE. Text font numbers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a text font has been approved by the ISO Working Group on Computer Graphics[1)], the text font number will be assigned by the Registration Authority.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
75 *Text font is equal to zero*

SET CHARACTER EXPANSION FACTOR **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	character expansion factor	>0	R

[1)] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Effect: The 'current character expansion factor' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent TEXT output primitives, created when the 'current character expansion factor ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT output primitives, created when the 'current character expansion factor ASF' entry in the GKS state list is BUNDLED.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
77 *Character expansion factor is less than or equal to zero*

SET CHARACTER SPACING GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	character spacing	R

Effect: The 'current character spacing' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent TEXT output primitives, created when the 'current character spacing ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT output primitives, created when the 'current character spacing ASF' entry in the GKS state list is BUNDLED.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*

SET TEXT COLOUR INDEX GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	text colour index	(0..n)	I

Effect: The 'current text colour index' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent TEXT output primitives, created when the 'current text colour index ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent TEXT output primitives, created when the 'current text colour index ASF' entry in the GKS state list is BUNDLED.

The colour index is a pointer into the colour tables of the workstations. If the specified colour index is not present in a workstation colour table, a workstation dependent colour index is used on that workstation.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
92 *Colour index is less than zero*

SET CHARACTER HEIGHT **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	character height	WC	>0	R

Effect: The 'current character height' entry in the GKS state list is set to the value specified by the parameter. The 'current character width' entry in the GKS state list is also set to the value specified by the parameter. These values are used when creating subsequent TEXT output primitives.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
78 *Character height is less than or equal to zero*

SET CHARACTER UP VECTOR **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	character up vector	WC		2×R

Effect: The 'current character up vector' entry in the GKS state list is set to the value specified by the parameter. The 'current character base vector' entry in the GKS state list is set to a vector, of arbitrary length, at right angles in the clockwise direction to the value specified by the parameter. These values are used when creating subsequent TEXT output primitives.

References:

4.4.2
4.4.5

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
79 *Length of character up vector is zero*

SET TEXT PATH **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	text path	(RIGHT,LEFT,UP,DOWN)	E

Effect: The 'current text path' entry in the GKS state list is set to the value specified by the parameter. This value is used when creating subsequent TEXT output primitives.

NOTE A change in the value of 'current text path' may make the value of the 'current text alignment' entry inappropriate.

References:

4.4.2
4.4.5

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

SET TEXT ALIGNMENT — GKOP,WSOP,WSAC,SGOP — Lma

Parameters:

In text alignment (NORMAL,LEFT,CENTRE,RIGHT;NORMAL,TOP,CAP,HALF,BASE,BOTTOM) 2×E

Effect: The 'current text alignment' entry in the GKS state list is set to the value specified by the parameter. This value is used when creating subsequent TEXT output primitives. Text alignment has two components: horizontal and vertical.

References:

4.4.2
4.4.5

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

SET FILL AREA INDEX — GKOP,WSOP,WSAC,SGOP — L0a

Parameters:

In fill area index (1..n) I

Effect: The 'current fill area index' entry in the GKS state list is set to the value specified by the parameter. This value is used when creating subsequent FILL AREA output primitives.

References:

4.4.2
4.4.6

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
80 Fill area index is invalid

SET FILL AREA INTERIOR STYLE — GKOP,WSOP,WSAC,SGOP — Lma

Parameters:

In fill area interior style (HOLLOW,SOLID,PATTERN,HATCH) E

Effect: The 'current fill area interior style' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent FILL AREA output primitives, created when the 'current fill area interior style ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA output primitives, created when the 'current fill area interior style ASF' entry in the GKS state list is BUNDLED.

The fill area interior style is used to determine in what style the area is filled and the possible values are: HOLLOW, SOLID, PATTERN and HATCH (see **4.4.6**).

If the requested interior style is not available on a workstation, HOLLOW is used on that workstation.

References:

4.4.2
4.4.6

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*

SET FILL AREA STYLE INDEX **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	fill area style index	(-n..-1,1..n)	I

Effect: The 'current fill area style index' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent FILL AREA output primitives, created when the 'current fill area style index ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA output primitives, created when the 'current fill area style index ASF' entry in the GKS state list is BUNDLED.

For interior styles HOLLOW and SOLID, the style index value is unused. For interior style PATTERN, the style index value is greater than 0 and is a pointer into the pattern tables of the workstations. For interior style HATCH, the style index value is non-zero and determines which of a number of hatch styles is used: hatch styles greater than 0 are reserved for registration or future standardization; hatch styles less than 0 are workstation dependent.

If the requested style index is not available on a particular workstation, style index 1 is used on that workstation. If style index 1 is not present on that workstation, the result is workstation dependent.

NOTE. Hatch style values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a hatch style has been approved by the ISO Working Group on Computer Graphics [1)], the hatch style value will be assigned by the Registration Authority.

References:

4.4.2
4.4.6

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
84 *Style (pattern or hatch) index is equal to zero*

[1)] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

SET FILL AREA COLOUR INDEX **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	fill area colour index	(0..n)	I

Effect: The 'current fill area colour index' entry in the GKS state list is set to the value specified by the parameter. This value is used for the display of subsequent FILL AREA output primitives, created when the 'current fill area colour index ASF' entry in the GKS state list is INDIVIDUAL. This value does not affect the display of subsequent FILL AREA output primitives, created when the 'current fill area colour index ASF' entry in the GKS state list is BUNDLED.

The colour index is a pointer into the colour tables of the workstations. If the specified colour index is not present in a workstation colour table, a workstation dependent colour index is used on that workstation.

References:

4.4.2
4.4.6

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
92 *Colour index is less than zero*

SET PATTERN SIZE **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	pattern size	WC SX,SY>0	2×R

Effect: The 'current pattern width vector' entry in the GKS state list is set to the vector (SX,0). The 'current pattern height vector' entry in the GKS state list is set to the vector (0,SY). When the currently selected (either via the fill area bundle or individually, depending on the corresponding ASF) fill area interior style is PATTERN, these values are used, where possible, in conjunction with the 'current pattern reference point' entry in the GKS state list for displaying the FILL AREA output primitives.

References:

4.4.2
4.4.6

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
87 *Pattern size value is not positive*

SET PATTERN REFERENCE POINT **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	reference point	WC	P

Effect: The 'current pattern reference point' entry in the GKS state list is set to the value specified by the parameter. When the currently selected (either via the fill area bundle or individually, depending upon the corresponding ASF) fill area interior style is PATTERN, this value is used, where possible, in conjunction with the 'current pattern width vector' and 'current pattern height vector' entries in the GKS state list for displaying the FILL AREA output primitives.

References:

4.4.2
4.4.6

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

SET ASPECT SOURCE FLAGS **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In list of Aspect Source Flags (BUNDLED,INDIVIDUAL) 13×E

Effect: The Aspect Source Flags (ASFs) in the GKS state list are set to the values indicated by the parameter. The elements of the list of ASFs are arranged in the following order:

linetype ASF
linewidth scale factor ASF
polyline colour index ASF
marker type ASF
marker size scale factor ASF
polymarker colour index ASF
text font and precision ASF
character expansion factor ASF
character spacing ASF
text colour index ASF
fill area interior style ASF
fill area style index ASF
fill area colour index ASF

References:

4.4.2

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

SET PICK IDENTIFIER **GKOP,WSOP,WSAC,SGOP** **L1b**

Parameters:

In pick identifier N

Effect: The 'current pick identifier' entry in the GKS state list is set to the value specified by the parameter.

References:

4.4.2
4.7.1
4.8.1
4.8.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
97 *Pick identifier is invalid*

5.4.2 Workstation Attributes (Representations)

SET POLYLINE REPRESENTATION **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	workstation identifier		N
In	polyline index	(1..n)	I
In	linetype	(-n..-1,1..n)	I
In	linewidth scale factor	≥0	R
In	polyline colour index	(0..n)	I

Effect: In the polyline bundle table of the workstation state list, the given polyline index is associated with the specified parameters.

Linetype:

linetype values produce linetypes as indicated:

<0	implementation dependent
1	solid line
2	dashed line
3	dotted line
4	dashed-dotted line
≥5	reserved for registration or future standardization

Linewidth scale factor:

a scale factor applied to the nominal linewidth. The result is mapped by the workstation to the nearest available linewidth.

Polyline colour index:

pointer into the colour table of the workstation.

The polyline bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see Table 2, in **4.10**) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When polylines are displayed, the polyline index refers to an entry in the polyline bundle table. If polylines are displayed with a polyline index that is not present in the polyline bundle table, polyline index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see **4.4.2**).

NOTE. Linetype values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a linetype has been approved by the ISO Working Group on Computer Graphics [1)], the linetype value will be assigned by the Registration Authority.

References:

4.4.3
4.5.3

[1)] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
33	*Specified workstation is of category MI*
35	*Specified workstation is of category INPUT*
36	*Specified workstation is Workstation Independent Segment Storage*
60	*Polyline index is invalid*
63	*Linetype is equal to zero*
64	*Specified linetype is not supported on this workstation*
65	*Linewidth scale factor is less than zero*
93	*Colour index is invalid*

SET POLYMARKER REPRESENTATION **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	workstation identifier		N
In	polymarker index	(1..n)	I
In	marker type	(-n..-1,1..n)	I
In	marker size scale factor	≥ 0	R
In	polymarker colour index	(0..n)	I

Effect: In the polymarker bundle table of the workstation state list, the given polymarker index is associated with the specified parameters.

Markertype:

marker type values produce centred symbols as indicated:

<0	implementation dependent
1	.
2	+
3	*
4	0
5	X
≥ 6	reserved for registration or future standardization

Marker type 1 is always displayed as the smallest displayable dot.

Marker scale factor:

a scale factor applied to the nominal marker size. The result is mapped by the workstation to the nearest available marker size.

Polymarker colour index:

a pointer into the colour table of the workstation.

The polymarker bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see Table 2, in **4.10**) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When polymarkers are displayed, the polymarker index refers to an entry in the polymarker bundle table. If polymarkers are displayed with a polymarker index that is not present in the polymarker bundle table, polymarker index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see **4.4.2**).

NOTE. Marker type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a marker type has been approved by the ISO Working Group on Computer Graphics[1], the marker type value will be assigned by the Registration Authority.

References:

4.4.4
4.5.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
66 *Polymarker index is invalid*
69 *Marker type is equal to zero*
70 *Specified marker type is not supported on this workstation*
71 *Marker size scale factor is less than zero*
93 *Colour index is invalid*

SET TEXT REPRESENTATION WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
In	text index	(1..n)	I
In	text font and precision	(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)
In	character expansion factor	>0	R
In	character spacing		R
In	text colour index	(0..n)	I

Effect: In the text bundle table of the workstation state list, the given text index is associated with the specified parameters.

Text font and precision:

a single text aspect; a particular text font can be available at some, but not necessarily all, precisions. The text font value is used to select a particular font on this workstation. Text font 1 contains a graphical representation of the characters defined in ISO 646 (see **4.4.5**). Text fonts greater than 1 are reserved for registration or future standardization. Text fonts less than 0 are implementation dependent. The text precision value determines the fidelity with which the other text aspects are used. The values of text precision, in order of increasing fidelity, are STRING, CHAR and STROKE (see **4.4.5**).

Character expansion factor:

specifies the deviation of the width to height ratio of the characters from the ratio indicated by the font designer.

Character spacing:

specifies how much additional space is to be inserted between two adjacent character bodies. Character spacing is specified as a fraction of the font-nominal character height.

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Text colour index:
a pointer into the colour table of the workstation.

The text bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see Table 2 in **4.10**) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When text is displayed, the text index refers to an entry in the text bundle table. If text is displayed with a text index that is not present in the text bundle table, text index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see **4.4.2**).

NOTE. Text font numbers are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a text font has been approved by the ISO Working Group on Computer Graphics [1)], the text font number will be assigned by the Registration Authority.

References:

4.4.5
4.5.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
72 *Text index is invalid*
75 *Text font is equal to zero*
76 *Requested text font is not supported for the specified precision on this workstation*
77 *Character expansion factor is less than or equal to zero*
93 *Colour index is invalid*

SET FILL AREA REPRESENTATION — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier		N
In	fill area index	(1..n)	I
In	fill area interior style	(HOLLOW,SOLID,PATTERN,HATCH)	E
In	fill area style index	(-n..-1,1..n)	I
In	fill area colour index	(0..n)	I

Effect: In the fill area bundle table of the workstation state list, the given fill area index is associated with the specified parameters.

Fill area interior style:
is used to determine in what style the area is filled and the possible values are: HOLLOW, SOLID, PATTERN and HATCH (see **4.4.6**).

Fill area style index:
For interior styles HOLLOW and SOLID, this value is unused. For interior style PATTERN, this value is greater than 0 and is a pointer into the pattern table of the workstation. For interior style HATCH, this value is non-zero and determines which of a number of hatch styles is used: hatch styles greater than 0 are reserved

[1)] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

for registration or future standardization; hatch styles less than 0 are workstation dependent.

Fill area colour index:

pointer into the colour table of the workstation.

The fill area bundle table in the workstation state list has predefined entries taken from the workstation description table; a number (see Table 2 in **4.10**) are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When fill area is displayed, the current fill area index refers to an entry in the fill area bundle table. If fill areas are displayed with a fill area index that is not present in the fill area bundle table, fill area index 1 is used. Which of the aspects in the entry are used depends upon the setting of the corresponding ASFs (see **4.4.2**).

NOTE. Hatch style values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a hatch style has been approved by the ISO Working Group on Computer Graphics [1)], the hatch style value will be assigned by the Registration Authority.

References:

4.4.6
4.5.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
80 *Fill area index is invalid*
83 *Specified fill area interior style is not supported on this workstation*
85 *Specified pattern index is invalid*
86 *Specified hatch style is not supported on this workstation*
93 *Colour index is invalid*

SET PATTERN REPRESENTATION — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier		N
In	pattern index	(1..n)	I
In	dimensions of pattern array DX,DY	(1..n)	2×I
In	pattern array	(0..n)	n×n×I

Effect: In the pattern table of the workstation state list, the given pattern index is associated with the specified parameters.

A grid of DX×DY cells is specified. The colour is given individually for each cell by a colour index, a pointer into the colour table of the workstation. The arrangement of cells is described in **4.4.6**.

1) Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

If the workstation supports interior style PATTERN, the pattern table in the workstation state list has predefined entries taken from the workstation description table; a number (see Table 2 in **4.10**) are predefined for every workstation supporting interior style PATTERN. Any table entry (including the predefined entries) may be redefined with this function.

When a fill area is displayed, if the currently selected (either via the fill area bundle or individually, depending upon the corresponding ASF) interior style is PATTERN, the currently selected style index refers to an entry in the pattern table. If fill areas are displayed with a pattern index that is not present in the pattern table, pattern index 1 will be used. If pattern index 1 is not present (i.e. interior style PATTERN is not supported for this workstation), the result is workstation dependent.

References:

4.4.6
4.5.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
85 *Specified pattern index is invalid*
90 *Interior style PATTERN is not supported on this workstation*
91 *Dimensions of colour array are invalid*
93 *Colour index is invalid*

SET COLOUR REPRESENTATION WSOP,WSAC,SGOP Lma

Parameters:

In	workstation identifier		N
In	colour index	(0..n)	I
In	colour (red,green,blue intensities)	[0,1]	3×R

Effect: In the colour table of the workstation state list, the given colour index is associated with the specified colour. The colour is mapped by the workstation to the nearest available.

The colour table in the workstation state list has predefined entries taken from the workstation description table; at least indices 0 and 1 are predefined for every workstation of category OUTPUT and OUTIN. Any table entry (including the predefined entries) may be redefined with this function.

When output primitives are displayed, the colour index refers to an entry in the colour table. If output primitives are displayed with a colour index that is not present in the colour table, a workstation dependent colour index will be used. The background colour is defined by colour index 0.

NOTE. On monochrome workstations, the intensity is computed from the colour values in a workstation dependent way

References:

4.4.2
4.4.9
4.5.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
93 *Colour index is invalid*
96 *Colour is outside range [0,1]*

5.5 Transformation Functions

5.5.1 Normalization Transformation

SET WINDOW **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	transformation number		(1..n)	I
In	window limits XMIN<XMAX,YMIN<YMAX	WC		4×R

Effect: The window limits entry of the specified normalization transformation in the GKS state list is set to the value specified by the parameter.

References:

4.6.1
4.8.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
50 *Transformation number is invalid*
51 *Rectangle definition is invalid*

SET VIEWPORT **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	transformation number		(1..n)	I
In	viewport limits XMIN<XMAX,YMIN<YMAX	NDC		4×R

Effect: The viewport limits entry of the specified normalization transformation in the GKS state list is set to the value specified by the parameter. If the 'current normalization transformation number' entry in the GKS state list is the same as the specified transformation number, the 'clipping rectangle' entry in the GKS state list is set to the specified viewport limits.

References:

4.6.1
4.8.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
50 *Transformation number is invalid*
51 *Rectangle definition is invalid*
52 *Viewport is not within the Normalized Device Coordinate unit square*

SET VIEWPORT INPUT PRIORITY **GKOP,WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	transformation number	(0..n)	I
In	reference transformation number	(0..n)	I
In	relative priority	(HIGHER,LOWER)	E

Effect: The viewport input priority of the specified normalization transformation in the GKS state list is set to the next higher or next lower priority relative to the reference transformation according to the specified relative priority. If the specified transformation number is the same as the reference transformation number, the function has no effect.

References:

4.6.4
4.8.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
50 *Transformation number is invalid*

SELECT NORMALIZATION TRANSFORMATION GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	transformation number	(0..n)	I

Effect: The 'current normalization transformation number' entry in the GKS state list is set to the value specified by the parameter. The 'clipping rectangle' entry in the GKS state list is set to the viewport limits of the specified transformation number.

References:

4.6.1

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
50 *Transformation number is invalid*

SET CLIPPING INDICATOR GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	clipping indicator	(CLIP,NOCLIP)	E

Effect: The 'clipping indicator' entry in the GKS state list is set to the value specified by the parameter.

References:

4.6.2
4.7.4
4.7.6
4.8.4

Errors:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*

5.5.2 Workstation Transformation

SET WORKSTATION WINDOW **WSOP,WSAC,SGOP** **Lma**

Parameters:

In	workstation identifier		N
In	workstation window limits XMIN<XMAX,YMIN<YMAX	NDC	4×R

Effect: The 'requested workstation window' entry in the workstation state list of the specified workstation is set to the value specified by the parameter.

If the 'dynamic modification accepted for workstation transformation' entry in the workstation description table is set to IMM, or if the 'display surface empty' entry in the workstation state list is set to EMPTY, then the 'current workstation window' entry in the workstation state list is set to the value specified by the parameter and the 'workstation transformation update state' entry is set to NOTPENDING. Otherwise the 'workstation transformation update state' entry in the workstation state list is set to PENDING and the 'current workstation window' entry is not changed.

References:

4.6.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
36 *Specified workstation is Workstation Independent Segment Storage*
51 *Rectangle definition is invalid*
53 *Workstation window is not within the Normalized Device Coordinate unit square*

SET WORKSTATION VIEWPORT **WSOP,WSAC,SGOP** **Lma**

Parameters:

In	workstation identifier		N
In	workstation viewport limits XMIN<XMAX, YMIN<YMAX	DC	4×R

Effect: The 'requested workstation viewport' entry in the workstation state list of the specified workstation is set to the value specified by the parameter.

If the 'dynamic modification accepted for workstation transformation' entry in the workstation description table is set to IMM, or if the 'display surface empty' entry in the workstation state list is set to EMPTY, then the 'current workstation viewport' entry in the workstation state list is set to the value specified by the parameter and the 'workstation transformation update state' entry is set to NOTPENDING. Otherwise the 'workstation transformation update state' entry in the workstation state list is set to PENDING and the 'current workstation viewport' entry is not changed.

References:

4.6.3

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
36 *Specified workstation is Workstation Independent Segment Storage*
51 *Rectangle definition is invalid*
54 *Workstation viewport is not within the display space*

5.6 Segment functions

5.6.1 Segment manipulation functions

CREATE SEGMENT **WSAC** **L1a**

Parameters:

In	segment name	N

Effect: GKS is set into the operating state SGOP = 'Segment open'. The segment state list is set up and initialised as indicated in **6.7**. The segment name is recorded as the 'name of the open segment' in the GKS state list (see **6.4**). All subsequent output primitives until the next CLOSE SEGMENT will be collected into this segment. The segment name is entered in the 'set of stored segments for this workstation' in the workstation state list (see **6.5**) for every active workstation. All active workstations are included in the 'set of associated workstations' of the segment state list of the newly opened segment. The segment name is entered into the 'set of segment names in use' in the GKS state list. Primitive attributes are not affected.

References:

4.7.1

Errors:

3 *GKS not in proper state: GKS shall be in the state WSAC*
120 *Specified segment name is invalid*
121 *Specified segment name is already in use*

CLOSE SEGMENT **SGOP** **L1a**

Parameters:

none

Effect: GKS is put into the operating state WSAC = 'At least one workstation active'. Primitives may no longer be added to the previously open segment. The 'name of the open segment' in the GKS state list (see **6.4**) becomes unavailable for inquiry.

References:

4.7.1

Errors:

4 *GKS not in proper state: GKS shall be in the state SGOP*

RENAME SEGMENT **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	old segment name	N
In	new segment name	N

Effect: Each occurrence of old segment name in the 'set of stored segments for this workstation' in each workstation state list (see **6.5**) and in the 'set of segment names in use' in the GKS state list is replaced by new segment name. If old segment name is the name of the open segment, the 'name of the open segment' in the GKS state list is set to new segment name.

NOTE The old segment name may be reused by the application program.

References:

4.7.1

Errors:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
120 Specified segment name is invalid
121 Specified segment name is already in use
122 Specified segment does not exist

DELETE SEGMENT **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	segment name	N

Effect: The segment is deleted. The segment name is removed from each 'set of stored segments for this workstation' (in the workstation state lists (see **6.5**)) which contains it and from the 'set of segment names in use' in the GKS state list. The segment's state list is cancelled.

NOTE The segment name may be reused by the application program.

References:

4.5.3
4.7.1

Errors:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
120 Specified segment name is invalid
122 Specified segment does not exist
125 Specified segment is open

DELETE SEGMENT FROM WORKSTATION **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	workstation identifier	N
In	segment name	N

Effect: The segment is deleted from the specified workstation. The segment name is removed from the 'set of stored segments for this workstation' in the workstation state list (see **6.5**). The workstation identifier is removed from the 'set of associated workstations' in the segment state list (see **6.7**). If the 'set of associated workstations' becomes empty, the segment is deleted, i.e. the DELETE SEGMENT function is performed.

References:

4.5.3
4.7.1

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
120 *Specified segment name is invalid*
123 *Specified segment does not exist on specified workstation*
125 *Specified segment is open*

ASSOCIATE SEGMENT WITH WORKSTATION — WSOP, WSAC — L2a

Parameters:

In	workstation identifier	N
In	segment name	N

Effect: The segment is sent to the specified workstation in the same way as if the workstation were active when the segment was created. Clipping rectangles are copied unchanged. The segment name is added to the 'set of stored segments for this workstation' in the workstation state list (see **6.5**). The workstation identifier is included in the 'set of associated workstations' in the segment state list (see **6.7**).

NOTE. If the specified segment is not present in the Workstation Independent Segment Storage, an error occurs

If the segment is already associated with the specified workstation, the function has no effect.

References:

4.5.3
4.7.1
4.7.6

Errors:

6 *GKS not in proper state: GKS shall be either in the state WSOP or in the state WSAC*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
27 *Workstation Independent Segment Storage is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
120 *Specified segment name is invalid*
124 *Specified segment does not exist on Workstation Independent Segment Storage*

COPY SEGMENT TO WORKSTATION — WSOP, WSAC — L2a

Parameters:

In	workstation identifier	N
In	segment name	N

Effect: The primitives in the segment are sent to the specified workstation after segment transformation and clipping at the clipping rectangle stored with each primitive. The primitives are not stored in a segment.

NOTE. If the specified segment is not present in the Workstation Independent Segment Storage, an error occurs. The specified workstation cannot be the Workstation Independent Segment Storage.

All primitives keep the values of the primitive attributes (for example, polyline index, character path, pick identifier), that were assigned to them when they were created, for their whole lifetime (see **4.7.1**). In particular, when segments are copied, the values of the primitive attributes within the copied segments are unchanged.

References:

4.5.3
4.7.1
4.7.6

Errors:

6 *GKS not in proper state: GKS shall be either in the state WSOP or in the state WSAC*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
27 *Workstation Independent Segment Storage is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
120 *Specified segment name is invalid*
124 *Specified segment does not exist on Workstation Independent Segment Storage*

INSERT SEGMENT WSAC,SGOP L2a

Parameters:

In	segment name	N
In	transformation matrix	2×3×R

Effect: Having been transformed as described below, the primitives contained in the segment are copied either (in state SGOP) into the open segment or (in state WSAC) into the stream of primitives outside segments.

In both cases the transformed primitives are sent to all active workstations. The coordinates of the primitives contained in the inserted segment are transformed, firstly, by the segment transformation of the inserted segment, and, secondly, by applying the following matrix multiplication to them:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} \\ M_{21} & M_{22} & M_{23} \end{bmatrix} \times \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

The original coordinates are (x,y), the transformed coordinates are (x',y'), both in NDC. The values M_{13} and M_{23} of the transformation matrix are NDC coordinates, the other values are unitless. For geometric attributes which are vectors (for example, CHARACTER UP VECTOR), the values M_{13} and M_{23} are ignored.

The insert transformation (conceptually) takes place in NDC space. Other than the segment transformation, attributes of the inserted segment are ignored.

All clipping rectangles in the inserted segment are ignored. Each primitive processed is assigned a new clipping rectangle which is the clipping rectangle in the GKS state list if the 'clipping indicator' entry in the GKS state list is CLIP and is $[0,1]\times[0,1]$ if the 'clipping indicator' entry in the GKS state list is NOCLIP. All primitives processed by a single invocation of INSERT SEGMENT receive the same clipping rectangle.

NOTE. If the specified segment is not in the Workstation Independent Segment Storage or is the open segment, an error occurs.

All primitives keep the values of the primitive attributes (for example, POLYLINE INDEX, TEXT PATH, PICK IDENTIFIER), that were assigned to them when they were created, for their whole lifetime (see **4.7.1**). In particular, when segments are inserted, the values of the primitive attributes within the inserted segments are unchanged. The values of primitive attributes in the GKS state list, that are used in the creation of subsequent primitives within the segment into which the insertion takes place, are not changed by that insertion.

References:

4.5.3
4.7.6

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
27 *Workstation Independent Segment Storage is not open*
120 *Specified segment name is invalid*
124 *Specified segment does not exist on Workstation Independent Segment Storage*
125 *Specified segment is open*

5.6.2 Segment attributes

SET SEGMENT TRANSFORMATION **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	segment name	N
In	transformation matrix	2×3×R

Effect: The 'segment transformation matrix' entry in the segment state list of the named segment is set to the value specified by the parameter. When a segment is displayed, the coordinates of its primitives are transformed by applying the following matrix multiplication to them:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} M_{11} & M_{12} & M_{13} \\ M_{21} & M_{22} & M_{23} \end{bmatrix} \times \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

The original coordinates are (x,y), the transformed coordinates are (x',y'), both in NDC. The values M_{13} and M_{23} of the transformation matrix are in NDC coordinates, the other values are unitless. For geometric attributes which are vectors (for example, CHARACTER UP VECTOR), the values M_{13} and M_{23} are ignored.

This function can be used to transform a segment stored on a workstation. The transformation applies to all workstations where the specified segment is stored even if they are not all active.

The segment transformation (conceptually) takes place in NDC space. The segment transformation will be stored in the segment state list and will not affect the contents of the segment. The segment transformation is not cumulative, i.e. it always applies to the segment as originally created.

NOTE. Applying the same segment transformation twice to a segment gives identical results. The identity transformation shows the segment in its original geometrical appearance.

References:

4.5.3
4.7.3

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
120	*Specified segment name is invalid*
122	*Specified segment does not exist*

SET VISIBILITY **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	segment name		N
In	visibility	(VISIBLE,INVISIBLE)	E

Effect: The 'visibility' entry in the segment state list of the named segment is set to the value specified by the parameter.

References:

4.5.3
4.7.2
4.8.4

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
120	*Specified segment name is invalid*
122	*Specified segment does not exist*

SET HIGHLIGHTING **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	segment name		N
In	highlighting	(NORMAL,HIGHLIGHTED)	E

Effect: The 'highlighting' entry in the segment state list of the named segment is set to the value specified by the parameter. If the segment is marked as HIGHLIGHTED and VISIBLE, the primitives in it are highlighted in an implementation dependent manner.

References:

4.5.3
4.7.2

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
120	*Specified segment name is invalid*
122	*Specified segment does not exist*

SET SEGMENT PRIORITY WSOP,WSAC,SGOP L1a

Parameters:

In	segment name		N
In	segment priority	[0,1]	R

Effect: The 'segment priority' entry in the segment state list of the named segment is set to the value specified by the parameter. Segment priority affects the display of segments and pick input if segments overlap, in which case GKS gives precedence to segments with higher priority. If segments with the same priority overlap, the result is implementation dependent.

NOTE. The use of segment priority applies only to workstations where the entry 'number of segment priorities supported' in the workstation description table is greater than 1 or equal to 0 (indicating that a continuous range of priorities is supported).

If 'number of segment priorities supported' is greater than 1, the range [0,1] for segment priority is mapped onto the range 1 to 'number of segment priorities supported' for a specific workstation before being used by a device driver. If 'number of segment priorities supported' is equal to 0, the implementation allows all values of segment priority to be differentiated.

This feature is intended to address appropriate hardware capabilities only. It cannot be used to force software checking of interference between segments on non-raster displays.

The segment priority is also used for picking segments. When overlapping or intersecting segments are picked, the segment with higher priority is delivered as a result of the pick input primitive. All workstations having pick input provide this mechanism.

References:

4.5.3
4.7.2
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
120 *Specified segment name is invalid*
122 *Specified segment does not exist*
126 *Segment priority is outside the range [0,1]*

SET DETECTABILITY WSOP,WSAC,SGOP L1b

Parameters:

In	segment name		N
In	detectability	(UNDETECTABLE,DETECTABLE)	E

Effect: The 'detectability' entry in the segment state list of the named segment is set to the value specified by the parameter. If the segment is marked as DETECTABLE and VISIBLE, the primitives in it are available for pick input. DETECTABLE but INVISIBLE segments cannot be picked.

References:

4.7.2
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
120 *Specified segment name is invalid*
122 *Specified segment does not exist*

5.7 Input Functions

5.7.1 Initialisation of Input Devices

INITIALISE LOCATOR **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier			N
In	locator device number		(1..n)	I
In	initial normalization transformation number		(0..n)	I
In	initial locator position	WC		P
In	prompt and echo type		(-n..-1,1..n)	I
In	echo area XMIN<XMAX,YMIN<YMAX	DC		4×R
In	locator data record			D

Effect: The initial locator position, initial normalization transformation number, prompt and echo type, echo area and locator data record are stored in the workstation state list entry for the specified LOCATOR device.

For some LOCATOR prompt and echo types, two positions are required. One of the positions, which remains fixed during the input operation, is the initial locator position. The other position is the current locator position that varies dynamically as the operator uses the LOCATOR.

Prompt and echo type:

<0 prompting and echoing is LOCATOR device dependent.

1 designate the current position of the LOCATOR using an implementation-defined technique.

2 crosshair, i.e. designate the current position of the LOCATOR using a vertical line and a horizontal line spanning over the display surface or the workstation viewport intersecting at the current locator position.

3 designate the current position of the LOCATOR using a tracking cross.

4 designate the current position of the LOCATOR using a rubber band line connecting the initial locator position given by this function and the current locator position.

5 designate the current position of the LOCATOR using a rectangle. The diagonal of the rectangle is the line connecting the initial locator position given by this function and the current locator position.

6 display a digital representation of the current position of the LOCATOR in LOCATOR device dependent coordinates within the echo area.

≥7 reserved for registration or future standardization.

NOTE. LOCATOR prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a LOCATOR prompt and echo type has been approved by the ISO Working Group on Computer Graphics[1], the LOCATOR prompt and echo type value will be assigned by the Registration Authority.

References:

4.8.2
4.8.6

Data Record

Prompt and echo type = 4

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

1	attribute control flag	(CURRENT, SPECIFIED)	F

if attribute control flag = SPECIFIED

2	linetype ASF	(BUNDLED, INDIVIDUAL)	E
3	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
4	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
5	polyline index	(1..n)	I
6	linetype index	(-n..-1,1..n)	I
7	linetype scale factor	>0	R
8	polyline colour index	(0..n)	I

if attribute control flag = CURRENT the current polyline attributes at LOCATOR initialization are used.

Prompt and echo type = 5

1	polyline/fill area control flag	(POLYLINE, FILL AREA)	E
2	attribute control flag	(CURRENT, SPECIFIED)	E

if attribute control flag = SPECIFIED and polyline/fill area control flag = POLYLINE

3	linetype ASF	(BUNDLED, INDIVIDUAL)	E
4	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
5	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
6	polyline index	(1..n)	I
7	linetype index	(-n..-1,1..n)	I
8	linewidth scale factor	>0	R
9	polyline colour index	(0..n)	I

if attribute control flag = SPECIFIED and polyline/fill area control flag = FILL AREA

3	fill area interior style ASF	(BUNDLED, INDIVIDUAL)	E
4	fill area style index ASF	(BUNDLED, INDIVIDUAL)	E
5	fill area colour index ASF	(BUNDLED, INDIVIDUAL)	E
6	fill area index	(1..n)	I
7	fill area interior style	(HOLLOW, SOLID, PATTERN, HATCH)	E
8	fill area style index	(-n..-1,1..n)	I
9	fill area colour index	(0..n)	I

If attribute control flag = CURRENT and polyline/fill area control flag = POLYLINE, then the current polyline attributes at LOCATOR initialization will be used. If attribute control flag = CURRENT and polyline/fill area control flag = FILL AREA, then the current fill area attributes at LOCATOR initialization will be used.

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
51	*Rectangle definition is invalid*
60	*Polyline index is invalid*
63	*Linetype is equal to zero*
65	*Linewidth scale factor is less than zero*
80	*Fill area index is invalid*
84	*Style (pattern or hatch) index is equal to zero*
92	*Colour index is less than zero*
140	*Specified input device is not present on workstation*
141	*Input device is not in REQUEST mode*
144	*Specified prompt and echo type is not supported on this workstation*
145	*Echo area is outside display space*
146	*Contents of input data record are invalid*
152	*Initial value is invalid*

INITIALISE STROKE **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier			N
In	stroke device number		(1..n)	I
In	initial normalization transformation number		(0..n)	I
In	number of points in initial stroke		(0..n)	I
In	points in initial stroke	WC		n×P
In	prompt and echo type		(-n..-1,1..n)	I
In	echo area XMIN<XMAX, YMIN<YMAX	DC		4×R
In	stroke data record			D

Effect: The initial stroke, initial normalization transformation number, prompt and echo type, echo area and stroke data record are stored in the workstation state list entry for the specified STROKE device.

For all prompt and echo types, the first entry in the stroke data record is the input buffer size which is an integer in the range (1..n). This is compared against an implementation defined 'maximum input buffer size' for this device (contained in the workstation description table). If the requested buffer size is greater, the 'maximum input buffer size' is substituted in the stored data record. If the initial stroke is longer than the buffer size, an error is issued.

When a STROKE measure process comes into existence, it obtains a buffer of the current input buffer size. The initial stroke is copied into the buffer, and the editing position is placed at the initial buffer editing position within it. Replacement of points begins at this initial position. If the initial buffer editing position cannot be specified in the stroke data record, the value 1 is used.

Prompt and echo types:

<0 prompting and echoing is STROKE device dependent.

1 display the current stroke using an implementation defined technique.

2 display a digital representation of the current stroke position within the echo area.

3 display a marker at each point of the current stroke.

4 display a line joining successive points of the current stroke.

≥5 reserved for registration or future standardization.

If the operator enters more points than the current input buffer size, the additional points are lost. The operator should be informed of this situation.

Stroke data record entries for variables such as intervals in X, Y and time may be provided to constrain the number of points delivered.

NOTE. For all prompt and echo types, the stroke data record may contain an initial buffer editing position, which may range from 1 to length of initial stroke plus 1.

STROKE prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a STROKE prompt and echo type has been approved by the ISO Working Group on Computer Graphics[1], the STROKE prompt and echo type value will be assigned by the Registration Authority.

References:

4.8.2
4.8.6

Data Record.

1	input buffer size	(1..n)	I
2	editing position	(1..n)	I
3	x,y interval	WC > 0	2×R
4	time interval (seconds)		R

Prompt and echo type = 3

5	attribute control flag	(CURRENT, SPECIFIED)	E

if attribute control flag = SPECIFIED

6	marker type ASF		E
7	marker size scale factor ASF	(BUNDLED, INDIVIDUAL)	E
8	polymarker colour index ASF	(BUNDLED, INDIVIDUAL)	E
9	polymarker index	(1..n)	I
10	marker type index	(-n..-1,1..n)	I
11	marker size scale factor	>0	R
12	polymarker colour index	(0..n)	I

If attribute control flag = CURRENT, then the current polyline attributes at STROKE initialization are used.

Prompt and echo type = 4

5	attribute control flag	(CURRENT, SPECIFIED)	E

if attribute control flag = SPECIFIED

6	linetype ASF	(BUNDLED, INDIVIDUAL)	E
7	linewidth scale factor ASF	(BUNDLED, INDIVIDUAL)	E
8	polyline colour index ASF	(BUNDLED, INDIVIDUAL)	E
9	polyline index	(1..n)	I
10	linetype index	(-n..-1,1..n)	I
11	linewidth scale factor		R
12	polyline colour index	(0..n)	I

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

If attribute control flag = CURRENT, then the current poly attributes at STROKE initialization are used

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
51 *Rectangle definition is invalid*
60 *Polyline index is invalid*
63 *Linetype is equal to zero*
66 *Polymarker index is invalid*
65 *Linewidth scale factor is less than zero*
67 *A representation for the specified polymarker index has not been defined on this workstation*
69 *Marker type is equal to zero*
92 *Colour index is less than zero*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*
144 *Specified prompt and echo type is not supported on this workstation*
145 *Echo area is outside display space*
146 *Contents of input data record are invalid*
152 *Initial value is invalid*
153 *Number of points in the initial stroke is greater than the buffer size*

INITIALISE VALUATOR WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation identifier			N
In	valuator device number		(1..n)	I
In	initial value			R
In	prompt and echo type		(-n..-1,1..n)	I
In	echo area XMIN<XMAX,YMIN<YMAX	DC		4×R
In	valuator data record			D

Effect: The initial value, prompt and echo type, echo area and valuator data record are stored in the workstation state list entry for the specified VALUATOR device. For all VALUATOR prompt and echo types, the valuator data record includes, in the first two positions, a low value and a high value, in that order, specifying the range. The values from the device will be scaled linearly to the specified range.

Prompt and echo types:

<0prompting and echoing is VALUATOR device dependent.

1 designate the current VALUATOR value using an implementation defined technique.

2 display a graphical representation of the current VALUATOR value within the echo area (for example, a dial or a pointer).

3 display a digital representation of the current VALUATOR value within the echo area.

≥4reserved for registration or future standardization.

NOTE VALUATOR prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a VALUATOR prompt and echo type has been approved by the ISO Working Group on Computer Graphics[1], the VALUATOR prompt and echo

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

type value will be assigned by the Registration Authority.

References:

4.8.2
4.8.6

Data Record:

1	low value of valuator range	R
2	high value of valuator	R

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
51 *Rectangle definition is invalid*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*
144 *Specified prompt and echo type is not supported on this workstation*
145 *Echo area is outside display space*
146 *Contents of input data record are invalid*
152 *Initial value is invalid*

INITIALISE CHOICE — WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation identifier		N
In	choice device number	(1..n)	I
In	initial status	(OK,NOCHOICE)	E
In	initial choice number	(1..n)	I
In	prompt and echo type	(-n..-1,1..n)	I
In	echo area XMIN<XMAX,YMIN<YMAX	DC	4×R
In	choice data record		D

Effect: The initial status, initial choice number, prompt and echo type, echo area and choice data record are stored in the workstation state list entry for the specified CHOICE device.

Prompt and echo types:

<0 prompting and echoing is CHOICE device dependent.

1 designate the current CHOICE number using an implementation defined technique.

2 the physical input devices that are most commonly used to implement a CHOICE logical input device normally have a built-in prompting capability. This prompt and echo type allows the application program to invoke this prompting capability. If the value of the i-th element of 'prompt array' in the choice data record is OFF, prompting of the i-th alternative of the specified choice input device is turned off. An ON value indicates that prompting for that alternative is turned on. The first entry in the choice data record is the number of choice alternatives. This is compared against an implementation defined 'maximum number of choice alternatives' for this device (contained in the workstation description table). If the maximum value is exceeded, an error is issued. The second entry in the choice data record is the 'prompt array'.

3 allow the operator to indicate a CHOICE number by selecting, using an appropriate technique, one of a set of CHOICE strings. The CHOICE strings are contained in the choice data record and are displayed within the echo area. The logical input value is the number of the string selected. The first entry in the choice data record is the number of choice strings. This is compared against an implementation defined 'maximum number of choice alternatives' for this device (contained in the workstation description table). If the maximum value is exceeded, an error is issued. The second entry in the choice data record is the 'array of choice strings'.

4 allow the operator to indicate a CHOICE number by selecting, via an alphanumeric keyboard, one of a set of CHOICE strings. The CHOICE strings are contained in the choice data record and may be displayed in the echo area as a prompt. The string typed in by the operator is echoed in the echo area. The logical input value is the number of the first string in the array that has been typed in by the operator. The first entry in the choice data record is the number of choice strings. This is compared against an implementation defined 'maximum number of choice alternatives' for this device (contained in the workstation description table). If the maximum value is exceeded, an error is issued. The second entry in the choice data record is the 'array of choice strings'.

5 the segment named by the choice data record is interpreted during execution of INITIALISE CHOICE for later use as a prompt of the specified CHOICE device. It will be displayed within the echo area by mapping the unit square $[0,1] \times [0,1]$ of NDC space onto the echo area. The pick identifiers in the segment are mapped to CHOICE numbers in a CHOICE device dependent fashion. Picking these primitives selects the corresponding CHOICE value. After the interpretation, no logical connection between the specified segment and the specified CHOICE device exists. The first entry in the choice data record is the segment name.

≥ 6 reserved for registration or future standardization.

NOTE. CHOICE prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a CHOICE prompt and echo type has been approved by the ISO Working Group on Computer Graphics[1)], the CHOICE prompt and echo type value will be assigned by the Registration Authority.

References:

4.8.2
4.8.6

Data Record:

Prompt and echo type = 2

1	number of choice alternatives	(1..n)	I
2	array of prompts	(OFF, ON)	n×E

Prompt and echo type = 3

1	number of choice strings	(1..n)	I
2	array of strings		n×S

Prompt and echo type = 4

1	number of choice strings	(1..n)	I
2	array of strings		n×S

1) Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Prompt and echo type = 5

1	segment name		N
2	number of choice alternatives	(1..n)	I
3	array of pick identifers		n×N

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
51 *Rectangle definition is invalid*
120 *Specified segment name is invalid*
122 *Specified segment does not exist*
123 *Specified segment does not exist on specified workstation*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*
144 *Specified prompt and echo type is not supported on this workstation*
145 *Echo area is outside display space*
146 *Contents of input data record are invalid*
152 *Initial value is invalid*

INITIALISE PICK WSOP,WSAC,SGOP L1b

Parameters:

In	workstation identifier		N
In	pick device number	(1..n)	I
In	initial status	(OK,NOPICK)	E
In	initial segment		N
In	initial pick identifier		N
In	prompt and echo type	(-n..-1,1..n)	I
In	echo area XMIN<XMAX,YMIN<YMAX	DC	4×R
In	pick data record		D

Effect: The initial status, initial segment, initial pick identifier, prompt and echo type, echo area and the pick data record are stored in the workstation state list entry for the specified PICK device.

Prompt and echo types:

<0 prompting and echoing is PICK device dependent.

1 use an implementation-defined technique that at least highlights the 'picked' primitive for a short period of time.

2 echo the contiguous group of primitives within the segment with the same pick identifier as the "picked" primitive, or all primitives of the segment with the same pick identifier as the "picked" primitive.

3 echo the whole segment containing the "picked" primitive.

≥4 reserved for registration or future standardization.

NOTE. PICK prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a PICK prompt and echo type has been approved by the ISO Working Group on Computer Graphics[1)], the PICK prompt and echo type value will be assigned by the

[1)] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Registration Authority

References:

4.8.2
4.8.6

Data Record:

No predefined entries for Prompt and Echo types 1 through 3.

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
37	*Specified workstation is not of category OUTIN*
51	*Rectangle definition is invalid*
140	*Specified input device is not present on workstation*
141	*Input device is not in REQUEST mode*
144	*Specified prompt and echo type is not supported on this workstation*
145	*Echo area is outside display space*
146	*Contents of input data record are invalid*
152	*Initial value is invalid*

INITIALISE STRING WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation identifier			N
In	string device number		(1..n)	I
In	initial string			S
In	prompt and echo type		(-n..-1,1..n)	I
In	echo area XMIN<XMAX,YMIN<YMAX	DC		4×R
In	string data record			D

Effect: The initial string, prompt and echo type, echo area and string data record are stored in the workstation state list entry for the specified STRING device.

For all prompt and echo types, the first entry of the string data record is the input buffer size, which is an integer in the range (1..n). This is compared against an implementation defined 'maximum input buffer size' for this device (contained in the workstation description table). If the requested buffer size is greater, the 'maximum input buffer size' is substituted in the stored record. If the initial string is longer than the buffer size, an error is issued.

For all prompt and echo types, the second entry of the string data record is an initial cursor position, which may range from 1 to the length of the initial string plus 1.

When a STRING measure process comes into existence, it obtains a buffer of the current input buffer size. The initial string is copied into the buffer, and the cursor is placed at the initial cursor position within it. Replacement of characters begins at this cursor position.

Prompt and echo types:

<0 prompting and echoing is STRING device dependent.

1 display the current STRING value within the echo area.

≥2 reserved for registration or future standardization.

NOTE. If the operator enters more characters than the current input buffer size, the additional characters are lost.

STRING prompt and echo type values are registered in the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When a STRING prompt and echo type has been approved by the ISO Working Group on Computer Graphics[1], the STRING prompt and echo type value will be assigned by the Registration Authority.

References:

4.8.2
4.8.6

Data Record:

1	Input buffer size	(1..n)	I
2	Initial cursor position	(1..n)	I

Errors:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN
51 Rectangle definition is invalid
140 Specified input device is not present on workstation
141 Input device is not in REQUEST mode
144 Specified prompt and echo type is not supported on this workstation
145 Echo area is outside display space
146 Contents of input data record are invalid
152 Initial value is invalid
154 Length of the initial string is greater than the buffer size

5.7.2 Setting Mode of Input Devices

SET LOCATOR MODE **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier		N
In	locator device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given LOCATOR device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by 'operating mode' and 'echo switch' is stored in the workstation state list for the given LOCATOR device.

References:

4.8.1
4.8.3

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
140	*Specified input device is not present on workstation*
143	*EVENT and SAMPLE input mode are not available at this level of GKS*

SET STROKE MODE — WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation identifier		N
In	stroke device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given STROKE device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by 'operating mode' and 'echo switch' is stored in the workstation state list for the given STROKE device.

References:

4.8.1
4.8.3

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
140	*Specified input device is not present on workstation*
143	*EVENT and SAMPLE input mode are not available at this level of GKS*

SET VALUATOR MODE — WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation identifier		N
In	valuator device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given VALUATOR device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by 'operating mode' and 'echo switch' is stored in the workstation state list for the given VALUATOR device.

References:

4.8.1
4.8.3

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
140	*Specified input device is not present on workstation*
143	*EVENT and SAMPLE input mode are not available at this level of GKS*

SET CHOICE MODE — WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation identifier		N
In	choice device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given CHOICE device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end., The input device state defined by 'operating mode' and 'echo switch' is stored in the workstation state list for the given CHOICE device.

References:

4.8.1
4.8.3

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
140	*Specified input device is not present on workstation*
143	*EVENT and SAMPLE input mode are not available at this level of GKS*

SET PICK MODE — WSOP,WSAC,SGOP — L1b

Parameters:

In	workstation identifier		N
In	pick device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given PICK device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by 'operating mode' and 'echo switch' is stored in the workstation state list for the given PICK device.

References:

4.8.1
4.8.3

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
37	*Specified workstation is not of category OUTIN*
140	*Specified input device is not present on workstation*
143	*EVENT and SAMPLE input mode are not available at this level of GKS*

SET STRING MODE **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier		N
In	string device number	(1..n)	I
In	operating mode	(REQUEST,SAMPLE,EVENT)	E
In	echo switch	(ECHO,NOECHO)	E

Effect: The given STRING device is set to the specified operating mode and its echoing state is set to ECHO or NOECHO. Depending on the specified operating mode, an interaction with the given device may begin or end. The input device state defined by 'operating mode' and 'echo switch' is stored in the workstation state list for the given STRING device.

References:

4.8.1
4.8.3

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
140	*Specified input device is not present on workstation*
143	*EVENT and SAMPLE input mode are not available at this level of GKS*

5.7.3 Request Input Functions

REQUEST LOCATOR **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier		N
In	locator device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	normalization transformation number	(0..n)	I
Out	locator position	WC	P

Effect: GKS performs a REQUEST on the specified LOCATOR device. If the break facility is invoked by the operator, the status NONE is returned; otherwise OK is returned together with the logical input value which is the current measure of the LOCATOR device. This measure consists of a locator position in world coordinates and the normalization transformation number, which was used in the conversion to world coordinates. The locator position is within the window of the normalization transformation.

References:

4.6.4
4.8.1
4.8.2
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*

REQUEST STROKE **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier			N
In	stroke device number		(1..n)	I
Out	status		(OK,NONE)	E
Out	normalization transformation number		(0..n)	I
Out	number of points		(0..n)	I
Out	points in stroke	WC		n×P

Effect: GKS performs a REQUEST on the specified STROKE device. If the break facility is invoked by the operator, the status NONE is returned; otherwise OK is returned together with the logical input value which is the current measure of the STROKE device. This consists of a sequence of not more than 'input buffer size' (in the stroke data record) points in world coordinates, and the normalization transformation number, which was used in the conversion to world coordinates. The points in the stroke all lie within the window of the normalization transformation.

NOTE. If an operator enters more points than the stroke input buffer size (in the workstation state list) allows, the additional points are lost. The operator should be informed of this situation.

References:

4.6.5
4.8.1
4.8.2
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*

REQUEST VALUATOR **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier		N
In	valuator device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	value		R

Effect: GKS performs a REQUEST on the specified VALUATOR device. If the break facility is invoked by the operator, the status NONE is returned; otherwise OK is returned together with the logical input value which is the current measure of the VALUATOR device. The value delivered is in the range specified in the workstation state list entry (for this device) in the data record.

References:

4.8.1
4.8.2
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*

REQUEST CHOICE **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier		N
In	choice device number	(1..n)	I
Out	status	(OK,NOCHOICE,NONE)	E
Out	choice number	(1..n)	I

Effect: GKS performs a REQUEST on the specified CHOICE device. If the break facility is invoked by the operator, the status NONE is returned; if the measure of the CHOICE device indicates no choice, status NOCHOICE is returned; otherwise OK is returned together with a choice number which is set according to the current measure of the CHOICE device.

References:

4.8.1
4.8.2
4.8.3
4.8.4

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
38	*Specified workstation is neither of category INPUT nor of category OUTIN*
140	*Specified input device is not present on workstation*
141	*Input device is not in REQUEST mode*

REQUEST PICK **WSOP,WSAC,SGOP** **L1b**

Parameters:

In	workstation identifier		N
In	pick device number	(1..n)	I
Out	status	(OK,NOPICK,NONE)	E
Out	segment name		N
Out	pick identifier		N

Effect: GKS performs a REQUEST on the specified PICK device. If the break facility is invoked by the operator, the status NONE is returned; if the measure of the PICK device indicates no pick, status NOPICK is returned; otherwise OK is returned together with a segment name and a pick identifier which are set according to the current measure of the PICK device. The pick identifier is associated with the primitive, within the segment, that was picked.

References:

4.8.1
4.8.2
4.8.3
4.8.4

Errors:

7	*GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20	*Specified workstation identifier is invalid*
25	*Specified workstation is not open*
37	*Specified workstation is not of category OUTIN*
140	*Specified input device is not present on workstation*
141	*Input device is not in REQUEST mode*

REQUEST STRING **WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation identifier		N
In	string device number	(1..n)	I
Out	status	(OK,NONE)	E
Out	character string		S

Effect: GKS performs a REQUEST on the specified STRING device. If the break facility is invoked by the operator, the status NONE is returned; otherwise OK is returned together with the logical input value which is the current measure of the STRING device.

NOTE The length of the returned string is less than or equal to the buffer size specified in the workstation state list entry (for this device) in the data record.

References:

4.8.1
4.8.2
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
141 *Input device is not in REQUEST mode*

5.7.4 Sample Input Functions

SAMPLE LOCATOR **WSOP,WSAC,SGOP** **Lmc**

Parameters:

In	workstation identifier			N
In	locator device number		(1..n)	I
Out	normalization transformation number		(0..n)	I
Out	locator position	WC		P

Effect: The logical input value, which is the current measure of the specified LOCATOR device, is returned. The measure consists of a locator position in world coordinates and the normalization transformation number, which was used in the conversion to world coordinates. The locator position is within the window of the normalization transformation.

References:

4.6.4
4.8.1
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
142 *Input device is not in SAMPLE mode*

SAMPLE STROKE **WSOP,WSAC,SGOP** **Lmc**

Parameters:

In	workstation identifier		N
In	stroke device number	(1..n)	I
Out	normalization transformation number	(0..n)	I
Out	number of points	(0..n)	I

Out	points in stroke	WC	n×P

Effect: The logical input value, which is the current measure of the specified STROKE device, is returned. The measure consists of a sequence of points in world coordinates, and the normalization transformation number which was used in the conversion to world coordinates. The points in the stroke all lie within the window of the normalization transformation.

NOTE. If an operator enters more points than the stroke input buffer size (in the workstation state list) allows, the additional points are lost. It is anticipated that the operator would be informed of this situation.

References:

4.6.5
4.8.1
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
142 *Input device is not in SAMPLE mode*

SAMPLE VALUATOR WSOP,WSAC,SGOP Lmc

Parameters:

In	workstation identifier		N
In	valuator device number	(1..n)	I
Out	value		R

Effect: The logical input value, which is the current measure of the specified VALUATOR device, is returned. The value delivered is in the range specified in the workstation state list entry (for this device) in the data record.

References:

4.8.1
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
142 *Input device is not in SAMPLE mode*

SAMPLE CHOICE WSOP,WSAC,SGOP Lmc

Parameters:

In	workstation identifier		N
In	choice device number	(1..n)	I

Out	status	(OK,NOCHOICE)	E
Out	choice number	(1..n)	I

Effect: If the current measure of the specified CHOICE device is indicating no choice, status NOCHOICE is returned; otherwise OK is returned together with a choice number which is set according to the current measure of the CHOICE device.

References:

4.8.1
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
142 *Input device is not in SAMPLE mode*

SAMPLE PICK **WSOP,WSAC,SGOP** **L1c**

Parameters:

In	workstation identifier		N
In	pick device number	(1..n)	I
Out	status	(OK,NOPICK)	E
Out	segment name		N
Out	pick identifier		N

Effect: If the current measure of the specified PICK device is indicating no pick, status NOPICK is returned; otherwise OK is returned together with a segment name and a pick identifier which are set according to the current measure of the PICK device. The pick identifier is associated with the primitive, within the segment, that was picked.

References:

4.8.1
4.8.3
4.8.4

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
37 *Specified workstation is not of category OUTIN*
140 *Specified input device is not present on workstation*
142 *Input device is not in SAMPLE mode*

SAMPLE STRING **WSOP,WSAC,SGOP** **Lmc**

Parameters:

In	workstation identifier		N
In	string device number	(1..n)	I
Out	character string		S

Effect: The logical input value, which is the current measure of the specified STRING device, is returned.

NOTE. The length of the returned string is less than or equal to the buffer size specified in the workstation state list entry (for this device) in the data record.

References:

4.8.1
4.8.3
4.8.4

Errors:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation
142 Input device is not in SAMPLE mode

5.7.5 Event Input Functions

AWAIT EVENT **WSOP,WSAC,SGOP** **Lmc**

Parameters:

In	timeout (seconds)		R
Out	workstation identifier		N
Out	input class	(NONE,LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)	E
Out	logical input device number	(1..n)	I

Effect: If the input queue is empty, GKS is set into a wait state until an input event is written into the queue or the time specified in the timeout parameter has elapsed. If a timeout occurs and there is still no entry in the queue, a NONE value is returned for input class. If there is at least one entry in the queue, the oldest event report is moved from the event queue to the current event report in the GKS state list. The workstation identifier, the input class, and the logical input device number are returned and the corresponding values are made available for subsequent interrogation by the GET <input class> functions.

NOTE. The operation is performed even if error 147 has occurred.

A timeout of zero causes an immediate inspection of the queue, and a NONE value for input class is returned if the queue is empty.

Some operating systems may not provide a reliable timeout facility. In this case a timeout different from zero may never cause a timeout at all.

References:

4.8.1
4.8.2
4.8.3
4.8.5

Errors:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
147 Input queue has overflowed
151 Timeout is invalid

FLUSH DEVICE EVENTS WSOP,WSAC,SGOP Lmc

Parameters:

In	workstation identifier		N
In	input class	(LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)	E
In	logical input device number	(1..n)	I

Effect: All entries in the input queue from the specified logical input device are removed.

NOTE. The operation is performed even if error 147 has occurred

References:

4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*
147 *Input queue has overflowed*

GET LOCATOR WSOP,WSAC,SGOP Lmc

Parameters:

Out	normalization transformation number		(0..n)	I
Out	locator position	WC		P

Effect: The LOCATOR logical input value in the current event report is returned. This consists of a locator position in world coordinates and the normalization transformation number, which was used in the conversion to world coordinates.

References:

4.6.4
4.8.4
4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
150 *No input value of the correct class is in the current event report*

GET STROKE WSOP,WSAC,SGOP Lmc

Parameters:

Out	normalization transformation number		(0..n)	I
Out	number of points		(0..n)	I
Out	points in stroke	WC		n×P

Effect: The STROKE logical input value from the current event report is returned. This consists of a sequence of points in world coordinates, and the normalization transformation number, which was used in the conversion to world coordinates. The points in the stroke all lie within the window of the normalization transformation.

NOTE. The number of points in the stroke is less than or equal to the stroke buffer size specified in the workstation state list for this device.

References:

4.6.5
4.8.4
4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
150 *No input value of the correct class is in the current event report*

GET VALUATOR **WSOP,WSAC,SGOP** **Lmc**

Parameters:

Out	value	R

Effect: The VALUATOR logical input value in the current event report is returned. The value delivered is in the range specified in the workstation state list entry (for the device) in the data record.

References:

4.8.4
4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
150 *No input value of the correct class is in the current event report*

GET CHOICE **WSOP,WSAC,SGOP** **Lmc**

Parameters:

Out	status	(OK,NOCHOICE)	E
Out	choice number	(1..n)	I

Effect: The CHOICE logical input value in the current event report is returned. This consists of a CHOICE status and a choice number.

References:

4.8.4
4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
150 *No input value of the correct class is in the current event report*

GET PICK **WSOP,WSAC,SGOP** **L1c**

Parameters:

Out	status	(OK,NOPICK)	E
Out	segment name		N
Out	pick identifier		N

Effect: The PICK logical input value in the current event report is returned. This consists of a PICK status, a segment name and the pick identifier associated with the primitive within the segment that was picked.

References:

4.8.4
4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
150 *No input value of the correct class is in the current event report*

GET STRING **WSOP,WSAC,SGOP** **Lmc**

Parameters:

Out character string S

Effect: The STRING logical input value in the current event report is returned.

NOTE. The length of the returned string is less than or equal to the buffer size specified in the workstation state list entry (for this device) in the data record, at the time the event was queued.

References:

4.8.4
4.8.5

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
150 *No input value of the correct class is in the current event report*

5.8 Metafile Functions

WRITE ITEM TO GKSM — WSAC,SGOP — L0a

Parameters:

In	workstation identifier		N
In	item type		I
In	item data record length	(0..n)	I
In	item data record		D

Effect: An item containing non-graphical data provided by the application program is written to the GKSM. The parameters 'item data record' and 'item data record length' define the data to be output whilst 'item type' specifies their type.

NOTE: This function can only be used to transfer non-graphical information to GKSM. Graphical data are sent automatically after a workstation of category MO has been activated.

References:

4.9

Errors:

5 *GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP*
20 *Specified workstation identifier is invalid*
30 *Specified workstation is not active*
32 *Specified workstation is not of category MO*
160 *Item type is not allowed for user items*
161 *Item length is invalid*

GET ITEM TYPE FROM GKSM — WSOP,WSAC,SGOP — L0a

Parameters:

In	workstation identifier		N
Out	item type		I
Out	item data record length	(0..n)	I

Effect: GKS inspects the type of the current item and the length of its data record in the GKSM and returns the type and length back to the application program.

References:

4.9

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
34 *Specified workstation is not of category MI*
162 *No item is left in GKS Metafile input*
163 *Metafile item is invalid*

READ ITEM FROM GKSM **WSOP,WSAC,SGOP** **L0a**

Parameters:

In	workstation identifier		N
In	maximum item data record length	(0..n)	I
Out	item data record		D

Effect: GKS returns the current item on the GKSM back to the application program and then makes the next item in the metafile the current item. If the item data record length is greater than 'maximum item data record length', the excess parts of the item are lost.

NOTE. By specifying 'maximum item data record length' = 0, the current item can be skipped.

Any program which makes use of the access that this function provides to the content of GKSM items is using information that is not part of the standard, viz. the format and content of metafile items

References:

4.9

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
34 *Specified workstation is not of category MI*
162 *No item is left in GKS Metafile input*
163 *Metafile item is invalid*
165 *Content of item data record is invalid for the specified item type*
166 *Maximum item data record length is invalid*

INTERPRET ITEM **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	item type		I
In	item data record length	(0..n)	I
In	item data record		D

Effect: The supplied item is interpreted. This causes appropriate changes in the set of GKS state variables (see **4.9**) and the generation of appropriate graphical output, as determined by the metafile specification.

NOTE. Apart from errors noted below, other GKS errors may occur as a result of interpreting the item.

References:

4.9

Errors:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
161 *Item length is invalid*
163 *Metafile item is invalid*
164 *Item type is not a valid GKS item*
165 *Content of item data record is invalid for the specified item type*
167 *User item cannot be interpreted*
168 *Specified function is not supported in this level of GKS*

5.9 Inquiry Functions

5.9.1 Introduction

Inquiry functions return values from the various state lists. The data types of the values and the default values of the state list entries are summarized in section 6. Errors detected by inquiry functions are reported through an error indicator parameter, see **4.11.2**. The error handling procedure is not called. The list of states in the function heading indicates those states in which the inquiry function can return valid values. Some inquiry functions that retrieve values from the workstation state lists have an input parameter of type 'Enumeration' that can take the following values:

a) SET: the values returned are those provided by the application program.

b) REALIZED: the values returned are those used by the workstation when the actual values are mapped to the available values in the workstation.

Inquiries for predefined representations in the workstation description table (see **5.9.6**) have no such parameter unlike the corresponding inquiries for the representations in the workstation state list (see **5.9.5**). The values of predefined representations are available on the workstation. Thus all values returned from a predefined representation are such that, if used by an application program to set a representation, a subsequent inquiry for that representation in the workstation state list would return the same values whether SET or REALIZED was specified.

5.9.2 Inquiry Function for Operating State Value

INQUIRE OPERATING STATE VALUE GKCL,GKOP,WSOP,WSAC,SGOP L0a

Parameters:

Out	operating state value	(GKCL,GKOP,WSOP,WSAC,SGOP)	E

Effect: The operating state of GKS is returned.

References:

4.11.1
4.11.2

Errors:

none

5.9.3 Inquiry Functions for GKS Description Table

INQUIRE LEVEL OF GKS **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

Out	error indicator		I
Out	level of GKS	(ma,mb,mc,0a,0b,0c,1a,1b,1c,2a,2b,2c)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.10
4.11.2

Errors:

none

INQUIRE LIST OF AVAILABLE WORKSTATION TYPES
GKOP,WSOP,WSAC,SGOP **L0a**

Parameters:

Out	error indicator		I
Out	number of available workstation types	(1..n)	I
Out	list of available workstation types		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.5.1
4.11.2

Errors:

none

INQUIRE WORKSTATION MAXIMUM NUMBERS

GKOP,WSOP,WSAC,SGOP L1a

Parameters:

Out	error indicator		I
Out	maximum number of simultaneously open workstations	(1..n)	I
Out	maximum number of simultaneously active workstations	(1..n)	I
Out	maximum number of workstations associated with segment	(1..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and the values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.5
4.11.2

Errors:

none

INQUIRE MAXIMUM NORMALIZATION TRANSFORMATION NUMBER

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

Out	error indicator		I
Out	maximum normalization transformation number	(1..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.6.1
4.11.2

Errors:

none

5.9.4 Inquiry functions for GKS state list

INQUIRE SET OF OPEN WORKSTATIONS **GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

Out	error indicator		I
Out	number of open workstations	(0..n)	I
Out	set of open workstations		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.5.2
4.11.2

Errors:

none

INQUIRE SET OF ACTIVE WORKSTATIONS **GKOP,WSOP,WSAC,SGOP** **L1a**

Parameters:

Out	error indicator		I
Out	number of active workstations	(0..n)	I
Out	set of active workstations		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.5.2
4.11.2

Errors:

none

INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES GKOP,WSOP,WSAC,SGOP Lma

Parameters:

Out	error indicator			I
Out	current polyline index		(1..n)	I
Out	current polymarker index		(1..n)	I
Out	current text index		(1..n)	I
Out	current character height	WC	>0	R
Out	current character up vector	WC		2×R
Out	current character width	WC	>0	R
Out	current character base vector	WC		2×R
Out	current text path		(RIGHT,LEFT,UP,DOWN)	E
Out	current text alignment (NORMAL,LEFT,CENTRE,RIGHT;NORMAL,TOP,CAP,HALF,BASE,BOTTOM)			2×E
Out	current fill area index		(1..n)	I
Out	current pattern width vector	WC		2×R
Out	current pattern height vector	WC		2×R
Out	current pattern reference point	WC		P

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.4.2
4.11.2

Errors:

none

INQUIRE CURRENT PICK IDENTIFIER VALUE GKOP,WSOP,WSAC,SGOP L1b

Parameters:

Out	error indicator	I
Out	current pick identifier	N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.4.2
4.7.1
4.11.2

Errors:

none

INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES

GKOP,WSOP,WSAC,SGOP Lma

Parameters:

Out	error indicator		I
Out	current linetype	(-n..-1,1..n)	I
Out	current linewidth scale factor	≥ 0	R
Out	current polyline colour index	(0..n)	I
Out	current marker type	(-n..-1,1..n)	I
Out	current marker size scale factor	≥ 0	R
Out	current polymarker colour index	(0..n)	I
Out	current text font and precision	(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)
Out	current character expansion factor	>0	R
Out	current character spacing		R
Out	current text colour index	(0..n)	I
Out	current fill area interior style	(HOLLOW,SOLID,PATTERN,HATCH)	E
Out	current fill area style index	(-n..-1,1..n)	I
Out	current fill area colour index	(0..n)	I
Out	current list of aspect source flags	(BUNDLED,INDIVIDUAL)	13×E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.4.2
4.11.2

Errors:

none

INQUIRE CURRENT NORMALIZATION TRANSFORMATION NUMBER

GKOP,WSOP,WSAC,SGOP Lma

Parameters:

Out	error indicator		I
Out	current normalization transformation number	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.6.1
4.11.2

Errors:

none

INQUIRE LIST OF NORMALIZATION TRANSFORMATION NUMBERS

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

Out	error indicator	I
Out	list of transformation numbers	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters. The transformation numbers are returned in a list, which is ordered by viewport input priority, starting with the highest priority transformation number.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.6.1
4.11.2

Errors:

none

INQUIRE NORMALIZATION TRANSFORMATION

GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	normalization transformation number		(0..n)	I
Out	error indicator			I
Out	window limits	WC		4×R
Out	viewport limits	NDC		4×R

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

50 Transformation number is invalid

References:

4.6.1
4.11.2

Errors:

none

INQUIRE CLIPPING GKOP,WSOP,WSAC,SGOP Lma

Parameters:

Out	error indicator		I
Out	clipping indicator	(CLIP,NOCLIP)	E
Out	clipping rectangle	NDC	4×R

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

References:

4.6.2
4.11.2

Errors:

none

INQUIRE NAME OF OPEN SEGMENT SGOP L1a

Parameters:

Out	error indicator	I
Out	name of open segment	N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

4 GKS not in proper state: GKS shall be in the state SGOP

References:

4.7.1
4.11.2

Errors:

none

INQUIRE SET OF SEGMENT NAMES IN USE — WSOP,WSAC,SGOP — L1a

Parameters:

Out	error indicator		I
Out	number of segment names	(0..n)	I
Out	set of segment names in use		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP

References:

4.7.1
4.11.2

Errors:

none

INQUIRE MORE SIMULTANEOUS EVENTS — WSOP,WSAC,SGOP — Lmc

Parameters:

Out	error indicator		I
Out	more simultaneous events	(NOMORE,MORE)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to the following error number to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP

References:

4.8.5
4.11.2

Errors:

none

5.9.5 Inquiry functions for workstation state list

INQUIRE WORKSTATION CONNECTION AND TYPE WSOP,WSAC,SGOP Lma

Parameters:

In	workstation identifier	N
Out	error indicator	I
Out	connection identifier	N
Out	workstation type	N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open

References:

4.5.2
4.11.2

Errors:

none

INQUIRE WORKSTATION STATE WSOP,WSAC,SGOP L0a

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	workstation state	(INACTIVE,ACTIVE)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT

References:

4.5.2
4.11.2

Errors:

none

INQUIRE WORKSTATION DEFERRAL AND UPDATE STATES

WSOP,WSAC,SGOP **L0a**

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	deferral mode	(ASAP,BNIG,BNIL,ASTI)	E
Out	implicit regeneration mode	(SUPPRESSED,ALLOWED)	E
Out	display surface empty	(EMPTY,NOTEMPTY)	E
Out	new frame action necessary at update	(NO,YES)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage

References:

4.5.3
4.5.4
4.11.2

Errors:

none

INQUIRE LIST OF POLYLINE INDICES

WSOP,WSAC,SGOP **L1a**

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of polyline bundle table entries	(5..n)	I
Out	list of defined polyline indices	(1..n)	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage

References:

4.4.3
4.11.2

Errors:

none

INQUIRE POLYLINE REPRESENTATION **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	workstation identifier		N
In	polyline index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	linetype	(-n..-1,1..n)	I
Out	linewidth scale factor	≥ 0	R
Out	polyline colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified polyline index is not present in the polyline bundle table on the workstation and the specified type of returned values is REALIZED, the representation for polyline index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage
60 Polyline index is invalid
61 A representation for the specified polyline index has not been defined on this workstation

References:

4.4.3
4.11.2

Errors:

none

INQUIRE LIST OF POLYMARKER INDICES WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of polymarker bundle table entries	(5..n)	I
Out	list of defined polymarker indices	(1..n)	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage

References:

4.4.4
4.11.2

Errors:

none

INQUIRE POLYMARKER REPRESENTATION WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
In	polymarker index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	marker type	(-n..-1,1..n)	I
Out	marker size scale factor	≥ 0	R
Out	polymarker colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified polymarker index is not present in the polymarker bundle table on the workstation and the specified type of returned values is REALIZED, the representation for polymarker index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage
66 Polymarker index is invalid

67 A representation for the specified polymarker index has not been defined on this workstation

References:

4.4.4
4.11.2

Errors:

none

INQUIRE LIST OF TEXT INDICES — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of text bundle table entries	(6..n)	I
Out	list of defined text indices	(1..n)	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage

References:

4.4.5
4.11.2

Errors:

none

INQUIRE TEXT REPRESENTATION — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier		N
In	text index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	text font and precision	(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)
Out	character expansion factor	>0	R
Out	character spacing		R
Out	text colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified text index is not present in the text bundle table on the workstation and the specified type of returned values is REALIZED, the representation for text index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage
72 Text index is invalid
73 A representation for the specified text index has not been defined on this workstation

References:

4.4.5
4.11.2

Errors:

none

INQUIRE TEXT EXTENT **WSOP,WSAC,SGOP** **Lma**

Parameters:

In	workstation identifier		N
In	text position	WC	P
In	character string		S
Out	error indicator		I
Out	concatenation point	WC	P
Out	text extent parallelogram	WC	4×P

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The extent of the specified character string is computed using the text font and precision, character expansion factor and character spacing currently selected (either via the bundle or individually, depending upon the corresponding ASFs) and the current text attributes (CHARACTER HEIGHT, CHARACTER WIDTH, CHARACTER UP VECTOR, CHARACTER BASE VECTOR, TEXT PATH, TEXT ALIGNMENT). If the current text index is not present in the text bundle table, text index 1 is used.

At precisions STRING and CHAR, the text extent parallelogram is an approximation of that defined in **4.4.5**, being the minimum which completely encloses the character bodies of the displayed string (see figure 16). For UP and DOWN text paths, the widest character body in the font is enclosed. The parallelogram is returned as four corner points in anticlockwise order. If, at STROKE precision, the CHARACTER WIDTH VECTOR and CHARACTER BASE VECTOR are perpendicular, the text extent parallelogram is a rectangle.

The concatenation point can be used as the origin of a subsequent TEXT output primitive for the concatenation of character strings, where meaningful. For certain combinations of TEXT PATH and TEXT ALIGNMENT, concatenation is not meaningful and the returned concatenation point is the same as the text position.

If TEXT PATH is RIGHT or LEFT, the concatenation point is displaced from the text position, in a direction determined by the horizontal component of TEXT ALIGNMENT. If this component is LEFT, the direction is to the right; if it is CENTRE, the displacement is zero; if it is RIGHT, the direction is to the left. Unless the horizontal component of TEXT ALIGNMENT is CENTRE, the magnitude of the displacement is the width of the text extent parallelogram plus one additional character spacing. (The width of the text extent parallelogram is the length of the sides parallel to the CHARACTER BASE VECTOR.)

If TEXT PATH is UP or DOWN, the concatenation point is displaced from the text position in a direction determined by the vertical component of TEXT ALIGNMENT. If this component is TOP or CAP, the direction is down; if it is HALF, the displacement is zero; if it is BASE or BOTTOM, the direction is up. Unless the vertical component of TEXT ALIGNMENT is HALF, the magnitude of the displacement is the height of the text extent parallelogram plus an additional character spacing. (The height of the text extent parallelogram is the length of the sides parallel to the CHARACTER UP VECTOR.)

Control characters in the character string have a workstation dependent effect consistent with their treatment in the TEXT function (see **5.3**).

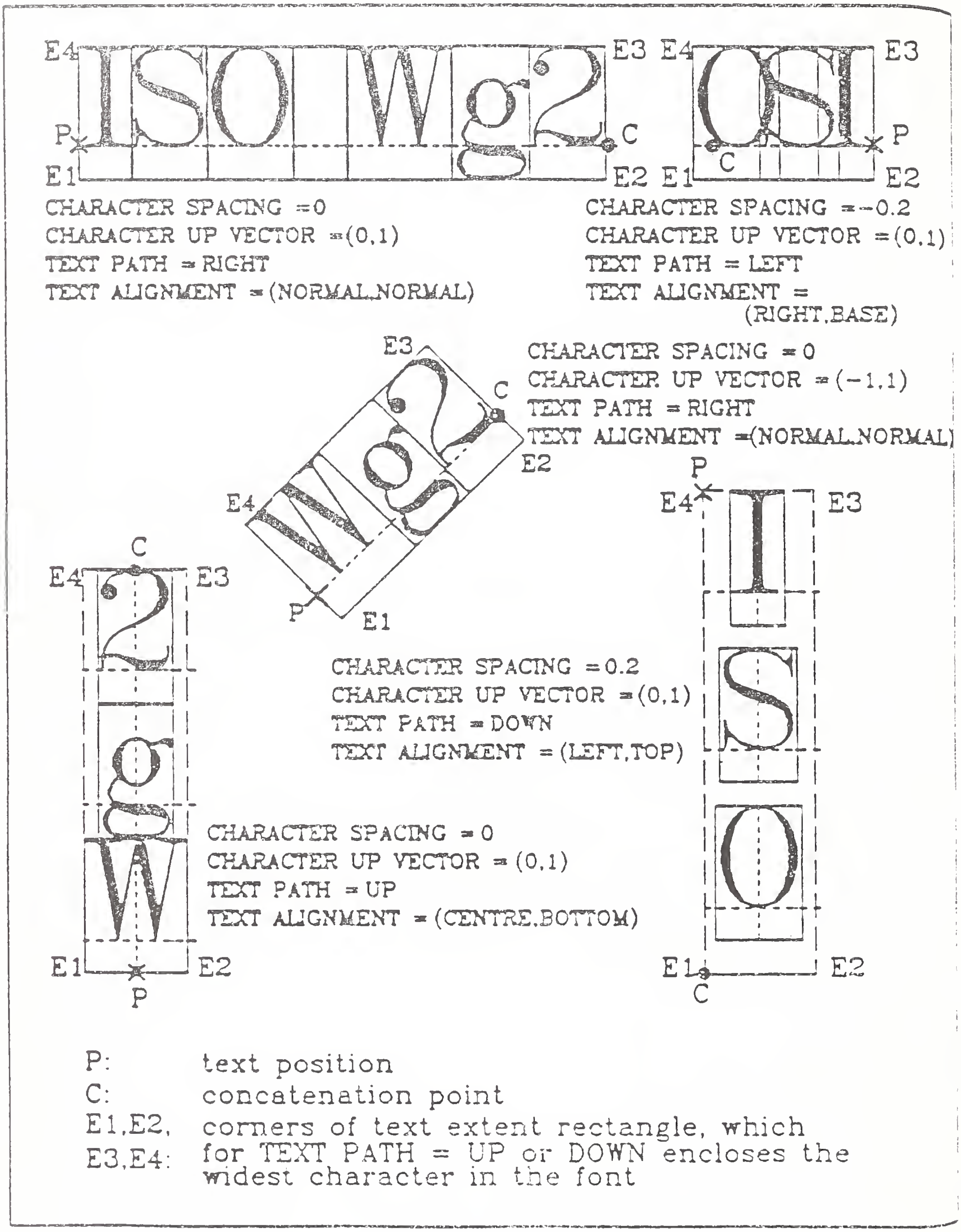


Figure 16. Examples of replies to INQUIRE TEXT EXTENT with different text attributes.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
39 *Specified workstation is neither of category OUTPUT nor of category OUTIN*
101 *Invalid code in string*

References:

4.4.5
4.11.2

Errors:

none

INQUIRE LIST OF FILL AREA INDICES — WSOP,WSAC,SGOP — L1a

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of fill area bundle table entries	(5..n)	I
Out	list of defined fill area indices	(1..n)	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*

References:

4.4.6
4.11.2

Errors:

none

INQUIRE FILL AREA REPRESENTATION WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
In	fill area index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	fill area interior style	(HOLLOW,SOLID,PATTERN,HATCH)	E
Out	fill area style index	(-n..-1,1..n)	I
Out	fill area colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified fill area index is not present in the fill area bundle table on the workstation and the specified type of returned values is REALIZED, the representation for fill area index 1 is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*
35 *Specified workstation is of category INPUT*
36 *Specified workstation is Workstation Independent Segment Storage*
80 *Fill area index is invalid*
81 *A representation for the specified fill area index has not been defined on this workstation*

References:

4.4.6
4.11.2

Errors:

none

INQUIRE LIST OF PATTERN INDICES WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of pattern table entries	(0..n)	I
Out	list of pattern indices	(1..n)	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 *GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP*
20 *Specified workstation identifier is invalid*
25 *Specified workstation is not open*
33 *Specified workstation is of category MI*

35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage

References:

4.4.6
4.11.2

Errors:
none

INQUIRE PATTERN REPRESENTATION WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
In	pattern index	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	pattern array dimensions	(1..n)	2×I
Out	pattern array	(0..n)	n×n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified pattern index is not present in the pattern table on the workstation and the specified type of returned values is REALIZED, the representation for pattern index 1 is returned (pattern index 1 is present if interior style PATTERN is supported on the workstation).

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage
85 Specified pattern index is invalid
88 A representation for the specified pattern index has not been defined on this workstation
90 Interior style PATTERN is not supported on this workstation

References:

4.4.6
4.11.2

Errors:
none

INQUIRE LIST OF COLOUR INDICES WSOP,WSAC,SGOP Lma

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of colour table entries	(2..n)	I
Out	list of colour indices	(0..n)	n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage

References:

4.4.9
4.11.2

Errors:

none

INQUIRE COLOUR REPRESENTATION WSOP,WSAC,SGOP Lma

Parameters:

In	workstation identifier		N
In	colour index	(0..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	colour (red,green,blue intensities)	[0,1]	3×R

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the specified colour index is not present in the colour table on the workstation and the specified type of returned values is REALIZED, the representation of the workstation dependent colour index, that would be used if output primitives were displayed with the specified colour index, is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage
93 Colour index is invalid
94 A representation for the specified colour index has not been defined on this workstation

References:

4.4.9
4.11.2

Errors:
none

INQUIRE WORKSTATION TRANSFORMATION WSOP,WSAC,SGOP Lma

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	workstation transformation update state	(NOTPENDING,PENDING)	E
Out	requested workstation window	NDC	4×R
Out	current workstation window	NDC	4×R
Out	requested workstation viewport	DC	4×R
Out	current workstation viewport	DC	4×R

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The workstation transformation update state is PENDING if a workstation transformation change has been requested but not yet provided.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
36 Specified workstation is Workstation Independent Segment Storage

References:

4.6.3
4.11.2

Errors:
none

INQUIRE SET OF SEGMENT NAMES ON WORKSTATION

WSOP,WSAC,SGOP L1a

Parameters:

In	workstation identifier		N
Out	error indicator		I
Out	number of segment names	(0..n)	I
Out	set of stored segments for this workstation		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
33 Specified workstation is of category MI
35 Specified workstation is of category INPUT

References:

4.5.2
4.7.1
4.11.2

Errors:

none

INQUIRE LOCATOR DEVICE STATE

WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation identifier		N
In	locator device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial normalization transformation number	(0..n)	I
Out	initial locator position	WC	P
Out	prompt and echo type	(-n..-1,1..n)	I
Out	echo area	DC	4×R
Out	locator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.8
4.11.2

Errors:

none

INQUIRE STROKE DEVICE STATE — WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation identifier		N
In	stroke device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial normalization transformation number	(0..n)	I
Out	initial number of points	(0..n)	I
Out	initial points in stroke	WC	n×P
Out	prompt and echo type	(-n..-1,1..n)	I
Out	echo area	DC	4×R
Out	stroke data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.8
4.11.2

Errors:

none

INQUIRE VALUATOR DEVICE STATE WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation identifier		N
In	valuator device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial value		R
Out	prompt and echo type	(-n..-1,1..n)	I
Out	echo area	DC	4×R
Out	valuator data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.8
4.11.2

Errors:

none

INQUIRE CHOICE DEVICE STATE WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation identifier		N
In	choice device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial status	(OK,NOCHOICE)	E
Out	initial choice number	(1..n)	I
Out	prompt and echo type	(-n..-1,1..n)	I
Out	echo area	DC	4×R
Out	choice data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN

140 Specified input device is not present on workstation

References:

4.8
4.11.2

Errors:

none

INQUIRE PICK DEVICE STATE **WSOP,WSAC,SGOP** **L1b**

Parameters:

In	workstation identifier		N
In	pick device number	(1..n)	I
In	type of returned values	(SET,REALIZED)	E
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial status	(OK,NOPICK)	E
Out	initial segment		N
Out	initial pick identifier		N
Out	prompt and echo type	(-n..-1,1..n)	I
Out	echo area	DC	4×R
Out	pick data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
37 Specified workstation is not of category OUTIN
140 Specified input device is not present on workstation

References:

4.8
4.11.2

Errors:

none

INQUIRE STRING DEVICE STATE — WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation identifier		N
In	string device number	(1..n)	I
Out	error indicator		I
Out	operating mode	(REQUEST,SAMPLE,EVENT)	E
Out	echo switch	(ECHO,NOECHO)	E
Out	initial string		S
Out	prompt and echo type	(-n..-1,1..n)	I
Out	echo area	DC	4×R
Out	string data record		D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.8
4.11.2

Errors:

none

5.9.6 Inquiry functions for workstation description table

INQUIRE WORKSTATION CATEGORY — GKOP,WSOP,WSAC,SGOP — L0a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	workstation category	(OUTPUT,INPUT,OUTIN,WISS,MO,MI)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist

References:

4.5.1
4.11.2

Errors:

none

INQUIRE WORKSTATION CLASSIFICATION GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	vector, raster, or other type	(VECTOR,RASTER,OTHER)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE DISPLAY SPACE SIZE GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	workstation type			N
Out	error indicator			I
Out	device coordinate units		(METRES,OTHER)	E
Out	maximum display surface size in device coordinate units	DC	>0	2×R
Out	maximum display surface size in raster units		(1..n)	2×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
31 Specified workstation is of category MO
33 Specified workstation is of category MI
36 Specified workstation is Workstation Independent Segment Storage

References:

4.5.1
4.11.2

Errors:

none

INQUIRE DYNAMIC MODIFICATION OF WORKSTATION ATTRIBUTES

GKOP,WSOP,WSAC,SGOP L1a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	polyline bundle representation changeable	(IRG,IMM)	E
Out	polymarker bundle representation changeable	(IRG,IMM)	E
Out	text bundle representation changeable	(IRG,IMM)	E
Out	fill area bundle representation changeable	(IRG,IMM)	E
Out	pattern representation changeable	(IRG,IMM)	E
Out	colour representation changeable	(IRG,IMM)	E
Out	workstation transformation changeable	(IRG,IMM)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

IRG means that implicit regeneration is necessary; IMM means the action is performed immediately.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.5.3
4.11.2

Errors:

none

INQUIRE DEFAULT DEFERRAL STATE VALUES GKOP,WSOP,WSAC,SGOP L1a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	default value for deferral mode	(ASAP,BNIG,BNIL,ASTI)	E
Out	default value for implicit regeneration mode	(SUPPRESSED,ALLOWED)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.5.3
4.11.2

Errors:

none

INQUIRE POLYLINE FACILITIES GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	workstation type			N
Out	error indicator			I
Out	number of available linetypes		(4..n)	I
Out	list of available linetypes		(-n..-1,1..n)	n×I
Out	number of available linewidths		(0..n)	I
Out	nominal linewidth	DC	>0	R
Out	range of linewidths (minimum,maximum)	DC	>0	2×R
Out	number of predefined polyline indices		(0,5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available linewidths is returned as 0, the workstation supports a continuous range of linewidths.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PREDEFINED POLYLINE REPRESENTATION

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
In	predefined polyline index	(1..n)	I
Out	error indicator		I
Out	linetype	(-n..-1,1..n)	I
Out	linewidth scale factor		R
Out	polyline colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
60 Polyline index is invalid
62 A representation for the specified polyline index has not been predefined on this workstation

References:

4.5.1
4.11.2

Errors:

none

INQUIRE POLYMARKER FACILITIES **GKOP,WSOP,WSAC,SGOP** **Lma**

Parameters:

In	workstation type			N
Out	error indicator			I
Out	number of available marker types		(5..n)	I
Out	list of available marker types		(-n..-1,1..n)	n×I
Out	number of available marker sizes		(0..n)	I
Out	nominal marker size	DC	>0	R
Out	range of marker sizes (minimum,maximum)	DC	>0	2×R
Out	number of predefined polymarker indices		(0,5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available marker sizes is returned as 0, the workstation supports a continuous range of marker sizes.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PREDEFINED POLYMARKER REPRESENTATION
GKOP,WSOP,WSAC,SGOP **L0a**

Parameters:

In	workstation type		N
In	predefined polymarker index	(1..n)	I
Out	error indicator		I
Out	marker type	(-n..-1,1..n)	I
Out	marker size scale factor		R
Out	polymarker colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

66 Polymarker index is invalid

68 A representation for the specified polymarker index has not been predefined on this workstation

References:

4.5.1
4.11.2

Errors:

none

INQUIRE TEXT FACILITIES GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	workstation type			N
Out	error indicator			I
Out	number of text font and precision pairs		(1..n)	I
Out	list of text font and precision pairs		(-n..-1,1..n;STRING,CHAR,STROKE)	n×(I;E)
Out	number of available character heights		(0..n)	I
Out	range of character heights (minimum,maximum)	DC	>0	2×R
Out	number of available character expansion factors		(0..n)	I
Out	range of character expansion factors (minimum,maximum)		>0	2×R
Out	number of predefined text indices		(0,2..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available character heights is returned as 0, the workstation supports a continuous range of character heights. If the number of available character expansion factors is returned as 0, the workstation supports a continuous range of character expansion factors. If the available character heights and character expansion factors vary between fonts, the character heights and character expansion factors returned are for font 1.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

22 Specified workstation type is invalid

23 Specified workstation type does not exist

39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PREDEFINED TEXT REPRESENTATION

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
In	predefined text index	(1..n)	I
Out	error indicator		I
Out	text font and precision	(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)
Out	character expansion factor	>0	R
Out	character spacing		R
Out	text colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
72 Text index is invalid
74 A representation for the specified text index has not been predefined on this workstation

References:

4.5.1
4.11.2

Errors:

none

INQUIRE FILL AREA FACILITIES

GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	workstation type		N
Out	error indicator		I
Out	number of available fill area interior styles	(1..n)	I
Out	list of available fill area interior styles	(HOLLOW,SOLID,PATTERN,HATCH)	n×E
Out	number of available hatch styles	(0..n)	I
Out	list of available hatch styles	(-n..-1,1..n)	n×I
Out	number of predefined fill area indices	(0,5..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PREDEFINED FILL AREA REPRESENTATION

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
In	predefined fill area index	(1..n)	I
Out	error indicator		I
Out	fill area interior style	(HOLLOW,SOLID,PATTERN,HATCH)	E
Out	fill area style index	(-n..-1,1..n)	I
Out	fill area colour index	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
80 Fill area index is invalid
82 A representation for the specified fill area index has not been predefined on this workstation

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PATTERN FACILITIES — GKOP,WSOP,WSAC,SGOP — L0a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	number of predefined pattern indices	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PREDEFINED PATTERN REPRESENTATION — GKOP,WSOP,WSAC,SGOP — L0a

Parameters:

In	workstation type		N
In	predefined pattern index	(1..n)	I
Out	error indicator		I
Out	pattern array dimensions	(1..n)	2×I
Out	pattern array	(0..n)	n×n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
85 Specified pattern index is invalid
89 A representation for the specified pattern index has not been predefined on this workstation
90 Interior style PATTERN is not supported on this workstation

References:

4.5.1
4.11.2

Errors:

none

INQUIRE COLOUR FACILITIES GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	workstation type		N
Out	error indicator		I
Out	number of available colours or intensities	(0,2..n)	I
Out	colour available	(COLOUR,MONOCHROME)	E
Out	number of predefined colour indices	(2..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of available colours or intensities is returned as 0, the workstation supports a continuous range of colours or intensities.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE PREDEFINED COLOUR REPRESENTATION GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
In	predefined colour index	(0..n)	I
Out	error indicator		I
Out	colour (red, green, blue intensities)	[0,1]	3×R

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
93 Colour index is invalid
95 A representation for the specified colour index has not been predefined on this workstation

References:

4.5.1
4.11.2

Errors:

none

INQUIRE LIST OF AVAILABLE GENERALIZED DRAWING PRIMITIVES

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	number of available generalized drawing primitives	(0..n)	I
Out	list of GDP identifiers		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE GENERALIZED DRAWING PRIMITIVE

GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	workstation type		N
In	GDP identifier		N
Out	error indicator		I
Out	number of sets of attributes used	(0..n)	I
Out	list of sets of attributes used	(POLYLINE,POLYMARKER,TEXT,FILL AREA)	n×E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
41 Specified workstation type is not able to generate the specified generalized drawing primitive

References:

4.5.1
4.11.2

Errors:

none

INQUIRE MAXIMUM LENGTH OF WORKSTATION STATE TABLES

GKOP,WSOP,WSAC,SGOP Lma

Parameters:

In	workstation type		N
Out	error indicator		I
Out	maximum number of polyline bundle table entries	(0,5..n)	I
Out	maximum number of polymarker bundle table entries	(0,5..n)	I
Out	maximum number of text bundle table entries	(0,2..n)	I
Out	maximum number of fill area bundle table entries	(0,5..n)	I
Out	maximum number of pattern indices	(0..n)	I
Out	maximum number of colour indices	(2..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.11.2

Errors:

none

INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED

GKOP,WSOP,WSAC,SGOP L1a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	number of segment priorities supported	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the number of segment priorities supported is returned as 0, the workstation supports an infinite number of segment priorities.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.7.2
4.11.2

Errors:

none

INQUIRE DYNAMIC MODIFICATION OF SEGMENT ATTRIBUTES

GKOP,WSOP,WSAC,SGOP L1a

Parameters:

In	workstation type		N
Out	error indicator		I
Out	segment transformation changeable	(IRG,IMM)	E
Out	visibility changeable from 'visible' to 'invisible'	(IRG,IMM)	E
Out	visibility changeable from 'invisible' to 'visible'	(IRG,IMM)	E
Out	highlighting changeable	(IRG,IMM)	E
Out	segment priority changeable	(IRG,IMM)	E
Out	adding primitives to the open segment	(IRG,IMM)	E
Out	segment deletion immediately visible	(IRG,IMM)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

IRG means that implicit regeneration is necessary; IMM means the action is performed immediately.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.5.1
4.5.3
4.11.2

Errors:

none

INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES

GKOP,WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation type		N
Out	error indicator		I
Out	number of locator devices	(0..n)	I
Out	number of stroke devices	(0..n)	I
Out	number of valuator devices	(0..n)	I
Out	number of choice devices	(0..n)	I
Out	number of pick devices	(0..n)	I
Out	number of string devices	(0..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
22 *Specified workstation type is invalid*
23 *Specified workstation type does not exist*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*

References:

4.5.1
4.8.1
4.11.2

Errors:

none

INQUIRE DEFAULT LOCATOR DEVICE DATA GKOP,WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation type			N
In	logical input device number		(1..n)	I
Out	error indicator			I
Out	default initial locator position	WC		P
Out	number of available prompt and echo types		(1..n)	I
Out	list of available prompt and echo types		(-n..-1,1..n)	n×I
Out	default echo area	DC		4×R
Out	default locator data record			D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 *GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
22 *Specified workstation type is invalid*
23 *Specified workstation type does not exist*
38 *Specified workstation is neither of category INPUT nor of category OUTIN*
140 *Specified input device is not present on workstation*

References:

4.5.1
4.8.1
4.8.6
4.11.2

Errors:

none

INQUIRE DEFAULT STROKE DEVICE DATA GKOP,WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation type			N
In	logical input device number		(1..n)	I
Out	error indicator			I
Out	maximum input buffer size		(64..n)	I
Out	number of available prompt and echo types		(1..n)	I
Out	list of available prompt and echo types		(-n..-1,1..n)	n×I
Out	default echo area	DC		4×R
Out	default stroke data record			D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

- *8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
- *22 Specified workstation type is invalid*
- *23 Specified workstation type does not exist*
- *38 Specified workstation is neither of category INPUT nor of category OUTIN*
- *140 Specified input device is not present on workstation*

References:

4.5.1
4.8.1
4.8.6
4.11.2

Errors:

none

INQUIRE DEFAULT VALUATOR DEVICE DATA GKOP,WSOP,WSAC,SGOP Lmb

Parameters:

In	workstation type			N
In	logical input device number		(1..n)	I
Out	error indicator			I
Out	default initial value			R
Out	number of available prompt and echo types		(1..n)	I
Out	list of available prompt and echo types		(-n..-1,1..n)	n×I
Out	default echo area	DC		4×R
Out	default valuator data record			D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

- *8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP*
- *22 Specified workstation type is invalid*
- *23 Specified workstation type does not exist*

38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.5.1
4.8.1
4.8.6
4.11.2

Errors:

none

INQUIRE DEFAULT CHOICE DEVICE DATA **GKOP,WSOP,WSAC,SGOP** **Lmb**

Parameters:

In	workstation type			N
In	logical input device number		(1..n)	I
Out	error indicator			I
Out	maximum number of choice alternatives		(1..n)	I
Out	number of available prompt and echo types		(1..n)	I
Out	list of available prompt and echo types		(-n..-1,1..n)	n×I
Out	default echo area	DC		4×R
Out	default choice data record			D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.5.1
4.8.1
4.8.6
4.11.2

Errors:

none

INQUIRE DEFAULT PICK DEVICE DATA — GKOP,WSOP,WSAC,SGOP — L1b

Parameters:

In	workstation type			N
In	logical input device number		(1..n)	I
Out	error indicator			I
Out	number of available prompt and echo types		(1..n)	I
Out	list of available prompt and echo types		(-n..-1,1..n)	n×I
Out	default echo area	DC		4×R
Out	default pick data record			D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
38 Specified workstation is neither of category INPUT nor of category OUTIN
140 Specified input device is not present on workstation

References:

4.5.1
4.8.1
4.8.6
4.11.2

Errors:

none

INQUIRE DEFAULT STRING DEVICE DATA — GKOP,WSOP,WSAC,SGOP — Lmb

Parameters:

In	workstation type			N
In	logical input device number		(1..n)	I
Out	error indicator			I
Out	maximum string buffer size		(72..n)	I
Out	number of available prompt and echo types		(1..n)	I
Out	list of available prompt and echo types		(-n..-1,1..n)	n×I
Out	default echo area	DC		4×R
Out	default string data record			D

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP
22 Specified workstation type is invalid
23 Specified workstation type does not exist
38 Specified workstation is neither of category INPUT nor of category OUTIN

140 Specified input device is not present on workstation

References:

4.5.1
4.8.1
4.8.6
4.11.2

Errors:

none

5.9.7 Inquiry functions for segment state list

INQUIRE SET OF ASSOCIATED WORKSTATIONS **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	segment name		N
Out	error indicator		I
Out	number of associated workstations	(1..n)	I
Out	set of associated workstation identifiers		n×N

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
120 Specified segment name is invalid
122 Specified segment does not exist

References:

4.7
4.11.2

Errors:

none

INQUIRE SEGMENT ATTRIBUTES **WSOP,WSAC,SGOP** **L1a**

Parameters:

In	segment name		N
Out	error indicator		I
Out	segment transformation matrix		2×3×R
Out	visibility	(VISIBLE,INVISIBLE)	E
Out	highlighting	(NORMAL,HIGHLIGHTED)	E
Out	segment priority	[0,1]	R
Out	detectability	(UNDETECTABLE,DETECTABLE)	E

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
120 Specified segment name is invalid
122 Specified segment does not exist

References:

4.7
4.11.2

Errors:

none

5.9.8 Pixel inquiries

INQUIRE PIXEL ARRAY DIMENSIONS **WSOP,WSAC,SGOP** **L0a**

Parameters:

In	workstation identifier			N
In	2 points P,Q	WC		2×P
Out	error indicator			I
Out	dimensions of pixel array		(1..n)	2×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

The points P,Q define a rectangle. By transforming P and Q by the current normalization and workstation transformations, the rectangle is mapped onto the display surface. The number of columns and the number of rows of pixels, whose positions lie within the rectangle, are returned. For this calculation no clipping is applied.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
39 Specified workstation is neither of category OUTPUT nor of category OUTIN

References:

4.11.2

Errors:

none

INQUIRE PIXEL ARRAY WSOP,WSAC,SGOP L0a

Parameters:

In	workstation identifier			N
In	point P	WC		P
In	dimensions of colour index array DX,DY		(1..n)	2×I
Out	error indicator			I
Out	presence of invalid values		(ABSENT,PRESENT)	E
Out	colour index array		(-1..n)	n×n×I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

By transforming P by the current normalization and workstation transformations, it is mapped onto a pixel of the display surface. The colour indices of the array of pixels, whose upper left corner is this pixel (associated with the (1,1) element), are returned in the colour index array. The orientation of the array is such that the first dimension increases as the X device coordinate increases and the second dimension increases as the Y device coordinate decreases. If the colour index corresponding to a particular pixel cannot be ascertained (for example, the point P was transformed such that the position of the pixel is not on the display surface), the value -1 (i.e. invalid) is assigned for that cell.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
40 Specified workstation has no pixel store readback capability
91 Dimensions of colour array are invalid

References:

4.11.2

Errors:

none

INQUIRE PIXEL WSOP,WSAC,SGOP L0a

Parameters:

In	workstation identifier			N
In	point P	WC		P
Out	error indicator			I
Out	colour index		(-1..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

By transforming P by the current normalization and workstation transformations, it is mapped onto a pixel of the display surface. The colour index of this pixel is returned. If a colour index cannot be ascertained (for example, the point P was transformed such that the position of the pixel is not on the display surface), the value -1 (i.e. invalid) is returned.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
20 Specified workstation identifier is invalid
25 Specified workstation is not open
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
40 Specified workstation has no pixel store readback capability

References:

4.11.2

Errors:

none

5.9.9 Inquiry function for GKS error state list

INQUIRE INPUT QUEUE OVERFLOW **WSOP,WSAC,SGOP** **Lmc**

Parameters:

Out	error indicator			I
Out	workstation identifier			N
Out	input class	(LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)		E
Out	logical input device number		(1..n)	I

Effect: If the inquired information is available, the error indicator is returned as 0 and values are returned in the output parameters.

If the input queue has overflowed since OPEN GKS or the last invocation of INQUIRE INPUT QUEUE OVERFLOW, the identification of the logical input device that caused the overflow is returned. The entry is removed from the error state list.

If the inquired information is not available, the values returned in the output parameters are implementation dependent and the error indicator is set to one of the following error numbers to indicate the reason for non-availability:

7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
148 Input queue has not overflowed since GKS was opened or the last invocation of INQUIRE INPUT QUEUE OVERFLOW
149 Input queue has overflowed, but associated workstation has been closed

References:

4.8.5
4.11.2

Errors:

none

5.10 Utility Functions

EVALUATE TRANSFORMATION MATRIX GKOP,WSOP,WSAC,SGOP L1a

Parameters:

In	fixed point	WC or NDC		P
In	shift vector	WC or NDC		2×R
In	rotation angle in radians (positive if anticlockwise)			R
In	scale factors			2×R
In	coordinate switch		(WC,NDC)	E
Out	segment transformation matrix			2×3×R

Effect: The transformation defined by fixed point, shift vector, rotation angle, and scale factors is evaluated and the result is put in the output segment transformation matrix (for use, for example, by INSERT SEGMENT and SET SEGMENT TRANSFORMATION). The coordinate switch determines whether the shift vector and fixed point are given in WC coordinates or NDC coordinates. If WC coordinates are used, the shift vector and the fixed point are transformed by the current normalization transformation. The order of transformation is: scale, rotate (both relative to the specified fixed point), and shift. The elements M_{13} and M_{23} of the resulting 2×3 transformation matrix are in NDC coordinates; the other elements are unitless.

References:

4.7.3

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

ACCUMULATE TRANSFORMATION MATRIX GKOP,WSOP,WSAC,SGOP L1a

Parameters:

In	segment transformation matrix			2×3×R
In	fixed point	WC or NDC		P
In	shift vector	WC or NDC		2×R
In	rotation angle in radians (positive if anticlockwise)			R
In	scale factors			2×R
In	coordinate switch		(WC,NDC)	E
Out	segment transformation matrix			2×3×R

Effect: The transformation defined by fixed point, shift vector, rotation angle, and scale factors is composed with the input segment transformation matrix and the result is returned in the output segment transformation matrix (for use, for example, by INSERT SEGMENT and SET SEGMENT TRANSFORMATION). The coordinate switch determines whether the shift vector and fixed point are given in WC coordinates or NDC coordinates. If WC coordinates are used, the shift vector and the fixed point are transformed by the current normalization transformation. The order of transformation is: specified input matrix, scale, rotate (both relative to the specified fixed point), and shift. The elements M_{13} and M_{23} of the 2×3 input matrix and the resulting 2×3 transformation matrix are in NDC coordinates; the other elements are unitless.

References:

4.7.3

Errors:

8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

5.11 Error Handling

EMERGENCY CLOSE GKS **GKCL,GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

none

Effect: GKS is emergency closed (see **4.12**). The following actions are performed (if possible):

a) CLOSE SEGMENT (if open);

b) UPDATE for all open workstations;

c) DEACTIVATE all active workstations;

d) CLOSE all open workstations;

e) CLOSE GKS.

This function may be called even if the error state is ON. If GKS is already closed (operating state GKCL), no action is taken.

References:

4.12

Errors:

none

ERROR HANDLING **GKCL,GKOP,WSOP,WSAC,SGOP** **L0a**

Parameters:

In	error number as listed in section 5.	I
In	identification of the GKS procedure called by the application program which caused the error detection	N
In	error file	F

NOTE. The last parameter has been defined in OPEN GKS.

Effect: The ERROR HANDLING procedure is called by GKS in any of the error situations listed in section 5. The standard procedure just calls the ERROR LOGGING procedure with the same parameters.

NOTE. The ERROR HANDLING procedure may be replaced by an application program supplied procedure to allow specific reaction to some error situations.

References:

4.12

Errors:

none

ERROR LOGGING GKCL,GKOP,WSOP,WSAC,SGOP L0a

Parameters:

In	error number as listed in section 5.	I
In	identification of the GKS procedure called by the application program which caused the error detection	N
In	error file	F

NOTE: The last parameter has been defined in OPEN GKS.

Effect: The ERROR LOGGING procedure:

a) prints an error message and GKS function identification on the error file;

b) returns to the calling procedure.

References:

4.12

Errors:

none

6 GKS data structures

6.1 Notation and data types

In this section, the contents of the GKS data structures are listed.

The information for each entry includes:

a) the name of the entry;

b) the coordinate system (if appropriate);

c) the permitted values;

d) the data type;

e) the initial value (if appropriate).

The notation used to express the data type, coordinate system and permitted values is also used to describe the parameters of the GKS functions in section 5.

The data type can be a simple type, which is one of the following:

I integer	whole number
R real	floating point number
S string	number of characters and character sequence
P point	2 real values specifying the x- and y-coordinates of a location in WC, NDC or DC space
N name	identification (used for error file, workstation identifier, connection identifier, workstation type, specific escape function identification, GDP identifier, pick identifier, segment name and identification of a GKS function). In a programming language, not all these instances of the name data type need be bound to the same data type in the language.
E enumeration type	a data type comprising a set of values. The set is defined by enumerating the identifiers which denote the values. This type could be mapped, for example, onto scalar types in Pascal, or onto integers in FORTRAN.

Alternatively, the data type can be a combination of simple types, thus:

f) a vector of values, for example, $2 \times R$

g) a matrix of values, for example, $2 \times 3 \times R$

h) a list of values of one type: the type can be a simple type or a vector, for example, $n \times I$ and $n \times 4 \times R$

i) an array of values of simple type, for example, $n \times n \times I$

j) an ordered pair of different types, for example, (I;E)

or it can be:

D data record	a compound data type, the content and structure of which are not defined in this standard.

An occurrence of n merely indicates a variable integer value and does not necessarily relate to other occurrences of n.

How these data types are represented in a given implementation is dependent on the features of the programming language and on the capabilities of the system. Each language dependent layer has to map the GKS data types onto the data types available in the programming language.

For coordinate data, the relevant coordinate system is indicated:

k) WC : world coordinate system;

l) NDC : normalized device coordinate system;

m) DC : device coordinate systems.

See **4.3** for more information about coordinate systems in GKS. It should be pointed out that different coordinate systems may be used in a function call and in the state lists to describe the same entry.

Permitted values can be specified by:

n) a condition, for example, >0 or [0,1]; the latter implies that the value lies between 0 and 1 inclusively;

o) a standard range of integer values, for example, (1..4);

p) a range of integer values in which the maximum is determined by implementation or other constraints, for example (32..n). An occurrence of n does not necessarily imply any relationship with other occurrences of n: n merely denotes a variable integer in this context;

q) a list of values which constitute an enumeration type, for example, (SUPPRESSED,ALLOWED);

r) an ordered list of any of the above.

Initial values, if present, occur on the last column of the data structure lists. The following abbreviations occur:

s) undef: undefined value;

t) i.d: implementation dependent;

u) w.d.t: initial value taken from workstation description table.

If no initial value is given, the value is set by the relevant GKS function.

6.2 Operating state

Operating state value (static variable)	(GKCL,GKOP,WSOP,WSAC,SGOP)	E	GKCL

6.3 GKS description table

level of GKS	(ma,mb,mc,0a,0b,0c,1a,1b,1c,2a,2b,2c)	E	i.d
number of available workstation types	(1..n)	I	i.d
list of available workstation types		n × N	i.d
maximum number of simultaneously open workstations	(1..n)	I	i.d
maximum number of simultaneously active workstations	(1..n)	I	i.d
maximum number of workstations associated with a segment	(1..n)	I	i.d
maximum normalization transformation number	(1..n)	I	i.d

6.4 GKS state list

set of open workstations			n×N	empty
set of active workstations			n×N	empty
current polyline index		(1..n)	I	1
current linetype		(-n..-1,1..n)	I	1
current linewidth scale factor		≥0	R	1.0
current polyline colour index		(0..n)	I	1
current linetype ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current linewidth scale factor ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current polyline colour index ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current polymarker index		(1..n)	I	1
current marker type		(-n..-1,1..n)	I	3
current marker size scale factor		≥0	R	1.0
current polymarker colour index		(0..n)	I	1
current marker type ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current marker size scale factor ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current polymarker colour index ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current text index		(1..n)	I	1
current text font and precision		(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)	1;STRING
current character expansion factor		>0	R	1.0
current character spacing			R	0.0
current text colour index		(0..n)	I	1
current text font and precision ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current character expansion factor ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current character spacing ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current text colour index ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current character height	WC	>0	R	0.01
current character up vector	WC		2×R	0,1
current character width	WC	>0	R	0.01
current character base vector	WC		2×R	1,0
current text path		(RIGHT,LEFT,UP,DOWN)	E	RIGHT
current text alignment (horizontal and vertical)		(NORMAL,LEFT,CENTRE,RIGHT;NORMAL,TOP,CAP,HALF,BASE,BOTTOM)	2×E	(NORMAL;NORMAL)
current fill area index		(1..n)	I	1
current fill area interior style		(HOLLOW,SOLID,PATTERN,HATCH)	E	HOLLOW
current fill area style index		(-n..-1,1..n)	I	1
current fill area colour index		(0..n)	I	1
current fill area interior style ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current fill area style index ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current fill area colour index ASF		(BUNDLED,INDIVIDUAL)	E	INDVDL
current pattern width vector	WC		2×R	1,0
current pattern height vector	WC		2×R	0,1
current pattern reference point	WC		P	(0,0)
current pick identifier			N	language binding dependent
current normalization transformation number		(0..n)	I	0
list of normalization transformations ordered by viewport input priority (initially in numerical order with 0 highest), for every entry:				
normalization transformation number		(0..n)	I	entry number
window	WC		4×R	0,1,0,1
viewport	NDC		4×R	0,1,0,1

clipping indicator	(CLIP,NOCLIP)	E	CLIP
clipping rectangle	NDC	4×R	0,1,0,1
name of open segment		N	undef
set of segment names in use		n×N	empty
set of segment state lists (one state list for every segment: see 6.7)			empty
input queue (one entry for each event report)			empty
for every entry:			
workstation identifier		N	undef
device number	(1..n)	I	undef
last of group of simultaneous events	(LAST,NOTLAST)	E	undef
(a single event is indicated by LAST)			
input class	(LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)	E	undef
if LOCATOR			
normalization transformation number	(0..n)	I	undef
position	WC	2×R	undef
if STROKE			
normalization transformation number	(0..n)	I	undef
number of points	(0..n)	I	undef
points in stroke	WC	n×P	undef
if VALUATOR			
value		R	undef
if CHOICE			
status	(OK,NOCHOICE)	E	undef
choice number	(1..n)	I	undef
if PICK			
status	(OK,NOPICK)	E	undef
segment name		N	undef
pick identifier		N	undef
if STRING			
string		S	undef
current event report containing:			
input class	(NONE,LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)	E	NONE
if LOCATOR			
normalization transformation number	(0..n)	I	undef
position	WC	P	undef
if STROKE			
normalization transformation number	(0..n)	I	undef
number of points	(0..n)	I	undef
points in stroke	WC	n×P	undef
if VALUATOR			
value		R	undef
if CHOICE			
status	(OK,NOCHOICE)	E	undef
choice number	(1..n)	I	undef
if PICK			
status	(OK,NOPICK)	E	undef
segment name		N	undef
pick identifier		N	undef
if STRING			
string		S	undef
more simultaneous events	(NOMORE,MORE)	E	NOMORE

6.5 Workstation state list

One workstation state list exists for every open workstation. For workstations of category MO, the values marked w.d.t in the following list are actually implementation dependent because the workstation description table does not contain the corresponding entries.

Entries in this group exist for all workstation categories			
workstation identifier		N	
connection identifier		N	
workstation type		N	
the above 3 entries are initialised by OPEN WORKSTATION			
Entries in this group do not exist for workstations of category INPUT and MI			
workstation state	(ACTIVE,INACTIVE)	E	INACTIVE
set of stored segments for this workstation		n×N	empty
Entries in this group do not exist for workstations of categories INPUT, WISS and MI			
deferral mode	(ASAP,BNIG,BNIL,ASTI)	E	w.d.t
implicit regeneration mode	(SUPPRESSED,ALLOWED)	E	w.d.t
display surface empty	(EMPTY,NOTEMPTY)	E	EMPTY
new frame action necessary at update	(NO,YES)	E	NO
number of polyline bundle table entries	(5..n)	I	w.d.t
table of defined polyline bundles,			
for every entry:			
polyline index	(1..n)	I	w.d.t
linetype	(-n..-1,1..n)	I	w.d.t
linewidth scale factor	≥0	R	w.d.t
polyline colour index	(0..n)	I	w.d.t
number of polymarker bundle table entries	(5..n)	I	w.d.t
table of defined polymarker bundles,			
for every entry:			
polymarker index	(1..n)	I	w.d.t
marker type	(-n..-1,1..n)	I	w.d.t
marker size scale factor	≥0	R	w.d.t
polymarker colour index	(0..n)	I	w.d.t
number of text bundle table entries	(2..n)	I	w.d.t
table of defined text bundles,			
for every entry:			
text index	(1..n)	I	w.d.t
text font and precision	(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)	w.d.t
character expansion factor	>0	R	w.d.t
character spacing		R	w.d.t
text colour index	(0..n)	I	w.d.t
number of fill area bundle table entries	(5..n)	I	w.d.t
table of defined fill area bundles,			
for every entry:			
fill area index	(1..n)	I	w.d.t
fill area interior style	(HOLLOW,SOLID,PATTERN,HATCH)	E	w.d.t

fill area style index	(-n..-1,1..n)	I	w.d.t
fill area colour index	(0..n)	I	w.d.t
number of pattern table entries	(0..n)	I	w.d.t
table of pattern representations,			
for every entry:			
pattern index	(1..n)	I	w.d.t
pattern array dimensions	(1..n)	2×I	w.d.t
pattern array	(0..n)	n×n×I	w.d.t
number of colour table entries	(2..n)	I	w.d.t
table of colour representations,			
for every entry:			
colour index	(0..n)	I	w.d.t
colour (red, green, blue intensities)	[0,1]	3×R	w.d.t
workstation transformation update state	(NOTPENDING,PENDING)	E	NOTPENDING
requested workstation window	NDC	4×R	0,1,0,1
current workstation window	NDC	4×R	0,1,0,1
requested workstation viewport	DC	4×R	0,xd,0,yd
current workstation viewport	DC	4×R	0,xd,0,yd
	where (xd,yd) is the display space size from the w.d.t		

Entries in this group do not exist for workstations of categories OUTPUT, WISS, MO and MI

for every logical input device of class LOCATOR:			
locator device number	(1..n)	I	w.d.t
operating mode	(REQUEST,SAMPLE,EVENT)	E	REQUEST
echo switch	(ECHO,NOECHO)	E	ECHO
initial normalization transformation number	(0..n)	I	0
initial locator position	WC	P	w.d.t
prompt and echo type	(-n..-1,1..n)	I	1
echo area	DC	4×R	w.d.t
locator data record		D	i.d
for every logical input device of class STROKE:			
stroke device number	(1..n)	I	w.d.t
operating mode	(REQUEST,SAMPLE,EVENT)	E	REQUEST
echo switch	(ECHO,NOECHO)	E	ECHO
initial normalization transformation number	(0..n)	I	undef
initial number of points	(0..n)	I	0
initial points in stroke	WC	n×P	empty
prompt and echo type	(-n..-1,1..n)	I	1
echo area	DC	4×R	w.d.t
stroke data record containing at least:		D	i.d
input buffer size	(1..n)	I	w.d.t

for every logical input device of class VALUATOR:

valuator device number	(1..n)	I	w.d.t
operating mode	(REQUEST,SAMPLE,EVENT)	E	REQUEST
echo switch	(ECHO,NOECHO)	E	ECHO
initial value		R	w.d.t
prompt and echo type	(-n..-1,1..n)	I	1
echo area	DC	4×R	w.d.t
valuator data record containing at least:		D	i.d
low value		R	w.d.t
high value		R	w.d.t

for every logical input device of class CHOICE:

choice device number	(1..n)	I	w.d.t
operating mode	(REQUEST,SAMPLE,EVENT)	E	REQUEST
echo switch	(ECHO,NOECHO)	E	ECHO
initial status	(OK,NOCHOICE)	E	NOCHOICE
initial choice number	(1..n)	I	undef
prompt and echo type	(-n..-1,1..n)	I	1
echo area	DC	4×R	w.d.t
choice data record		D	i.d

for every logical input device of class PICK:

pick device number	(1..n)	I	w.d.t
operating mode	(REQUEST,SAMPLE,EVENT)	E	REQUEST
echo switch	(ECHO,NOECHO)	E	ECHO
initial status	(OK,NOPICK)	E	NOPICK
initial segment		N	undef
initial pick identifier		N	undef
prompt and echo type	(-n..-1,1..n)	I	1
echo area	DC	4×R	w.d.t
pick data record		D	i.d

for every logical input device of class STRING:

string device number	(1..n)	I	w.d.t
operating mode	(REQUEST,SAMPLE,EVENT)	E	REQUEST
echo switch	(ECHO,NOECHO)	E	ECHO
initial string		S	''
prompt and echo type	(-n..-1,1..n)	I	1
echo area	DC	4×R	w.d.t
string data record containing at least:		D	i.d
input buffer size	(1..n)	I	w.d.t
initial cursor position	(1..n)	I	w.d.t

6.6 Workstation description table

There are three special categories of GKS workstation:

a) WISS (Workstation Independent Segment Storage);

b) MO (GKSM Output);

c) MI (GKSM Input).

For levels m, 0 and 1 there is no WISS; for level 2 there is exactly one WISS.

There may be a number of different workstation types for MO and MI to accommodate different metafile formats. These special workstations have a restricted workstation description table.

Further workstation types may be assigned and are implementation dependent, for example:

d) storage tube type 1;

e) flat bed plotter 1.

The workstation description tables cannot be changed by the application program. There is only one workstation description table for each workstation type available in a given implementation.

Entries in this group exist for all workstation categories

workstation type		N	i.d
workstation category	(OUTPUT,INPUT,OUTIN,WISS,MO,MI)	E	i.d

Entries in this group do not exist for workstations of categories WISS, MO and MI

device coordinate units	(METRES,OTHER)	E	i.d
display space size			
(visible area of the display surface or available area on tablet for workstations of category INPUT)			
in device coordinate units	DC >0	2×R	i.d
in raster units	(integer by integer) >0	2×I	i.d
(for vector displays, for example, the raster units give the highest possible resolution; for raster displays, the number of columns and lines of the raster array)			

Entries in this group do not exist for workstations of categories INPUT, WISS, MO and MI

raster or vector display	(VECTOR,RASTER,OTHER)	E	i.d
(VECTOR = vector display, RASTER = raster device, OTHER = other device, for example, vector+ raster)			
dynamic modification accepted for:			
polyline bundle representation	(IRG,IMM)	E	i.d
polymarker bundle representation	(IRG,IMM)	E	i.d
text bundle representation	(IRG,IMM)	E	i.d
fill area bundle representation	(IRG,IMM)	E	i.d
pattern representation	(IRG,IMM)	E	i.d
colour representation	(IRG,IMM)	E	i.d
workstation transformation	(IRG,IMM)	E	i.d
where:			
IRG: implicit regeneration necessary (may be deferred)			
IMM: performed immediately			
default value for:			
deferral mode	(ASAP,BNIG,BNIL,ASTI)	E	i.d
implicit regeneration mode	(SUPPRESSED,ALLOWED)	E	i.d

number of available linetypes		(4..n)	I	i.d
list of available linetypes		(-n..-1,1..n)	n×I	i.d
number of available linewidths		(0..n)	I	i.d
(a value of 0 indicates that a continuous range of linewidths is supported)				
nominal linewidth	DC	>0	R	i.d
minimum linewidth	DC	>0	R	i.d
maximum linewidth	DC	>0	R	i.d
number of predefined polyline indices(bundles)		(5..n)	I	i.d
table of predefined polyline bundles,				
for every entry:				
linetype		(-n..-1,1..n)	I	i.d
linewidth scale factor			R	i.d
polyline colour index (within range of predefined colour indices)		(0..n)	I	i.d
number of available marker types		(5..n)	I	i.d
list of available marker types		(-n..-1,1..n)	n×I	i.d
number of available marker sizes		(0..n)	I	i.d
(a value of 0 indicates that a continuous range of marker sizes is supported)				
nominal marker size	DC	>0	R	i.d
minimum marker size	DC	>0	R	i.d
maximum marker size	DC	>0	R	i.d
number of predefined polymarker indices (bundles)		(5..n)	I	i.d
table of predefined polymarker bundles,				
for every entry:				
marker type		(-n..-1,1..n)	I	i.d
marker size scale factor			R	i.d
polymarker colour index (within range of predefined colour indices)	(0..n)	I	i.d	
number of text font and precision pairs		(1..n)	I	i.d
list of text font and precision pairs		(-n..-1,1..n;STRING,CHAR,STROKE)	n×(I;E)	i.d
number of available character expansion factors		(0..n)	I	i.d
(a value of 0 indicates that a continuous range of character expansion factors is supported)				
minimum character expansion factor		>0	R	i.d
maximum character expansion factor		>0	R	i.d
(if the available character expansion factors vary between fonts, these values are for font 1)				
number of available character heights		(0..n)	I	i.d
(a value of 0 indicates that a continuous range of character heights is supported)				
minimum character height	DC	>0	R	i.d
maximum character height	DC	>0	R	i.d
(if the available character heights vary between fonts, these values are for font 1)				
number of predefined text indices(bundles)		(2..n)	I	i.d
table of predefined text bundles,				
for every entry:				
text font and precision		(-n..-1,1..n;STRING,CHAR,STROKE)	(I;E)	i.d
character expansion factor		>0	R	i.d
character spacing			R	i.d
text colour index (within range of predefined colour indices)		(0..n)	I	i.d
number of available fill area interior styles		(1..4)	I	i.d
list of available fill area interior styles		(HOLLOW,SOLID,PATTERN,HATCH)	n×E	i.d
number of available hatch styles		(0..n)	I	i.d
list of available hatch styles		(-n..-1,1..n)	n×I	i.d

number of predefined fill area indices(bundles)	(5..n)	I	i.d
table of predefined fill area bundles,			
for every entry:			
fill area interior style	(HOLLOW,SOLID,PATTERN,HATCH)	E	i.d
fill area style index	(-n..-1,1..n)	I	i.d
(for interior style PATTERN is within range of predefined pattern indices)			
(for interior style HATCH is within range of available hatch styles)			
fill area colour index (within range of predefined colour indices)	(0..n)	I	i.d
number of predefined pattern indices (representations)	(0..n)	I	i.d
table of predefined pattern representations,			
for every entry:			
pattern array dimensions	(1..n)	2×I	i.d
pattern array	(0..n)	n×n×I	i.d
number of available colours or intensities	(0,2..n)	I	i.d
(a value of 0 indicates that a continuous range of colours is supported)			
colour available	(COLOUR,MONOCHROME)	E	i.d
number of predefined colour indices(representations)	(2..n)	I	i.d
table of predefined colour representations,			
for every entry:		at least entries sero and one	
colour(red, green, blue intensities)	[0,1]	3×R	i.d
number of available generalized drawing primitives	(0..n)	I	i.d
list of available generalised drawing primitives (may be empty),			
for every GDP:			
GDP identifier		N	i.d
number of sets of attributes used	(0..4)	I	i.d
list of sets of attributes used	(POLYLINE,POLYMARKER,TEXT,FILL AREA)	n×E	i.d
maximum number of polyline bundle table entries	(5..n)	I	i.d
maximum number of polymarker bundle table entries	(5..n)	I	i.d
maximum number of text bundle table entries	(2..n)	I	i.d
maximum number of fill area bundle table entries	(5..n)	I	i.d
maximum number of pattern indices	(0..n)	I	i.d
maximum number of colour indices	(2..n)	I	i.d
number of segment priorities supported	(0..n)	I	i.d
(a value of 0 indicates that a continuous range of priorities is supported)			
dynamic modification accepted for:			
segment transformation	(IRG,IMM)	E	i.d
visibility (visible → invisible)	(IRG,IMM)	E	i.d
visibility (invisible → visible)	(IRG,IMM)	E	i.d
highlighting	(IRG,IMM)	E	i.d
segment priority	(IRG,IMM)	E	i.d
adding primitives to open segment overlapping segment of higher priority	(IRG,IMM)	E	i.d
delete segment	(IRG,IMM)	E	i.d
where:			
IRG: implicit regeneration necessary (may be deferred)			
IMM: performed immediately			

Entries in this group do not exist for workstations of categories OUTPUT, WISS, MO and MI

for every logical input device of class LOCATOR:				
locator device number		(1..n)	I	i.d
default initial locator position	WC		P	i.d
number of available prompt and echo types		(1..n)	I	i.d
list of available prompt and echo types		(-n..-1,1..n)	n×I	i.d
default echo area	DC		4×R	i.d
default locator data record			D	i.d
for every logical input device of class STROKE:				
stroke device number		(1..n)	I	i.d
maximum input buffer size		(64..n)	I	i.d
number of available prompt and echo types		(1..n)	I	i.d
list of available prompt and echo types		(-n..-1,1..n)	n×I	i.d
default echo area	DC		4×R	i.d
default stroke data record containing at least:			D	i.d
input buffer size		(1..n)	I	i.d
for every logical input device of class VALUATOR:				
valuator device number		(1..n)	I	i.d
default initial value			R	i.d
number of available prompt and echo types		(1..n)	I	i.d
list of available prompt and echo types		(-n..-1,1..n)	n×I	i.d
default echo area	DC		4×R	i.d
default valuator data record containing at least:			D	i.d
low value			R	i.d
high value			R	i.d
for every logical input device of class CHOICE:				
choice device number		(1..n)	I	i.d
maximum number of choice alternatives		(1..n)	I	i.d
number of available prompt and echo types		(1..n)	I	i.d
list of available prompt and echo types		(-n..-1,1..n)	n×I	i.d
default echo area	DC		4×R	i.d
default choice data record			D	i.d
for every logical input device of class PICK:				
pick device number		(1..n)	I	i.d
number of available prompt and echo types		(1..n)	I	i.d
list of available prompt and echo types		(-n..-1,1..n)	n×I	i.d
default echo area	DC		4×R	i.d
default pick data record			D	i.d
for every logical input device of class STRING:				
string device number		(1..n)	I	i.d
maximum input buffer size		(72..n)	I	i.d
number of available prompt and echo types		(1..n)	I	i.d
list of available prompt and echo types		(-n..-1,1..n)	n×I	i.d
default echo area	DC		4×R	i.d
default string data record containing at least:			D	i.d
input buffer size		(1..n)	I	i.d
initial cursor position		(1..n)	I	1

6.7 Segment state list

One segment state list exists for the open segment and for each stored segment.

segment name		N	
set of associated workstations		n × N	active workstations at create segment
segment transformation matrix (the elements M_{13} and M_{23} are in NDC coordinates and the other elements are unitless)		2 × 3 × R	1,0,0 0,1,0
visibility	(VISIBLE,INVISIBLE)	E	VISIBLE
highlighting	(NORMAL,HIGHLIGHTED)	E	NORMAL
segment priority	[0,1]	R	0
detectability	(UNDETECTABLE,DETECTABLE)	E	UNDETECTABLE

6.8 GKS error state list

error state	(OFF,ON)	E	OFF
error file		N	i.d
identification of one of the logical input devices that caused an input queue overflow:			
workstation identifier		N	undef
input class	(LOCATOR,STROKE,VALUATOR,CHOICE,PICK,STRING)	E	undef
logical input device number	(1..n)	I	undef

Appendix A Function lists

NOTE. This appendix is not part of the Standard, but provides additional information.

A.1 Alphabetic

A.2 Order of appearance

A.2.1 Control functions 5.2

A.2.2 Output functions 5.3

A.2.5 Segment functions 5.6

A.2.5.1 Segment manipulation functions 5.6.1

A.2.5.2 Segment attributes 5.6.2

A.2.6 Input functions 5.7

A.2.6.1 Initialisation of input devices 5.7.1

A.2.6.2 Setting the mode of input devices 5.7.2

A.2.6.3 Request input functions 5.7.3

A.2.6.4 Sample input functions 5.7.4

A.3.2 Level mb

A.3.3 Level mc

A.3.4 Level 0a

A.3.5 Level 0b

none

A.3.6 Level 0c

none

A.3.7 Level 1a

A.3.8 Level 1b

A.3.9 Level 1c

A.3.10 Level 2a

A.3.11 Level 2b

none

A.3.12 Level 2c

none

A.4 Ordered by state

A.4.1 Functions allowed in state GKCL

A.4.2 Functions allowed in state GKOP

A.4.3 Functions not allowed in state WSOP

A.4.4 Functions not allowed in state WSAC

A.4.5 Functions not allowed in state SGOP

A.5 Applicability to workstation groups

Table 3 lists all GKS functions and the workstation categories to which they apply, directly or indirectly.

Table 3. GKS functions and workstation categories to which they apply

GKS Function	Applies to					
Control functions						
OPEN GKS	not applicable					
CLOSE GKS	not applicable					
OPEN WORKSTATION	SS	MO	O	OI	I	MI
CLOSE WORKSTATION	SS	MO	O	OI	I	MI
ACTIVATE WORKSTATION	SS	MO	O	OI		
DEACTIVATE WORKSTATION	SS	MO	O	OI		
CLEAR WORKSTATION	SS	MO	O	OI		
REDRAW ALL SEGMENTS ON WORKSTATION		MO	O	OI		
UPDATE WORKSTATION		MO	O	OI		
SET DEFERRAL STATE		MO	O	OI		
MESSAGE		MO	O	OI	I	
ESCAPE	SS	MO	O	OI	I	MI
Output functions						
POLYLINE	SS	MO	O	OI		
POLYMARKER	SS	MO	O	OI		
TEXT	SS	MO	O	OI		
FILL AREA	SS	MO	O	OI		
CELL ARRAY	SS	MO	O	OI		
GENERALIZED DRAWING PRIMITIVE (GDP)	SS	MO	O	OI		
Output attributes						
SET POLYLINE INDEX	SS	MO	O	OI		
SET LINETYPE	SS	MO	O	OI		
SET LINEWIDTH SCALE FACTOR	SS	MO	O	OI		
SET POLYLINE COLOUR INDEX	SS	MO	O	OI		
SET POLYMARKER INDEX	SS	MO	O	OI		
SET MARKER TYPE	SS	MO	O	OI		
SET MARKER SIZE SCALE FACTOR	SS	MO	O	OI		
SET POLYMARKER COLOUR INDEX	SS	MO	O	OI		
SET TEXT INDEX	SS	MO	O	OI		
SET TEXT FONT AND PRECISION	SS	MO	O	OI		
SET CHARACTER EXPANSION FACTOR	SS	MO	O	OI		
SET CHARACTER SPACING	SS	MO	O	OI		
SET TEXT COLOUR INDEX	SS	MO	O	OI		
SET CHARACTER HEIGHT	SS	MO	O	OI		
SET CHARACTER UP VECTOR	SS	MO	O	OI		
SET TEXT PATH	SS	MO	O	OI		
SET TEXT ALIGNMENT	SS	MO	O	OI		
SET FILL AREA INDEX	SS	MO	O	OI		
SET FILL AREA INTERIOR STYLE	SS	MO	O	OI		
SET FILL AREA STYLE INDEX	SS	MO	O	OI		
SET FILL AREA COLOUR INDEX	SS	MO	O	OI		
SET PATTERN SIZE	SS	MO	O	OI		
SET PATTERN REFERENCE POINT	SS	MO	O	OI		
SET ASPECT SOURCE FLAGS	SS	MO	O	OI		
SET PICK IDENTIFIER	SS	MO	O	OI		
SET POLYLINE REPRESENTATION		MO	O	OI		
SET POLYMARKER REPRESENTATION		MO	O	OI		
SET TEXT REPRESENTATION		MO	O	OI		
SET FILL AREA REPRESENTATION		MO	O	OI		
SET PATTERN REPRESENTATION		MO	O	OI		
SET COLOUR REPRESENTATION		MO	O	OI		
Transformation functions						
SET WINDOW	SS	MO	O	OI	I	
SET VIEWPORT	SS	MO	O	OI	I	
SET VIEWPORT INPUT PRIORITY	SS	MO	O	OI	I	
SELECT NORMALIZATION TRANSFORMATION	SS	MO	O	OI	I	
SET CLIPPING INDICATOR	SS	MO	O	OI		

GKS Function	Applies to					
SET WORKSTATION WINDOW		MO	O	OI	I	
SET WORKSTATION VIEWPORT		MO	O	OI	I	
Segment functions						
CREATE SEGMENT	SS	MO	O	OI		
CLOSE SEGMENT	SS	MO	O	OI		
RENAME SEGMENT	SS	MO	O	OI		
DELETE SEGMENT	SS	MO	O	OI		
DELETE SEGMENT FROM WORKSTATION	SS	MO	O	OI		
ASSOCIATE SEGMENT WITH WORKSTATION	SS	MO	O	OI		
COPY SEGMENT TO WORKSTATION	(SS)	MO	O	OI		
INSERT SEGMENT	SS	MO	O	OI		
SET SEGMENT TRANSFORMATION	SS	MO	O	OI		
SET VISIBILITY	SS	MO	O	OI		
SET HIGHLIGHTING	SS	MO	O	OI		
SET SEGMENT PRIORITY	SS	MO	O	OI		
SET DETECTABILITY	SS	MO	O	OI		
Input functions						
INITIALISE LOCATOR				OI	I	
INITIALISE STROKE				OI	I	
INITIALISE VALUATOR				OI	I	
INITIALISE CHOICE				OI	I	
INITIALISE PICK				OI		
INITIALISE STRING				OI	I	
SET LOCATOR MODE				OI	I	
SET STROKE MODE				OI	I	
SET VALUATOR MODE				OI	I	
SET CHOICE MODE				OI	I	
SET PICK MODE				OI		
SET STRING MODE				OI	I	
REQUEST LOCATOR				OI	I	
REQUEST STROKE				OI	I	
REQUEST VALUATOR				OI	I	
REQUEST CHOICE				OI	I	
REQUEST PICK				OI		
REQUEST STRING				OI	I	
SAMPLE LOCATOR				OI	I	
SAMPLE STROKE				OI	I	
SAMPLE VALUATOR				OI	I	
SAMPLE CHOICE				OI	I	
SAMPLE PICK				OI		
SAMPLE STRING				OI	I	
AWAIT EVENT				OI	I	
FLUSH DEVICE EVENTS				OI	I	
GET LOCATOR				OI	I	
GET STROKE				OI	I	
GET VALUATOR				OI	I	
GET CHOICE				OI	I	
GET PICK				OI		
GET STRING				OI	I	
Metafile functions						
WRITE ITEM TO GKSM		MO				
GET ITEM TYPE FROM GKSM						MI
READ ITEM FROM GKSM						MI
INTERPRET ITEM	SS	MO	O	OI	I	
Inquiry functions						
INQUIRE OPERATING STATE VALUE	not applicable					
INQUIRE LEVEL OF GKS	not applicable					
INQUIRE LIST OF AVAILABLE WORKSTATION TYPES	not applicable					
INQUIRE WORKSTATION MAXIMUM NUMBERS	not applicable					
INQUIRE MAXIMUM NORMALIZATION TRANSFORMATION NUMBER	not applicable					

GKS Function	Applies to					
INQUIRE SET OF OPEN WORKSTATIONS	not applicable					
INQUIRE SET OF ACTIVE WORKSTATIONS	not applicable					
INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES	not applicable					
INQUIRE CURRENT PICK IDENTIFIER VALUE	not applicable					
INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES	not applicable					
INQUIRE CURRENT NORMALIZATION TRANSFORMATION NUMBER	not applicable					
INQUIRE LIST OF NORMALIZATION TRANSFORMATION NUMBERS	not applicable					
INQUIRE NORMALIZATION TRANSFORMATION	not applicable					
INQUIRE CLIPPING	not applicable					
INQUIRE NAME OF OPEN SEGMENT	not applicable					
INQUIRE SET OF SEGMENT NAMES IN USE	not applicable					
INQUIRE MORE SIMULTANEOUS EVENTS	not applicable					
INQUIRE WORKSTATION CONNECTION AND TYPE	SS	MO	O	OI	I	MI
INQUIRE WORKSTATION STATE	SS	MO	O	OI		
INQUIRE WORKSTATION DEFERRAL AND UPDATE STATES		MO	O	OI		
INQUIRE LIST OF POLYLINE INDICES		MO	O	OI		
INQUIRE POLYLINE REPRESENTATION		MO	O	OI		
INQUIRE LIST OF POLYMARKER INDICES		MO	O	OI		
INQUIRE POLYMARKER REPRESENTATION		MO	O	OI		
INQUIRE LIST OF TEXT INDICES		MO	O	OI		
INQUIRE TEXT REPRESENTATION		MO	O	OI		
INQUIRE TEXT EXTENT			O	OI		
INQUIRE LIST OF FILL AREA INDICES		MO	O	OI		
INQUIRE FILL AREA REPRESENTATION		MO	O	OI		
INQUIRE LIST OF PATTERN INDICES		MO	O	OI		
INQUIRE PATTERN REPRESENTATION		MO	O	OI		
INQUIRE LIST OF COLOUR INDICES		MO	O	OI		
INQUIRE COLOUR REPRESENTATION		MO	O	OI		
INQUIRE WORKSTATION TRANSFORMATION		MO	O	OI	I	
INQUIRE SET OF SEGMENT NAMES ON WORKSTATION	SS	MO	O	OI		
INQUIRE LOCATOR DEVICE STATE				OI	I	
INQUIRE STROKE DEVICE STATE				OI	I	
INQUIRE VALUATOR DEVICE STATE				OI	I	
INQUIRE CHOICE DEVICE STATE				OI	I	
INQUIRE PICK DEVICE STATE				OI		
INQUIRE STRING DEVICE STATE				OI	I	
INQUIRE WORKSTATION CATEGORY	SS	MO	O	OI	I	MI
INQUIRE WORKSTATION CLASSIFICATION			O	OI		
INQUIRE DISPLAY SPACE SIZE			O	OI	I	
INQUIRE DYNAMIC MODIFICATION OF WORKSTATION ATTRIBUTES			O	OI		
INQUIRE DEFAULT DEFERRAL STATE VALUES			O	OI		
INQUIRE POLYLINE FACILITIES			O	OI		
INQUIRE PREDEFINED POLYLINE REPRESENTATION			O	OI		
INQUIRE POLYMARKER FACILITIES			O	OI		
INQUIRE PREDEFINED POLYMARKER REPRESENTATION			O	OI		
INQUIRE TEXT FACILITIES			O	OI		
INQUIRE PREDEFINED TEXT REPRESENTATION			O	OI		
INQUIRE FILL AREA FACILITIES			O	OI		
INQUIRE PREDEFINED FILL AREA REPRESENTATION			O	OI		
INQUIRE PATTERN FACILITIES			O	OI		
INQUIRE PREDEFINED PATTERN REPRESENTATION			O	OI		
INQUIRE COLOUR FACILITIES			O	OI		
INQUIRE PREDEFINED COLOUR REPRESENTATION			O	OI		
INQUIRE LIST OF AVAILABLE GENERALIZED DRAWING PRIMITIVES			O	OI		
INQUIRE GENERALIZED DRAWING PRIMITIVE			O	OI		
INQUIRE MAXIMUM LENGTH OF WORKSTATION STATE TABLES			O	OI		
INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED			O	OI		
INQUIRE DYNAMIC MODIFICATION OF SEGMENT ATTRIBUTES			O	OI		
INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES				OI	I	
INQUIRE DEFAULT LOCATOR DEVICE DATA				OI	I	
INQUIRE DEFAULT STROKE DEVICE DATA				OI	I	
INQUIRE DEFAULT VALUATOR DEVICE DATA				OI	I	
INQUIRE DEFAULT CHOICE DEVICE DATA				OI	I	
INQUIRE DEFAULT PICK DEVICE DATA				OI		

GKS Function	Applies to				
INQUIRE DEFAULT STRING DEVICE DATA				OI	I
INQUIRE SET OF ASSOCIATED WORKSTATIONS	SS	MO	O	OI	
INQUIRE SEGMENT ATTRIBUTES	SS	MO	O	OI	
INQUIRE PIXEL ARRAY DIMENSIONS			O	OI	
INQUIRE PIXEL ARRAY			O	OI	
INQUIRE PIXEL			O	OI	
INQUIRE INPUT QUEUE OVERFLOW	not applicable				
Utility functions					
EVALUATE TRANSFORMATION MATRIX	not applicable				
ACCUMULATE TRANSFORMATION MATRIX	not applicable				
Error handling					
EMERGENCY CLOSE GKS	not applicable				
ERROR HANDLING	not applicable				
ERROR LOGGING	not applicable				

Key:

- SS Workstation Independent Segment Storage
- MO workstation of category MO
- O workstation of category OUTPUT
- OI workstation of category OUTIN
- I workstation of category INPUT
- MI workstation of category MI
- (SS) Workstation Independent Segment Storage is fundamental to the operation of this GKS function, but the workstation identifier parameter cannot be Workstation Independent Segment Storage

Appendix B Error list

NOTE. This appendix is not part of the Standard, but provides additional information.

B.1 Implementation dependent

<0 Implementation dependent errors

B.2 States

1 GKS not in proper state: GKS shall be in the state GKCL
2 GKS not in proper state: GKS shall be in the state GKOP
3 GKS not in proper state: GKS shall be in the state WSAC
4 GKS not in proper state: GKS shall be in the state SGOP
5 GKS not in proper state: GKS shall be either in the state WSAC or in the state SGOP
6 GKS not in proper state: GKS shall be either in the state WSOP or in the state WSAC
7 GKS not in proper state: GKS shall be in one of the states WSOP, WSAC or SGOP
8 GKS not in proper state: GKS shall be in one of the states GKOP, WSOP, WSAC or SGOP

B.3 Workstations

20 Specified workstation identifier is invalid
21 Specified connection identifier is invalid
22 Specified workstation type is invalid
23 Specified workstation type does not exist
24 Specified workstation is open
25 Specified workstation is not open
26 Specified workstation cannot be opened
27 Workstation Independent Segment Storage is not open
28 Workstation Independent Segment Storage is already open
29 Specified workstation is active
30 Specified workstation is not active
31 Specified workstation is of category MO
32 Specified workstation is not of category MO
33 Specified workstation is of category MI
34 Specified workstation is not of category MI
35 Specified workstation is of category INPUT
36 Specified workstation is Workstation Independent Segment Storage
37 Specified workstation is not of category OUTIN
38 Specified workstation is neither of category INPUT nor of category OUTIN
39 Specified workstation is neither of category OUTPUT nor of category OUTIN
40 Specified workstation has no pixel store readback capability
41 Specified workstation type is not able to generate the specified generalized drawing primitive
42 Maximum number of simultaneously open workstations would be exceeded
43 Maximum number of simultaneously active workstations would be exceeded

B.4 Transformations

50 Transformation number is invalid
51 Rectangle definition is invalid
52 Viewport is not within the Normalized Device Coordinate unit square
53 Workstation window is not within the Normalized Device Coordinate unit square
54 Workstation viewport is not within the display space

B.5 Output attributes

60 Polyline index is invalid
61 A representation for the specified polyline index has not been defined on this workstation
62 A representation for the specified polyline index has not been predefined on this workstation
63 Linetype is equal to zero
64 Specified linetype is not supported on this workstation
65 Linewidth scale factor is less than zero
66 Polymarker index is invalid
67 A representation for the specified polymarker index has not been defined on this workstation
68 A representation for the specified polymarker index has not been predefined on this workstation
69 Marker type is equal to zero
70 Specified marker type is not supported on this workstation
71 Marker size scale factor is less than zero
72 Text index is invalid
73 A representation for the specified text index has not been defined on this workstation
74 A representation for the specified text index has not been predefined on this workstation
75 Text font is equal to zero
76 Requested text font is not supported for the specified precision on this workstation
77 Character expansion factor is less than or equal to zero
78 Character height is less than or equal to zero
79 Length of character up vector is zero
80 Fill area index is invalid
81 A representation for the specified fill area index has not been defined on this workstation
82 A representation for the specified fill area index has not been predefined on this workstation
83 Specified fill area interior style is not supported on this workstation
84 Style (pattern or hatch) index is equal to zero
85 Specified pattern index is invalid
86 Specified hatch style is not supported on this workstation
87 Pattern size value is not positive
88 A representation for the specified pattern index has not been defined on this workstation
89 A representation for the specified pattern index has not been predefined on this workstation
90 Interior style PATTERN is not supported on this workstation
91 Dimensions of colour array are invalid
92 Colour index is less than zero
93 Colour index is invalid
94 A representation for the specified colour index has not been defined on this workstation
95 A representation for the specified colour index has not been predefined on this workstation
96 Colour is outside range [0,1]
97 Pick identifier is invalid

B.6 Output primitives

100 Number of points is invalid
101 Invalid code in string
102 Generalized drawing primitive identifier is invalid
103 Content of generalized drawing primitive data record is invalid
104 At least one active workstation is not able to generate the specified generalized drawing primitive
105 At least one active workstation is not able to generate the specified generalized drawing primitive under the current transformations and clipping rectangle

B.7 Segments

- *120 Specified segment name is invalid*
- *121 Specified segment name is already in use*
- *122 Specified segment does not exist*
- *123 Specified segment does not exist on specified workstation*
- *124 Specified segment does not exist on Workstation Independent Segment Storage*
- *125 Specified segment is open*
- *126 Segment priority is outside the range [0,1]*

B.8 Input

- *140 Specified input device is not present on workstation*
- *141 Input device is not in REQUEST mode*
- *142 Input device is not in SAMPLE mode*
- *143 EVENT and SAMPLE input mode are not available at this level of GKS*
- *144 Specified prompt and echo type is not supported on this workstation*
- *145 Echo area is outside display space*
- *146 Contents of input data record are invalid*
- *147 Input queue has overflowed*
- *148 Input queue has not overflowed since GKS was opened or the last invocation of INQUIRE INPUT QUEUE OVERFLOW*
- *149 Input queue has overflowed, but associated workstation has been closed*
- *150 No input value of the correct class is in the current event report*
- *151 Timeout is invalid*
- *152 Initial value is invalid*
- *153 Number of points in the initial stroke is greater than the buffer size*
- *154 Length of the initial string is greater than the buffer size*

B.9 Metafiles

- *160 Item type is not allowed for user items*
- *161 Item length is invalid*
- *162 No item is left in GKS Metafile input*
- *163 Metafile item is invalid*
- *164 Item type is not a valid GKS item*
- *165 Content of item data record is invalid for the specified item type*
- *166 Maximum item data record length is invalid*
- *167 User item cannot be interpreted*
- *168 Specified function is not supported in this level of GKS*

B.10 Escape

- *180 Specified escape function is not supported*
- *181 Specified escape function identification is invalid*
- *182 Contents of escape data record are invalid*

B.11 Miscellaneous

- *200 Specified error file is invalid*

B.12 System

- *300 Storage overflow has occurred in GKS*
- *301 Storage overflow has occurred in segment storage*
- *302 Input/Output error has occurred while reading*
- *303 Input/Output error has occurred while writing*
- *304 Input/Output error has occurred while sending data to a workstation*
- *305 Input/Output error has occurred while receiving data from a workstation*

306 Input/Output error has occurred during program library management
307 Input/Output error has occurred while reading workstation description table
308 Arithmetic error has occurred

B.13 Reserved errors

Unused error numbers less than 2000 are reserved for future standardization.

Error numbers 2000-3999 are reserved for language bindings.

Error numbers greater than or equal to 4000 are reserved for registration or future standardization.

NOTE. Error numbers are registered in the the ISO International Register of Graphical Items, which is maintained by the Registration Authority. When an error has been approved by the ISO Working Group on Computer Graphics[1], the error number will be assigned by the Registration Authority.

[1] Currently, the Working Group on Computer Graphics is known as ISO/TC97/SC5/WG2.

Appendix C Interfaces

This appendix is not part of the standard, but provides additional information.

C.1 Introduction GKS is described in abstract terms, in order that it may be useful to applications in a wide range of environments such as programming languages and communication protocols. Before it can be used by a particular application program written in a particular programming language (host language), two further stages of specification are required:

a) language binding: the abstract functions and data types of GKS must be instantiated in terms of the constructs available in the host language;

b) implementation: this set of language specific facilities must then be provided using the facilities of a particular machine and operating system.

C.2 Language Binding

A GKS language binding is a document describing how GKS functions are accessed by programs written in a specific language. The following guidelines should be observed when binding GKS to a host language. The object of a binding is to provide the functions and data types of GKS in a natural and efficient manner using the facilities of the host language, without violating the style or design philosophy of the language.

Rule L1: GKS functionalities may be partitioned in a binding so long as this partitioning does not violate the GKS requirement that the GKS operating state or any value in any state list must not be in an ambiguous state between function invocations.

This guideline allows the binding to map single GKS abstract functions into sequences of language functions called by the application program, as long as the state of GKS is well-defined between each step in the sequence. This does not imply that such factoring should be done for its own sake, but only that it is allowed when other considerations make it desirable.

Rule L2: GKS functions should be bound in such a manner that the functionality of GKS could be, wherever possible, extended without requiring alterations to existing application programs.

The intent of this guideline is to allow possible future extensions of GKS without making obsolete applications based on GKS. An example is the addition of new attributes and the impact of this extension on setting and inquiring bundle contents.

Rule L3: The binding of GKS functions should observe the principles of good human factors engineering.

Function names should be easy to remember and associate with their functionality. In a subroutine binding, the maximum number of arguments per routine should be a reasonably small number, perhaps ten.

Rule L4: The language binding should specify a set of function identifiers acceptable to the language.

The names used for GKS functions in the standard are merely tools for describing the semantics of the standard; they should be replaced by actual identifiers conforming to the restrictions of the host language. A one-to-one mapping from abstract functions to language functions is preferred when no other considerations apply.

Rule L5: The language binding should specify, for each of the GKS data types, a corresponding data type acceptable to the language. Where convenient for the host language, additional data types may be specified in terms of the GKS data types.

The data types used in the standard are merely tools for describing the semantics of standard; they should be replaced by actual data types conforming to the restrictions of the host language.

Rule L6: The language binding should specify, for each GKS abstract function, how the corresponding language function or functions are to be invoked, and the means whereby each of the abstract input parameters is transmitted to the language function and the means whereby each of the abstract output parameters is received from the language function.

Where the host language allows, the abstract functions will be mapped onto language functions or procedures. The parameters will typically be transmitted via a parameter list. The items in such a list may either be, or be references to, items of the data types corresponding to the GKS data types, or aggregates of these types.

Rule L7: If the scope rules of the host language are not sufficient to restrict the visibility of identifiers outside a GKS implementation, then the language binding should specify a set of identifiers, acceptable to the language, which may be used by an implementation for internal communication.

An implementation may be unable to restrict its use of externally visable identifiers to those specified as a consequence of guidelines L4-L6. Applications should, therefore, avoid using identifiers from the set specified by guideline L7. The set may consist, for example, of all identifiers beginning with 'GKS.'

Rule L8: The identifiers and data types specified in a language binding should be similar to those in other language bindings if the languages are similar.

It would be detrimental to inter-language and programmer portability if each language binding were designated from scratch with no consideration of existing language bindings. While it is valuable to take advantage of the capabilities of the host language, bindings to similar languages can share many common aspects. For example, two languages that both restrict function identifiers to six alphanumeric characters should use the same set of function identifiers for GKS functions.

Rule L9: ANS GKS functions should be bound in such a manner that the language binding is compatible with the ISO 7942 specification of GKS.

The language binding should not needlessly incorporate features which can create incompatibilities with the ISO 7942 specification. For example, the enumerated type corresponding to the levels of ISO GKS should match those for ANSI GKS.

C.3 Implementation

One form of GKS implementation is a module or library of modules written for a specific programming language and conforming to a GKS language binding. The following guidelines should be observed when implementing GKS. The objective is to provide all the functions of a particular level of GKS in an efficient manner using the facilities available from the host machine and operating system.

Rule I1: The documentation of a GKS implementation should include a list of all identifiers for procedures, functions, global data aggregates, and files that are visible either to an application program or to the underlying operating system.

Because this set of identifiers is, in general, a superset of the names specified by the language binding, programs transported to an implementation from other implementations of the same binding might have used names that clash. Documentation is required to enable potential clashes to be detected (see also rule L7).

Rule I2: Implementations should minimize restrictions of an application program's use of non-graphical I/O facilities provided by the host language or operating system. However, a GKS implementation can assume (but need not guarantee) that it has exclusive control over the non-graphical and graphical resources it is managing. The documentation should include a list of all resources assumed to be reserved for exclusive use by the implementation.

Non-graphical resources reserved by a GKS implementation might include logical unit numbers used to identify graphics devices, and a file for error messages. If other processes outside GKS use a graphics device, such as for output of messages from the computer operator, the results are undefined. Since restricting such use is often impossible, it is not required. This guideline allows an implementation to leave graphics devices in graphics mode between functions, for example.

Rule I3: The documentation of an implementation should specify, for each of the implementation and workstation dependencies, how the dependencies have been resolved.

Several details of the standard have been deliberately unspecified so as to provide implementors with sufficient freedom to adapt to particular computers and operating systems. These are indicated in the text by the words ''implementation dependent''. Others have been left unspecified to allow for adaptation to particular graphics devices. These are indicated in the text by the words ''workstation dependent''. A list of all such details is given as Appendix D. The resolution of each of these details should be documented so that the behaviour of application programs may be predicted.

Rule I4: The documentation of each workstation of an implementation/installation should specify the correspondence between physical input devices and operator actions, and the logical input devices on that workstation (if any).

The correspondence between physical input devices and operator actions, and the logical input devices on a workstation may be static, and not under the control of the application program. These correspondences needs to be documented. It is desirable that workstation implementors provide means whereby these correspondences may be changed, perhaps during a GKS configuration phase. However, any such means lie outside the scope of the standard.

Rule I5: The documentation of a standard implementation should specify the highest level of GKS supported and list any extensions beyond that level. These extensions should be further identified as extensions defined at a higher level of GKS or extensions not defined at any level of GKS.

Extensions must be clearly identified so they can be avoided by application programs that require portability to different implementations. It is preferable that the escape and GDP functions be used to implement non-standard extensions where possible. Extensions not defined in GKS shall not interfere with the correct execution of functions within GKS.

Appendix D Allowable differences in GKS implementations

NOTE. This appendix is not part of the Standard, but provides additional information.

D.1 Introduction

A number of details of GKS are deliberately not specified, so as to provide the freedom to adapt implementations to different environments and different requirements. In particular, GKS is described in abstract terms, so that it can be useful to application programs written in a wide range of programming languages. In a language binding, the abstract GKS functions are embedded in a language dependent layer, according to a number of rules. These rules are set out in Appendix C and are not considered further here.

Other allowable differences fall into two categories:

a) global differences;

b) workstation dependent differences.

The purpose of this Appendix is to itemise these allowable differences. The documentation accompanying a particular implementation needs to list, for each allowable difference, the specific choices made in that implementation.

D.2 Global differences

A number of differences are global in the sense of applying to an implementation as a whole rather than to a particular workstation. These global differences are itemized below.

a) Functional scope:

1) GKS level.

b) Capacity:

1) number of available workstation types;

2) list of available workstation types;

3) maximum number of simultaneously open workstations;

4) maximum number of simultaneously active workstations;

5) maximum number of workstations associated with a segment;

6) maximum normalization transformation number;

7) number of simultaneously definable segments (per workstation);

8) maximum size of input queue;

9) number of fonts available;

10) number of GDP's;

11) number of ESCAPE functions.

c) Miscellaneous:

1) EMERGENCY CLOSE GKS behaviour;

2) actions performed on parameters of inquiry functions if information is unavailable;

3) metafile format used by each workstation type of category MO;

4) font definitions (with the restriction that font numbers greater than 1 may be registered).

5) Internal format of data records

NOTE 1. Items in a) and b) 1) to b) 6) are held in the GKS description table, and can be inquired by an application program.

NOTE 2. As well as specifying 'maximum size of input queue', the documentation needs to specify its interpretation (including the relative lengths of each item if necessary).

NOTE 3. At different GKS levels, certain minimum capabilities are defined in **4.10**.

D.3 Workstation dependent differences

This group of allowable differences provides for a range of workstations to be used in a GKS implementation. The major group of differences are listed as the workstation description table, specified in **6.6**, which forms part of the GKS data structures. Entries in this table may be inquired by an application program.

There are restrictions, however, on the values of some entries; at different GKS levels, certain minimal capabilities of a workstation are defined (see **4.10**).

In addition, a number of further workstation dependent differences are listed here:

a) Control functions:

1) Realization of GKS functions: MESSAGE, ESCAPE;

2) Buffering of deferred actions in deferral modes BNIL, BNIG and ASTI.

b) Output functions and attributes:

1) POLYLINE

i) whether linetype is continuous or restarted, at the start of a polyline, at the start of a clipped piece of a polyline and at each vertex of a polyline;

ii) graphical representation of available linetypes (with the restrictions that linetypes 1 to 4 need to be recognizable as solid, dashed, dotted and dashed-dotted, linetypes greater than 4 may be registered and linetypes less than 0 need to have similar appearance on all workstations on which they are available);

iii) the shape of the ends of lines for certain values of the linewidth scale factor aspect;

2) POLYMARKER

i) graphical representation of available marker types (with the restrictions that marker types 1 to 5 need to be recognizable as dot, plus sign, asterisk, circle and diagonal cross, marker types greater than 5 may be registered and marker types less than 0 need to have similar appearance on all workstations on which they are available);

ii) clipping of markers, whose position is just inside a clipping boundary;

3) TEXT

i) clipping of STRING and CHAR precision text;

ii) for STRING precision, how current settings of the text aspects are taken into account;

iii) for CHAR precision, evaluation of the aspects character expansion factor, CHARACTER HEIGHT, and CHARACTER UP VECTOR;

iv) the effect of control characters in the character string;

4) FILL AREA

i) graphical representation of available hatch styles (with the restriction that hatch styles greater than 0 may be registered and hatch styles less than 0 need to have similar appearance on all workstations on which they are available);

ii) whether patterns and hatching are affected by transformations;

iii) linetype and linewidth for interior style HOLLOW;

5) CELL ARRAY

i) whether CELL ARRAY is fully supported or sometimes simulated and, if the latter, the simulation (minimal action required is to draw the transformed boundaries of the cell rectangle, using implementation dependent colour, linetype and linewidth);

6) GDP

i) realization of each GDP;

7) all primitives

i) colour index used if an output primitive is displayed with a colour index that is not present in the colour table;

ii) on monochrome workstations, algorithm for mapping (red, green, blue) colour values to intensity. A recommended algorithm is:

$$\text{intensity} = 0.30 \times \text{red} + 0.59 \times \text{green} + 0.11 \times \text{blue}$$

as in U.S. colour television systems (NTSC encoding). The resulting intensity is mapped into the nearest available.

iii) what is drawn when points are collinear or points or lines coincide (see **4.5.3**). (All primitives except POLYMARKER.)

c) Segments:

1) picking segments of equal priority;

2) display of overlapping segments of equal priority;

3) realization of highlighting.

d) Input functions:

1) realization of logical input devices (for each logical input device, its measure and trigger need to be described in terms of the physical devices available on a workstation);

2) default prompt and echo type realization;

3) use of input data record for optional parameters.

e) Inquiry

1) values returned by INQUIRE TEXT EXTENT;

2) values returned by PIXEL inquiry functions;

3) answers returned by inquiry when the REALIZED flag is set.

Appendix E Metafile structure

NOTE. This annex does not form an integral part of the standard, but provides additional information.

E.1 Metafiles

E.1.1 Introduction

In section **1**, it states that GKS 'includes functions for storage on and retrieval from an external graphics file'. This external file is called a graphics metafile or metafile. GKS metafiles can be used for a variety of purposes (as stated in **4.9**);

a) transporting graphical information between systems;

b) transporting graphical information from one place to another;

c) transporting graphical information from one GKS application to another;

d) storing accompanying non-graphical information.

These purposes cover different aims including picture capture, structured picture capture and session capture, the latter also being called audit trail. The graphical information needed for these aims corresponds to different types of metafile. For picture capture, some output-related functions (such as those that manipulate segments) may be recorded as the resulting set of primitives and their attributes. For structured picture capture or session capture, all functions that GKS sends to the workstation need to be recorded.

The encoding mechanism used for writing the metafile may depend on the application or environment, for example:

e) encoding within the rules of ISO 2022 to enable network transfer;

f) binary encoding to ease storage on a machine for later use on that machine or to minimize the processing requirement;

g) clear text encoding to enable transfer between highly different computer architectures and easy editing.

The specification of the format and content of a metafile is not part of GKS. GKS only specifies the interface to the metafile. An implementation of GKS may support any number of workstation types of category MI or MO. The user may select the most appropriate of these depending on the application and environment. Two metafiles are outlined in **E.1.2** and **E.1.3**.

E.1.2 ISO 8632[1)]

This metafile (ISO 8632 Information Processing Systems - Computer Graphics - Metafile for Transfer and Storage of Picture Description Information) may be categorized as one which aims to provide a means of recording pictures using metafile elements compatible with Level 0a of GKS. It is suitable for picture capture but less suitable for session capture or structured picture capture, the latter not being possible.

The metafile permits a variety of encoding schemes to be used from a single abstract metafile specification. The encodings that are included are:

a) a character encoding based on ISO 2022 code extension procedures;

b) a binary encoding based on IEEE (Draft 810 Task P754) floating point formats;

c) a clear text encoding.

Other standardized encodings may be added in time; private encodings based on the abstract structure and the rules of conformance given in the standard are also allowed.

[1)] In course of preparation

E.1.3 Metafile designed for GKS

This metafile may be categorized as one which aims to provide a means of recording the exact sequence of function calls made to a GKS workstation. Its functional capability covers the entire range of GKS output functions, from level 0 to level 2. It is suitable for picture capture, structured picture capture or session capture. It is particularly suitable for transporting graphical information from one GKS application to another and for applications where the individual graphics actions need to be replayed, with optional editing.

Two encodings are specified for this metafile. They are:

a) a clear text encoding;

b) an unspecified binary format.

This metafile is described in the following subsections.

E.2 File format and data format

The GKS metafile is built up as a sequence of logical data items. The file starts with a file header in fixed format which describes the origin of the metafile (author, installation), the format of the following items, and the number representation. The file ends with an end item indicating the logical end of the file. In between these two items the following information is recorded in the sense of an audit trail:

a) workstation control items and message items;

b) output primitive items, describing elementary graphics objects;

c) attribute information, including output primitive attributes, segment attributes, and workstation attributes;

d) segment items, describing the segment structure and dynamic segment manipulations;

e) user items.

The overall structure of the GKS metafile is as follows:

FILE:	file header	item 1	...	item i	...	item N	end item

ITEM:	item header	item data record

ITEM HEADER:	'GKSM' optional	identification number	length of item data record in bytes

All data items except the file header have an item header containing:

f) the character string 'GKSM' (optional) which is present to improve legibility of the file and to provide an error control facility;

g) the item type identification number which indicates the kind of information that is contained in the item;

h) the length of the item data record.

The lengths of these fields of the item header are implementation dependent and are specified in the file header. The content of the item data record is fully described for each item type later in this annex.

The metafile contains characters, integer numbers, and real numbers marked (c), (i), (r) in the item description. Characters in the metafile are represented according to ISO 646 and ISO

2022. Numbers are represented according to ISO 6093 using format F1 for integers and format F2 for reals.

NOTE. Formats F1 and F2 can be written and read via FORTRAN formats I and F respectively.

Real numbers describing coordinates and length units are stored as normalized device coordinates. The workstation transformation, if specified in the application program for a workstation writing a metafile of this format, is not performed but WORKSTATION WINDOW and WORKSTATION VIEWPORT are stored in data items for later use. Real numbers may be stored as integers. In this case transformation parameters are specified in the file header to allow proper transformation of integers into normalized device coordinates.

For reasons of economy, numbers can be stored using an internal binary format. As no standard exists for binary number representation, this format limits the portability of the metafile. The specification of such a binary number representation is outside the scope of this standard.

When exchanging metafiles between different installations, the physical structure of data sets on specific storage media should be standardised. Such a specification is outside the scope of this standard.

E.3 Generation of metafiles

Table 4 contains a list, by class, of all GKS functions which apply to workstations of category MO, and their effects on this GKSM. In the table, GKSM-OUT is a workstation identifier indicating a workstation writing a metafile of this format.

The concepts of clipping rectangle and clipping indicator are encapsulated in one metafile item which specifies a clipping rectangle. This item is written to the metafile on activate workstation with the values (0,1,0,1), if the 'clipping indicator' entry in the GKS state list is NOCLIP, or the clipping rectangle in the GKS state list if the 'clipping indicator' entry in the GKS state list is CLIP. If the clipping rectangle in the GKS state list is redefined when the 'clipping indicator' entry in the GKS state list is CLIP, a further clipping rectangle item is written. If the 'clipping indicator' entry in the GKS state list is changed to NOCLIP, a clipping rectangle item (0,1,0,1) is written. If the 'clipping indicator' entry in the GKS state list is changed to CLIP, an item containing the clipping rectangle in the GKS state list is written. This is analogous to the handling of clipping in segments (see **4.7.6**).

Table 4. GKS functions and their effect on GKSM output workstations

GKS functions which apply to workstations of category MO	GKSM item created or effect
Control functions	
OPEN WORKSTATION (GKSM-OUT,...)	- (file header) 1 (CONDITIONAL)
CLOSE WORKSTATION (GKSM-OUT)	0 (end item)
ACTIVATE WORKSTATION (GKSM-OUT)	(61, 21-44) ensure attributes current; enable output
DEACTIVATE WORKSTATION (GKSM-OUT)	disable output
CLEAR WORKSTATION (GKSM-OUT,...)	1
REDRAW ALL SEGMENTS ON WORKSTATION (GKSM-OUT)	2
UPDATE WORKSTATION (GKSM-OUT,...)	3
SET DEFERRAL STATE (GKSM-OUT,..)	4
MESSAGE (GKSM-OUT,...)	5 (message)
ESCAPE	6
Output primitives	
POLYLINE	11
POLYMARKER	12
TEXT	13
FILL AREA	14
CELL ARRAY	15
GENERALIZED DRAWING PRIMITIVE	16
Output attributes	
SET POLYLINE INDEX	21
SET LINETYPE	22
SET LINEWIDTH SCALE FACTOR	23
SET POLYLINE COLOUR INDEX	24
SET POLYMARKER INDEX	25
SET MARKER TYPE	26
SET MARKER SIZE SCALE FACTOR	27
SET POLYMARKER COLOUR INDEX	28
SET TEXT INDEX	29
SET TEXT FONT AND PRECISION	30
SET CHARACTER EXPANSION FACTOR	31
SET CHARACTER SPACING	32
SET TEXT COLOUR INDEX	33
SET CHARACTER HEIGHT	34
SET CHARACTER UP VECTOR	34
SET TEXT PATH	35
SET TEXT ALIGNMENT	36
SET FILL AREA INDEX	37
SET FILL AREA INTERIOR STYLE	38
SET FILL AREA STYLE INDEX	39
SET FILL AREA COLOUR INDEX	40
SET PATTERN SIZE	41
SET PATTERN REFERENCE POINT	42
SET ASPECT SOURCE FLAGS	43

GKS functions which apply to workstations of category MO	GKSM item created or effect
SET PICK IDENTIFIER	44
Workstation attributes	
SET POLYLINE REPRESENTATION (GKSM-OUT,...)	51
SET POLYMARKER REPRESENTATION (GKSM-OUT,...)	52
SET TEXT REPRESENTATION (GKSM-OUT,...)	53
SET FILL AREA REPRESENTATION (GKSM-OUT,...)	54
SET PATTERN REPRESENTATION (GKSM-OUT,...)	55
SET COLOUR REPRESENTATION (GKSM-OUT,...)	56
Transformation functions	
SET WINDOW of current normalization transformation (see note 2)	34,41,42
SET VIEWPORT of current normalization transformation (see notes 1 and 2)	61,34,41,42
SELECT NORMALIZATION TRANSFORMATION (see notes 1 and 2)	61,34,41,42
SET CLIPPING INDICATOR (see note 1)	61
SET WORKSTATION WINDOW (GKSM-OUT,...)	71
SET WORKSTATION VIEWPORT (GKSM-OUT,...)	72
Segment functions	
CREATE SEGMENT	81
CLOSE SEGMENT	82
RENAME SEGMENT	83
DELETE SEGMENT	84
DELETE SEGMENT FROM WORKSTATION (GKSM-OUT,...)	84
ASSOCIATE SEGMENT WITH WORKSTATION (GKSM-OUT,...)	81, (91-95), (21-44), (11-16),(61),82
COPY SEGMENT TO WORKSTATION (GKSM-OUT,...)	(21-44),(11-16),(61)
INSERT SEGMENT	(21-44),(11-16),(61)
Segment attributes	
SET SEGMENT TRANSFORMATION	91
SET VISIBILITY	92
SET HIGHLIGHTING	93
SET SEGMENT PRIORITY	94
SET DETECTABILITY	95
Metafile functions	
WRITE ITEM TO GKSM	>100

NOTE 1. Item 61 (CLIPPING RECTANGLE) is described more fully in E.3.

NOTE 2. When the current normalization transformation is altered, items corresponding to attributes containing coordinate information are sent (items 34, 41 and 42).

E.4 Interpretation of metafiles

E.4.1 Introduction

The interpretation of metafiles in GKS is described in **4.9**. The effects of INTERPRET ITEM for all types of metafile item are described in **E.4.2** to **E.4.8.** Items are grouped by class as in table 4.

E.4.2 Control items

Interpretation of items in this class is described under the definitions of each item in **E.5**.

E.4.3 Output primitives

Interpretation of items in this class generates output corresponding to the primitive functions, except that coordinates of points are expressed in NDC. Output primitives have bound to them the appropriate primitive attributes from the GKS state list.

E.4.4 Output primitive attributes

Interpretation of items in this class sets entries in the GKS state list. The geometric attribute information, which is expressed in NDC, is transformed by the inverse of the currently selected normalization transformation before being used to set these entries. Interpretation of the character vectors item causes the two vectors to be thus transformed and the entries in the GKS state list to be set as follows. The 'current character height' entry is set to the length of the transformed character height vector and the 'current character up vector' entry is set to a vector of arbitrary length, parallel to the transformed character height vector. The 'current character width' and 'current character base vector' are similarly set using the transformed character width vector.

E.4.5 Workstation attributes

Interpretation of items in this class has the same effect as invocation of the corresponding GKS functions shown in table 4. The GKS functions are performed on all active workstations.

E.4.6 Transformations

Interpretation of a clipping rectangle item sets the 'clipping rectangle' entry in the GKS state list and also sets the 'clipping indicator' entry in the GKS state list to CLIP. Interpretation of other items in this class (WORKSTATION WINDOW and WORKSTATION VIEWPORT) causes the invocation of the corresponding GKS functions on all active workstations.

E.4.7 Segment manipulation

Interpretation of items in this class has the same effect as invocation of the corresponding GKS functions shown in table 4. (Item 84 causes an invocation of DELETE SEGMENT.)

E.4.8 Segment attributes

Interpretation of items in this class has the same effect as invocation of the corresponding GKS functions shown in table 4.

E.5 Control items

FILE HEADER

GKSM	N	D	V	H	T	L	I	R	F	RI	ZERO	ONE

All fields in the file header item have fixed length. Numbers are formatted according to Format F1 of ISO 6093.

General information:

GKSM	4 bytes	containing string 'GKSM'
N	40 bytes	containing name of author/installation
D	8 bytes	date (year/month/day, for example 79/12/31)
V	2 bytes	version number: the metafile described here has version number 1

Specification of field length

H	2 bytes	integer specifying how many bytes of the string 'GKSM' are repeated at the beginning of each record. Possible values: 0, 1, 2, 3, 4.
T	2 bytes	length of item type indicator field
L	2 bytes	length of item data record length indicator field
I	2 bytes	length of field for each integer in the item data record (applies to all data marked (i) in the item description)
R	2 bytes	length of field for each real in the item data record (applies to all data marked (r) in the item description)

Specification of number representation

F	2 bytes	Possible values: 1, 2. This applies to all data in the items marked (i) or (r) and to item type and item data record length: 1: all numbers are formatted according to ISO 6093 2: all numbers (except in the file header) are stored in an internal binary format
RI	2 bytes	Possible values: 1, 2. This is the number representation for data marked (r): 1 = real, 2 = integer
ZERO	11 bytes	integer equivalent to 0.0, if RI=2
ONE	11 bytes	integer equivalent to 1.0, if RI=2

After the file header, which is in fixed format, all values in the following items are in the format defined by the file header. For the following description, the setting:

H=4; T=3; F=1

is assumed. In addition to formats (c), (i) and (r), which are already described, (p) denotes a point represented by a pair of real numbers (2r). The notation allows the single letter to be preceded by an expression, indicating the number of values of that type.

END ITEM

'GKSM 0'	L

Last item of every GKS Metafile. Sets condition for the error 'No item is left in GKS Metafile input'

CLEAR WORKSTATION

'GKSM 1'	L	C

Requests CLEAR WORKSTATION on all active workstations

C(i): clearing control flag
(0=CONDITIONAL, 1=ALWAYS)

REDRAW ALL SEGMENTS ON WORKSTATION

'GKSM 2'	L

Requests REDRAW ALL SEGMENTS ON WORKSTATION on all active workstations

UPDATE WORKSTATION

'GKSM 3'	L	R

Requests UPDATE WORKSTATION on all active workstations

R(i): update regeneration flag
(0=PERFORM, 1=POSTPONE)

DEFERRAL STATE

'GKSM 4'	L	D	R

Requests SET DEFERRAL STATE on all active workstations

D(i): deferral mode
(0=ASAP, 1=BNIG, 2=BNIL, 3=ASTI)

R(i): implicit regeneration mode
(0=ALLOWED, 1=SUPPRESSED)

MESSAGE

'GKSM 5'	L	N	T

Requests MESSAGE on all active workstations

N(i): number of characters in string

T(Nc): string with N characters

ESCAPE

'GKSM 6'	L	FI	L	M	I	R

Requests ESCAPE

FI(i): function identifier

L(i): length of integer data in data record

M(i): length of real data in data record

I(Li): integer data

R(Mr): real data

E.6 Items for output primitives

POLYLINE

'GKSM 11'	L	N	P

N(i): number of points of the polyline

P(Np): list of points

POLYMARKER

'GKSM 12'	L	N	P

N(i): number of points

P(Np): list of points

TEXT

'GKSM 13'	L	P	N	T

P(p): starting point of character string

N(i): number of characters in string T

T(Nc): string with N characters from the set of ISO 646

FILL AREA

'GKSM 14'	L	N	P

N(i): number of points

P(Np): list of points

CELL ARRAY

'GKSM 15'	L	P	Q	R	N	M	CT

P(p),Q(p),R(p): coordinates of corner points of pixel array (P and Q are the images of the points P and Q specified in the function CELL ARRAY and R is the point associated with the (DX,1) cell)

N(i): number of columns in array

M(i): number of rows in array

CT(MNi): array of colour indices stored row by row

GENERALIZED DRAWING PRIMITIVE

'GKSM 16'	L	GI	N	LI	LR	P	I	R

GI(i): GDP identifier
N(i): number of points
LI(i): length of integer data in data record
LR(i): length of real data in data record
P(Np): list of points
I(LIi): integer data
R(LRr): real data

E.7 Items for output primitive attributes

POLYLINE INDEX

'GKSM 21'	L	I

I(i): polyline index

LINETYPE

'GKSM 22'	L	LT

LT(i): linetype

LINEWIDTH SCALE FACTOR

'GKSM 23'	L	LW

LW(r): linewidth scale factor

POLYLINE COLOUR INDEX

'GKSM 24'	L	CI

CI(i): polyline colour index

POLYMARKER INDEX

'GKSM 25'	L	I

I(i): polymarker index

MARKER TYPE

'GKSM 26'	L	MT

MT(i): marker type

MARKER SIZE SCALE FACTOR

'GKSM 27'	L	MS

MS(r): marker size scale factor

POLYMARKER COLOUR INDEX

'GKSM 28'	L	CI

CI(i): polymarker colour index

TEXT INDEX

'GKSM 29'	L	I

I(i): text index

TEXT FONT AND PRECISION

'GKSM 30'	L	F	P

F(i): text font

P(i): text precision
(0=STRING, 1=CHAR, 2=STROKE)

CHARACTER EXPANSION FACTOR

'GKSM 31'	L	CEF

CEF(r): character expansion factor

CHARACTER SPACING

'GKSM 32'	L	CS

CS(r): character spacing

TEXT COLOUR INDEX

'GKSM 33'	L	CI

CI(i): text colour index

CHARACTER VECTORS

'GKSM 34'	L	CH	CW

CH(2r): character height vector

CW(2r): character width vector

NOTE. These vectors are the height and width vectors described in **4.4.5**

TEXT PATH

'GKSM 35'	L	P

P(i): text path
(0=RIGHT, 1=LEFT, 2=UP, 3=DOWN)

TEXT ALIGNMENT

'GKSM 36'	L	H	V

H(i): horizontal character alignment
(0=NORMAL, 1=LEFT, 2=CENTRE, 3=RIGHT)

V(i) vertical character alignment
(0=NORMAL, 1=TOP, 2=CAP, 3=HALF, 4=BASE, 5=BOTTOM)

FILL AREA INDEX

'GKSM 37'	L	I

I(i): fill area index

FILL AREA INTERIOR STYLE

'GKSM 38'	L	S

S(i): fill area interior style
(0=HOLLOW, 1=SOLID, 2=PATTERN, 3=HATCH)

FILL AREA STYLE INDEX

'GKSM 39'	L	SI

SI(i): fill area style index

FILL AREA COLOUR INDEX

'GKSM 40'	L	CI

CI(i): fill area colour index

PATTERN VECTORS

'GKSM 41'	L	PW	PH

PW(2r): pattern width vector

PH(2r): pattern height vector

PATTERN REFERENCE POINT

'GKSM 42'	L	P

P(p): reference point

ASPECT SOURCE FLAGS

'GKSM 43'	L	F

F(13i): aspect source flags
(0=BUNDLED, 1=INDIVIDUAL)

PICK IDENTIFIER

'GKSM 44'	L	P

P(i): pick identifier

E.8 Items for workstation attributes

POLYLINE REPRESENTATION

'GKSM 51'	L	I	LT	LW	CI

I(i): polyline index
LT(i): linetype number
LW(r): linewidth scale factor
CI(i): polyline colour index

POLYMARKER REPRESENTATION

'GKSM 52'	L	I	MT	MS	CI

I(i): polymarker index
MT(i): marker type
MS(r): marker size scale factor
CI(i): polymarker colour index

TEXT REPRESENTATION

'GKSM 53'	L	I	F	P	CEF	CS	CI

I(i): text index
F(i): text font
P(i): text precision
(0=STRING, 1=CHAR, 2=STROKE)
CEF(r): character expansion factor
CS(r): character spacing
CI(i): text colour index

FILL AREA REPRESENTATION

'GKSM 54'	L	I	S	SI	CI

I(i): fill area index

S(i): fill area interior style
(0=HOLLOW, 1=SOLID, 2=PATTERN, 3=HATCH)

SI(i): fill area style index

CI(i): fill area colour index

PATTERN REPRESENTATION

'GKSM 55'	L	I	N	M	CT

I(i): pattern index

N(i): number of columns in array

M(i): number of rows in array

CT(MNi):table of colour indices stored row by row

COLOUR REPRESENTATION

'GKSM 56'	L	CI	RGB

CI(i): colour index

RGB(3r): red, green, blue intensities

E.9 Items for transformations

CLIPPING RECTANGLE

'GKSM 61'	L	C

C(4r): limits of clipping rectangle (XMIN, XMAX, YMIN, YMAX)

WORKSTATION WINDOW

'GKSM 71'	L	W

W(4r): limits of workstation window (XMIN, XMAX, YMIN, YMAX)

WORKSTATION VIEWPORT

'GKSM 72'	L	V

V(4r): limits of workstation viewport (XMIN, XMAX, YMIN, YMAX)

E.10 Items for segment manipulation

CREATE SEGMENT

'GKSM 81'	L	S

S(i): segment name

CLOSE SEGMENT

'GKSM 82'	L

Indicates end of segment

RENAME SEGMENT

'GKSM 83'	L	SO	SN

SO(i): old segment name

SN(i): new segment name

DELETE SEGMENT

'GKSM 84'	L	S

S(i): segment name

E.11 Items for segment attributes

SET SEGMENT TRANSFORMATION

'GKSM 91'	L	S	M

S(i): segment name

M(6r): transformation matrix
$M_{11}, M_{12}, M_{13}, M_{21}, M_{22}, M_{23}$

SET VISIBILITY

'GKSM 92'	L	S	V

S(i): segment name

V(i): visibility
(0=VISIBLE, 1=INVISIBLE)

SET HIGHLIGHTING

'GKSM 93'	L	S	H

S(i): segment name

H(i): highlighting
(0=NORMAL, 1=HIGHLIGHTED)

SET SEGMENT PRIORITY

'GKSM 94'	L	S	P

S(i): segment name

P(r): segment priority

SET DETECTABILITY

'GKSM 95'	L	S	D

S(i): segment name

D(i): detectability
(0=UNDETECTABLE, 1=DETECTABLE)

E.12 User items

USER ITEM

'GKSMXXX'	L	D

XXX > 100

D: user data (L bytes)

Appendix F GKS functions summary

NOTE. This appendix is not part of the Standard, but provides additional information.

F.1 Control functions

OPEN GKS
Start working with GKS.

CLOSE GKS
Stop working with GKS.

OPEN WORKSTATION
Create a connection between the specified workstation and GKS.

CLOSE WORKSTATION
Release the connection between the specified workstation and GKS.

ACTIVATE WORKSTATION
Output is routed to the specified workstation.

DEACTIVATE WORKSTATION
Output is no longer routed to the specified workstation.

CLEAR WORKSTATION
Perform all deferred actions and clear display space on the specified workstation. All segments stored on the workstation are deleted.

REDRAW ALL SEGMENTS ON WORKSTATION
Redraw all visible segments stored on the specified workstation.

UPDATE WORKSTATION
Perform all deferred actions and, if necessary, redraw all visible segments stored on the specified workstation.

SET DEFERRAL STATE
Set deferral state for the specified workstation.

MESSAGE
Send a message to the specified workstation.

ESCAPE
A standard way of invoking non-standard features.

F.2 Output functions

POLYLINE
Generate a polyline defined by points in world coordinates.

POLYMARKER
Generate markers of a given type at specified points in world coordinates.

TEXT
Generate a text string at the given position in world coordinates.

FILL AREA
Generate a polygon which may be filled with a colour, a hatch or a pattern, or may be hollow.

CELL ARRAY
Map the given array of colour indices onto the display surface.

GENERALIZED DRAWING PRIMITIVE
Generate a generalized drawing primitive defined by a sequence of points in world coordinates and a data record.

F.3 Output attributes

F.3.1 Workstation independent primitive attributes

SET POLYLINE INDEX
Select a bundle index for polylines.

SET LINETYPE
Set the linetype for use when the corresponding ASF is INDIVIDUAL.

SET LINEWIDTH SCALE FACTOR
Set the linewidth scale factor for use when the corresponding ASF is INDIVIDUAL.

SET POLYLINE COLOUR INDEX
Set the polyline colour index for use when the corresponding ASF is INDIVIDUAL.

SET POLYMARKER INDEX
Select a bundle index for polymarkers.

SET MARKER TYPE
Set the marker type for use when the corresponding ASF is INDIVIDUAL.

SET MARKER SIZE SCALE FACTOR
Set the marker size scale factor for use when the corresponding ASF is INDIVIDUAL.

SET POLYMARKER COLOUR INDEX
Set the polymarker colour index for use when the corresponding ASF is INDIVIDUAL.

SET TEXT INDEX
Select a bundle index for text.

SET TEXT FONT AND PRECISION
Set the text font and precision for use when the corresponding ASF is INDIVIDUAL.

SET CHARACTER EXPANSION FACTOR
Set the character expansion factor as a fraction of the character height for use when the corresponding ASF is INDIVIDUAL.

SET CHARACTER SPACING
Set the character spacing as a fraction of the character height for use when the corresponding ASF is INDIVIDUAL.

SET TEXT COLOUR INDEX
Set the text colour index for use when the corresponding ASF is INDIVIDUAL.

SET CHARACTER HEIGHT
Set the character height in world coordinates.

SET CHARACTER UP VECTOR
Set the character up vector in world coordinates.

SET TEXT PATH
Set the text path.

SET TEXT ALIGNMENT
Set the horizontal and vertical alignment of text strings.

SET FILL AREA INDEX
Select a bundle index for fill area.

SET FILL AREA INTERIOR STYLE
Set the fill area interior style for use when the corresponding ASF is INDIVIDUAL.

SET FILL AREA STYLE INDEX
Set the fill area style index for use when the corresponding ASF is INDIVIDUAL.

SET FILL AREA COLOUR INDEX
Set the fill area colour index for use when the corresponding ASF is INDIVIDUAL.

SET PATTERN SIZE
Set the pattern size in world coordinates for use in the display of fill area primtives with interior style PATTERN.

SET PATTERN REFERENCE POINT
Set the pattern reference point in world coordinates for use in the display of fill area primitives with interior style PATTERN.

SET ASPECT SOURCE FLAGS
Define whether the value of each non-geometric aspect is obtained from the corresponding individual attribute or from the appropriate bundle on the workstation.

SET PICK IDENTIFIER
Set pick identifier.

F.3.2 Workstation attributes (representations)

SET POLYLINE REPRESENTATION
Define the representation of polylines on the specified workstation.

SET POLYMARKER REPRESENTATION
Define the representation of polymarkers on the specified workstation.

SET TEXT REPRESENTATION
Define the representation of text on the specified workstation.

SET FILL AREA REPRESENTATION
Define the representation of fill area primitives on the specified workstation.

SET PATTERN REPRESENTATION
Define the pattern to be associated with a pattern index (i.e. a fill area style index) on the specified workstation.

SET COLOUR REPRESENTATION
Define the colour to be associated with a colour index on the specified workstation.

F.4 Transformation functions

F.4.1 Normalization transformation

SET WINDOW
Set the window in world coordinates of the specified normalization transformation.

SET VIEWPORT
Set the viewport in normalized device coordinates of the specified normalization transformation.

SET VIEWPORT INPUT PRIORITY
Set the input priority of the specified viewport for locator and stroke input.

SELECT NORMALIZATION TRANSFORMATION
Select a normalization transformation for output.

SET CLIPPING INDICATOR
Set the clipping indicator for the clipping rectangle.

F.4.2 Workstation transformation

SET WORKSTATION WINDOW
Set the workstation window in normalized device coordinates.

SET WORKSTATION VIEWPORT
Set the workstation viewport in device coordinates.

F.5 Segment functions

F.5.1 Segment manipulation functions

CREATE SEGMENT
The specified segment is created and becomes the open segment.

CLOSE SEGMENT
Close the open segment.

RENAME SEGMENT
Change the name of the specified segment.

DELETE SEGMENT
Delete the specified segment.

DELETE SEGMENT FROM WORKSTATION
Delete the specified segment from the specified workstation.

ASSOCIATE SEGMENT WITH WORKSTATION
Associate the specified segment, present in workstation independent segment storage, with the specified open workstation.

COPY SEGMENT TO WORKSTATION
Copy the primitives of the specified segment, present in workstation independent segment storage, to the specified workstation.

INSERT SEGMENT
Insert the specified segment, present in workstation independent segment storage, (after the segment transformation and the insert transformation have been applied) into the open segment or the stream of primitives outside segments.

F.5.2 Segment attributes

SET SEGMENT TRANSFORMATION
Set the segment transformation attribute for the specified segment.

SET VISIBILITY
Set the visibility attribute for the specified segment.

SET HIGHLIGHTING
Set the highlighting attribute for the specified segment.

SET SEGMENT PRIORITY
Set the segment priority attribute for the specified segment.

SET DETECTABILITY
Set the segment detectability attribute for the specified segment.

F.6 Input functions

F.6.1 Initialisation of input devices

INITIALISE LOCATOR
Initialise the specified locator device.

INITIALISE STROKE
Initialise the specified stroke device.

INITIALISE VALUATOR
Initialise the specified valuator device.

INITIALISE CHOICE
Initialise the specified choice device.

INITIALISE PICK
Initialise the specified pick device.

INITIALISE STRING
Initialise the specified string device.

F.6.2 Setting mode of input devices

SET LOCATOR MODE
Set operating mode of the specified locator device.

SET STROKE MODE
Set operating mode of the specified stroke device.

SET VALUATOR MODE
Set operating mode of the specified valuator device.

SET CHOICE MODE
Set operating mode of the specified choice device.

SET PICK MODE
Set operating mode of the specified pick device.

SET STRING MODE
Set operating mode of the specified string device.

F.6.3 Request input functions

REQUEST LOCATOR
Request position in world coordinates and normalization transformation number from the specified locator device.

REQUEST STROKE
Request sequence of points in world coordinates and normalization transformation number from the specified stroke device.

REQUEST VALUATOR
Request real value from the specified valuator device.

REQUEST CHOICE
Request non-negative integer, representing a selection from a number of choices, and choice status from the specified choice device.

REQUEST PICK
Request segment name, pick identifier and pick status from the specified pick device.

REQUEST STRING
Request character string from the specified string device.

F.6.4 Sample input functions

The current setting of a logical intput device is tested and the value is sent back without waiting for any operator action.

SAMPLE LOCATOR
Sample the specified locator device, delivering a point in world coordinates and a normalization transformation number.

SAMPLE STROKE

Sample the specified stroke device, delivering a sequence of points in world coordinates and a normalization transformation number.

SAMPLE VALUATOR

Sample the specified valuator device, delivering a real value.

SAMPLE CHOICE

Sample the specified choice device, delivering a non-negative integer, which represents a selection from a number of choices and choice status.

SAMPLE PICK

Sample the specified pick device, delivering a segment name, pick identifier and pick status.

SAMPLE STRING

Sample the specified string device, delivering a character string.

F.6.5 Event input functions

Input items are collected in an input queue managed by GKS and can be obtained by the application program from this queue.

AWAIT EVENT

If the input queue is empty, wait for an input item until the specified time has elapsed. Read the workstation identifier, input class, and logical input device number of the oldest entry in the input queue and pass the values to the current event report for subsequent interrogation by the GET functions.

FLUSH DEVICE EVENTS

Delete all the events from the specified logical input device in the input queue.

GET LOCATOR

Transfer position in world coordinates and normalization transformation number from the current event report to the application program.

GET STROKE

Transfer sequence of points in world coordinates and normalization transformation number from the current event report to the application program.

GET VALUATOR

Transfer real value from the current event report to the application program.

GET CHOICE

Transfer non-negative integer, representing a selection from a number of choices, and choice status from the current event report to the application program.

GET PICK

Transfer segment name, pick identifier and pick status from the current event report to the application program.

GET STRING

Transfer character string from the current event report to the application program.

F.7 Metafile functions

WRITE ITEM TO GKSM

Pass non-graphical data from the application program to the GKS metafile.

GET ITEM TYPE FROM GKSM

Pass the item type and item data record length of the current item back to the application program.

READ ITEM FROM GKSM

Pass the current item to the application program (graphical or non-graphical item).

INTERPRET ITEM

Interpret the item read in by READ ITEM FROM GKSM. The interpretation causes appropriate changes in the set of GKS state variables and generates appropriate graphical output as determined by the metafile specification.

F.8 Inquiry functions

There are some 75 different inquiry functions in GKS. All variables contained in any existing state list and in the description tables may be inquired at any time when GKS is open.

An inquiry function is provided for text extent to allow concatenation of character strings. On raster workstations, the size and colour of pixels may be inquired.

The operating state of GKS may be inquired, even when GKS is closed.

F.9 Utility functions

EVALUATE TRANSFORMATION MATRIX

Evaluate the transformation specified by fixed point, shift vector, rotation angle and scale factors and return the result in the output transformation matrix.

ACCUMULATE TRANSFORMATION MATRIX

Evaluate the transformation specified by fixed point, shift vector, rotation angle and scale factors, combine it with the input transformation matrix and return the result in the output transformation matrix.

F.10 Error handling

EMERGENCY CLOSE GKS

Tries to close GKS in case of an error, saving as much information as possible.

ERROR HANDLING

A procedure called by GKS when an error is detected. It may be user supplied.

ERROR LOGGING

A procedure called by the standard GKS error handling procedure. It prints an error message and function identification on the error file.

Appendix G Differences Between ANS GKS and ISO GKS

This appendix is not part of the Standard, but provides additional information.

The following is a description of the changes made to ISO GKS to produce ANS GKS. The changes are listed in the order in which they appear in the document.

1. A new title page with new abstract and a new Foreword with a history section were created to conform to the ANSI Style Manual.
2. Changes were made in the Table of Contents to reflect changes in the document.
3. In the Introduction a Conformance section was added. This included the a different definition of conforming to a level of GKS, reflected here and in other places in the document.
4. ANSI references were added to section 2.
5. Parts of the document discussing levels were changed to reflect the addition of level m. Areas affected include the Definitions, the description of the levels, the level designations of individual functions, and Appendix A.
6. Starting in Section 4 and continuing throughout the document, references to 'annexes' were changed to 'appendices'. This was done to avoid confusion, as the ANSI Style Manual has explicit rules with respect to appendices; retention of the term 'annexes' might have caused ambiguity. The non-U.S. spelling of variopus terms (e.g., 'colour') was not changed because there was little danger of ambiguity.
7. In 4.4.2, Output Primitive Attributes, the default for ASF's is INDIVIDUAL, rather than implementation dependent.
8. Input data records are part of the standard.
9. Appendix A and Appendix B were marked as not part of the standard. It is not part of the standard because all the information contained in it is also in the body of the standard; redundant information in the standard increases the potential for ambiguities.
10. Annex C was replaced with a new Appendix C reflecting a number of changes.
11. Annex F, Sample Programs, was deleted. Its function is replaced with examples in the derivative standards reflecting the bindings written for each language.
12. Annex G was changed to Appendix F.
13. This Appendix G was added consisting of this list of differences between ISO GKS and ANS GKS.

American National Standard

for information systems –

computer graphics – graphical kernel system (GKS) FORTRAN binding

ANSI X3.124.1-1985

American National Standard

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Abstract

This standard provides the FORTRAN language syntax for American National Standard for Information Systems – Computer Graphics – Graphical Kernel System (GKS) Functional Description, ANSI X3.124-1985. The FORTRAN language binding of GKS is a syntactic specification, presented as a set of subroutines that, taken as a whole, provide the semantics of GKS for use by a FORTRAN application program.

For each GKS function, the FORTRAN subroutine name, argument list, and argument data types are given. In addition, any special errors associated only with the FORTRAN language binding of GKS are specified and assigned unique error numbers. Finally, for the GKS enumeration data types, the spellings of integer variables and their numeric data value assignments are suggested to further aid in the production of portable and maintainable GKS FORTRAN programs.

Foreword

(This Foreword is not part of American National Standard X3.124.1-1985.)

This American National Standard provides access to a set of basic functions for computer graphics programming in American National Standard Programming Language FORTRAN, ANSI X3.9-1978, colloquially known as FORTRAN '77. These graphics functions taken as a whole are called the FORTRAN language binding of the graphical kernel system (GKS).

The graphical kernel system is a set of basic functions for computer graphics programming, useable by many graphics-producing applications. This standard (1) allows FORTRAN graphics application programs to be easily transported between installations, (2) aids FORTRAN graphics applications programmers in understanding and using graphics methods, and (3) guides device manufacturers on useful graphics capabilities.

This standard defines a FORTRAN application level programming interface to a graphics system. Hence, it contains functions for (1) outputting graphical primitives, (2) controlling the appearance of graphical primitives with attributes, (3) controlling graphical workstations, (4) controlling transformations and coordinate systems, (5) generating and controlling groups of primitives called segments, (6) obtaining graphical input, (7) manipulating groups of device-independent instructions called metafiles, (8) inquiring the capabilities and states of the graphics system, and (9) handling errors.

For each GKS function, the FORTRAN subroutine name, argument list, and argument data types are given. In addition, any special errors associated only with the FORTRAN language binding of GKS are specified and assigned unique error numbers. Finally, for the GKS enumeration data types, the spellings of integer variables and their numeric data value assignments are suggested to further aid in the production of portable and maintainable GKS FORTRAN programs.

Twelve upwardly compatible levels of conformance are defined, addressing the most common classes of equipment and applications.

American National Standard for Information Systems – Computer Graphics – Graphical Kernel System (GKS) Functional Description, ANSI X3.124-1985, is supplemented by this derivative standard. ANSI X3.124-1985 corresponds to ISO 7942-1985 in that it represents the functional aspects of GKS. ANSI X3.124.1-1985 contains specifications not present in ANSI X3.124-1985, namely, the syntax for using GKS functions and data types from FORTRAN '77.

The design of this standard is based on the work of many groups. Much of the early design methodology of graphics standards was developed at the Workshop on Graphics Standards Methodology held in May, 1976, in Seillac, France, under IFIP WG5.2 sponsorship. GKS itself was originally developed by Deutsches Institut fur Normung (DIN), the West German standardization institute, in 1978 and was subsequently refined extensively between 1980 and 1982 by Working Group 2 of the Subcommittee on Programming Languages of the Technical Committee on Information Processing of the International Organization for Standardization (ISO TC 97/SC5/WG2). The resulting International Standard (Information Processing – Computer Graphics – Graphical Kernel System (GKS) Functional Description, ISO 7942-1985) was the basis for ANSI X3.124-1985. The development of the GKS was heavily influenced by the work of the Graphic Standards Planning Committee of the Special Interest Group on Computer Graphics of the Association for Computing Machinery (ACM SIGGRAPH GSPC). This work, known as Core System Proposal, was published and widely distributed in 1977 and again (in a revised version) in 1979.

The FORTRAN binding of GKS was started by American and British participants of ISO TC 97/SC5/WG2, which, in 1985, was renamed ISO TC 97/SC21/WG2. After refinement by both Technical Committee X3H3 (Computer Graphics) of Accredited Standards Committee X3 (Information Processing) and by ISO TC 97/SC21/WG2, the document was registered as ISO DP 8651 Part 1 in February, 1985.

ANSI X3.124.1-1985 is identical to ISO DP 8651/1 in almost all areas of the standard. All functional capabilities of ISO GKS are found in the ANSI GKS and are bound to the FORTRAN programming language identically. The ANSI GKS does, however, differ in the following ways:

(1) A new minimal output level (denoted m) is defined in ANSI X3.124-1985.

(2) A new section defining a conforming program and a conforming implementation replaces a more restrictive conformance statement found in the body of the ISO GKS standard document.

(3) Several of the Annexes in the ISO GKS document have been modified. Also, the word "Annex" has been changed to "Appendix."

(4) The default for ASF's is INDIVIDUAL.

(5) The data records for INPUT have been defined.

(6) Appendix G of ANSI X3.124-1985 contains a detailed and exhaustive list of all the differences between ANSI X3.124-1985 and ISO 7942-1985.

All these differences are also reflected in this standard.

Three additional language bindings of GKS are under development by Technical Committee X3H3: Pascal, Ada, and C. These standards, when approved by X3 and ANSI, will be published as ANSI X3.124.2, X3.124.3, and X3.124.4, respectively. Internationally, these language bindings of GKS will be published as parts of a multipart ISO standard, currently known as ISO/DP 8651.

This standard was developed by Technical Committee X3H3 of Accredited Standards Committee X3 under two projects authorized by X3; namely, project 268D and project 362D. More specifically, GKS, as a whole, meets the goals of project 268D, while the minimal output level m found in this American National Standard, but not present in ISO 7942-1985, meets the goals of project 362D. Both projects authorized the specification of syntax (as embodied in a programming language binding) as well as semantics.

This standard was approved as an American National Standard by the American National Standards Institute on June 24, 1985.

Suggestions for improvement of this standard will be welcome. They should be sent to the Computer and Business Equipment Manufacturers Association, 311 First Street, NW, Suite 500, Washington, DC 20001.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Information Processing Systems, X3. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

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	Stanley Fenner (Alt)
Control Data Corporation	Charles E. Cooper
	Keith Lucke (Alt)
Cooperating Users of Burroughs Equipment	Thomas Easterday
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Technical Committee X3H3 on Computer Graphics, which developed the draft proposals, which held the U.S. Technical Advisory Group responsibilities for ISO TC 97/SC5/WG2, and through which this standard was completed, had the following members:

Peter R. Bono, Chair
(Athena Systems)
Barry Shepherd, Vice-Chair
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The document editor for this standard was Thomas Wright. The camera-ready masters for the body of this standard were provided by Integrated Software Systems Corporation, San Diego, CA.

Contents

American National Standard
for Information Systems –

Computer Graphics – Graphical Kernel System (GKS) FORTRAN Binding

0. Introduction

The Graphical Kernel System (GKS) is registered as ANS X3.124-1985. As explained in the Scope and Field of Applications of X3.124-1985, that American National Standard is specified in a language independent manner and needs to be embedded in language dependent layers (language bindings) for use with particular programming languages.

The purpose of this document is to define a standard binding for the FORTRAN computer programming language.

1. Scope and field of application

The Graphical Kernel System (GKS) ANS X3.124-1985 specifies a language independent nucleus of a graphics system. For integration into a programming language, GKS is embedded in a language dependent layer obeying the particular conventions of that language. This document specifies such a language dependent layer for the FORTRAN language.

2. References

ANSI X3.4-1977	7-bit coded character set for information processing interchange
ANSI X3.9-1978	FORTRAN Language Specification

3. Principles

This document defines the GKS language binding interface for ANS FORTRAN (ANSI X3.9-1978), commonly known as FORTRAN 77. With some minor modifications, application programs can be transported between full FORTRAN 77 and FORTRAN 77 Subset GKS installations.

3.1 Mapping of GKS Function Names to FORTRAN Subroutine Names

The function names of GKS are all mapped to FORTRAN subroutine names which start with the letter 'G'. The mapping is generally done in a one-to-one correspondence to the GKS document. However, some inquiry functions are split into more than one subroutine in this binding, due to the number of parameters required. The remaining letters after the first one are obtained by deriving a unique acronym from the words of the function name; e.g., ACTIVATE becomes AC, WORKSTATION becomes WK. Hence, the FORTRAN subroutine name of GKS function ACTIVATE WORKSTATION is GACWK. For a list of all abbreviations, see 'Generating FORTRAN Subroutine Names' below. Names used internally which may be known outside GKS, e.g., during linking, start with some easily recognized and documented form such as 'GK' (subroutine, function, and common block names). Therefore, no external names starting with this construct should be chosen when using GKS, in order to avoid name conflicts. Globally used GKS names may be renamed if necessary.

3.2 Parameters

In general, the order of GKS function parameters is preserved. For some subroutines, however, there are additional parameters which have been inserted in the normal parameter sequence (e.g., array length for arrays which are output parameters).

Values of input parameters are unaltered by any GKS function as well as PACK DATA RECORD and UNPACK DATA RECORD.

In order that any element of a list (member of a set), such as the set of segment names, can be inquired, in this binding the inquiry functions return only a single element of a list (member of a set). In addition, the total number of elements of the list (members of the set) is always returned. The elements (members) are numbered starting from 1; each invocation of the inquiry function requires the desired element (member) number as an input parameter and returns the corresponding element (member). When the list (set) is empty, a zero is returned as the number of elements (members) and the parameter representing the single element in the list is undefined.

3.3 The FORTRAN Subset

The binding for FORTRAN 77 Subset is different from that for full FORTRAN 77 in order to accommodate the FORTRAN 77 Subset restrictions.

Those GKS subroutines in the full FORTRAN 77 binding that have arguments of type CHARACTER*(*) have alternative subroutine definitions that include fixed length character strings, CHARACTER*80, for the Subset.

In some cases, an additional INTEGER parameter (the number of characters) appears in the parameter list and the Subset version is distinguished by the addition of a final 'S', so that they can coexist in the same implementation. In other cases the INTEGER is already present and the FORTRAN 77 Subset version has the same name as the full FORTRAN 77 version.

A full FORTRAN 77 implementation shall include both subroutines in the case when the names are distinct and only the full FORTRAN 77 version when the names are the same.

The enumeration values in this binding may be redefined by replacing the PARAMETER statements with corresponding DATA statements.

A 'FORTRAN 66' binding can be derived from the FORTRAN 77 Subset binding by replacing CHARACTER declarations with INTEGER arrays.

3.4 Error Handling

There are two error routines in every GKS system, named GERLOG and GERHND. The user may replace the latter with his own subroutine using the same name, GERHND. Furthermore, this user-defined error routine may call the system-defined error logging procedure GERLOG.

4. Generating FORTRAN Subroutine Names

For the binding of the GKS functions which inquire lists (sets), the word 'element' ('member') is added to the GKS function name before the subroutine name is generated from the resulting terms.

The derivation of the abbreviation for the subroutine names is performed in several steps. First, plurals are reduced to their singular form, and grammatical derivations are unified. Next, some compound terms are reduced. Finally, each remaining word is replaced by the null string or by an abbreviation.

Plurals

ATTRIBUTES	→	ATTRIBUTE	NUMBERS	→	NUMBER
DEVICES	→	DEVICE	PRIMITIVES	→	PRIMITIVE
EVENTS	→	EVENT	PRIORITIES	→	PRIORITY
FACILITIES	→	FACILITY	SEGMENTS	→	SEGMENT
FLAGS	→	FLAG	TYPES	→	TYPE
INDICES	→	INDEX	VALUES	→	VALUE
NAMES	→	NAME	WORKSTATIONS	→	WORKSTATION

Keeping Uniqueness

ACTIVE	→	ACTIVATE
DRAWING	→	DRAW
IDENTIFIER	→	IDENTIFICATION
SPACING	→	SPACE

Reduce Compound Terms:

STATE TABLES	→	TABLES
TRANSFORMATION NUMBER	→	TRANSFORMATION N
SET member	→	member
CURRENT NORMALISATION	→	CN
MAXIMUM LENGTH	→	LENGTH

Deletions

ALL	FACTOR	LIST	OF	TABLES
AND	FROM	member	ON	TO
AVAILABLE	GKSM	MODIFICATION	POINT	TYPE
CURRENT	IN	MORE	SIZE	VALUE
DATA	INDICATOR	NAME	STATES	VECTOR
DEVICE	LENGTH	NUMBER	SUPPORTED	WITH
EVENT				

Abbreviations

ACCUMULATE	→	AC
ACTIVATE	→	AC
ALIGNMENT	→	AL
AREA	→	A
ARRAY	→	A
ASPECT	→	A
ASSOCIATE	→	A
ASSOCIATED	→	AS
ATTRIBUTE	→	A
AWAIT	→	WAIT
BASE	→	B
CATEGORY	→	CA
CELL	→	C
CHARACTER	→	CH
CHOICE	→	CH
CLASSIFICATION	→	CL
CLEAR	→	CLR
CLIPPING	→	CLIP
CLOSE	→	CL
COLOUR	→	C
CONNECTION	→	C
COPY	→	C
CREATE	→	CR
DEACTIVATE	→	DA
DEFAULT	→	D
DEFERRAL	→	D
DELETE	→	D
DETECTABILITY	→	DTEC
DIMENSIONS	→	D
DISPLAY	→	D
DRAW	→	D
DYNAMIC	→	D
element	→	E
EMERGENCY	→	E
ERROR	→	ER
ESCAPE	→	ESC
EVALUATE	→	EV
EXPANSION	→	XP
EXTENT	→	X
FACILITY	→	F
FILL	→	F
FLAG	→	F
FONT	→	F
GENERALISED	→	G
GET	→	GT
GKS	→	KS
HANDLING	→	HND
HEIGHT	→	H
HIGHLIGHTING	→	HLIT
IDENTIFICATION	→	ID
INDEX	→	I
INITIALISE	→	IN
INPUT	→	I
INQUIRE	→	Q
INSERT	→	IN
INTERIOR	→	I
INTERPRET	→	I
ITEM	→	ITM
LINE	→	LN
LINETYPE	→	LN
LINEWIDTH	→	LN
LOCATOR	→	LC
LOGGING	→	LOG
LOGICAL	→	L
MARKER	→	MK
MATRIX	→	M
MAXIMUM	→	M
MESSAGE	→	MSG
MODE	→	M
NORMALIZATION	→	N
OPEN	→	OP
OPERATING	→	OP
OVERFLOW	→	OV
PACK	→	P
PATH	→	P
PATTERN	→	PA
PICK	→	PK
PIXEL	→	PX
POLYLINE	→	PL
POLYMARKER	→	PM
PRECISION	→	P
PREDEFINED	→	P
PRIMITIVE	→	P
PRIORITY	→	P
QUEUE	→	Q
READ	→	RD
RECORD	→	REC
REDRAW	→	R
REFERENCE	→	RF
RENAME	→	REN
REPRESENTATION	→	R
REQUEST	→	RQ
SAMPLE	→	SM
SCALE	→	SC
SEGMENT	→	SG
SELECT	→	SEL
SET	→	S
SIMULTANEOUS	→	SIM
SOURCE	→	S
SPACE	→	SP
STATE	→	S
STRING	→	ST
STROKE	→	SK
STYLE	→	S
SURFACE	→	S
TEXT	→	TX
TRANSFORMATION	→	T
UNPACK	→	U
UPDATE	→	U
USE	→	US
VALUATOR	→	VL
VIEWPORT	→	VP
VISIBILITY	→	VIS
WIDTH	→	W
WINDOW	→	WN
WORKSTATION	→	WK
WRITE	→	W

5. Data Types

In the GKS standard, parameters of several types are used. The following shows the correspondence between the types used in the GKS document and their realisation in a FORTRAN implementation.

GKS Data Type	FORTRAN Data Types
I integer	INTEGER
R real	REAL
S string	1) In a full FORTRAN 77 subroutine: a) INTEGER containing the number of characters returned (for output string argument only) b) CHARACTER*(*) containing the string. In addition, if a character string which is an input parameter may reasonably contain no characters, then an INTEGER (≥ 0) is used to give the number of characters to be passed to the subroutine. 2) In a FORTRAN 77 Subset subroutine: a) INTEGER containing the number of characters passed to the subroutine (for input string only, i.e. only one INTEGER needed for output). b) INTEGER containing the number of characters returned (for output string argument only). c) CHARACTER*80 containing the string.
P point	REAL, REAL containing the X- and Y-values

const x simple_type where simple_type is I or R(vector of values, for example 2xR)

In non-inquiry functions, separate simple_type parameters are used (note: in GKS, const ≤ 4)

In inquiry functions, if const ≤ 3, separate simple_type parameters are used; if const ≥ 4, a simple_type array of dimension const is used.

const x P (only occurs in non-inquiry functions)

Separate REAL parameters, with the X- and Y- coordinates of one point being followed by the X- and Y- coordinates of the next.

const x E (only occurrence in GKS is const = 13)

An array of INTEGER elements of dimension const is used, each element being an enumeration alternative.

const 1 x const 2 x R (matrix of values, for example 2x3xR)

REAL array (const 1, const 2)

list of n values of one simple_type (for example nxI)

1) For input parameter:
a) INTEGER (input parameter) containing length n of the list (unless the length is already present as a separate GKS parameter, in which case it is not duplicated)
b) array of dimension n, whose elements are of the appropriate simple_type.

When the length was legally be defined as zero within GKS, the binding indicates the array dimension by *. The implementation checks that the given length is ≥ 1.

2) For output parameter in non-inquiry functions:
a) INTEGER (input parameter) containing the dimension of the array
b) INTEGER (output parameter) containing the number of elements of the array actually used.
c) an array whose elements are of the appropriate simple_type. The input dimension being too small is a language binding error condition (error 2001).

In both cases (input or output), where the simple_type is a point, there is a REAL array for the X-coordinates and another for the Y-coordinates.

3) For inquiry functions, a single call only returns a single element of the list. For a complete list of length n,
a) INTEGER (input parameter) containing the sequence number of required list element (in the range 0...n).
b) INTEGER (output parameter) containing the number of items in the list n.
c) a parameter of the appropriate simple_type containing the requested element.

If the sequence number given is 0, the requested element returned is undefined, but an error is not indicated thereby; the number of items in the list n is returned. If the sequence number given is <0 or $>$n, then error 2002 is indicated, the number of items in the list is returned, but the requested element is undefined; the exception to this is when the list size is 0, and in that case an error is not indicated thereby.

4) A complete inquired list is returned from a single call when the maximum size of the list is a small constant m:
a) INTEGER (output parameter) containing the number of elements of the array actually used.
b) an array of dimension m, whose elements are of the appropriate simple_type.

list of n values of a compound type(for example, nx4xR):
This only occurs in an inquiry function. A single call only returns a single element of the list exactly as for the list of values of one simple_type, except that here the requested element is several FORTRAN parameters.

array of integers (in GKS, nxnxI, where thetwo occurrences of n may have different values).
This is described more fully below, where the representations of CELL ARRAY, PIXEL ARRAY and PATTERN are described.

an ordered pair of different types(for example (I;E))
The different types are represented in turn in the FORTRAN parameter list.

NAME	INTEGER 1) Workstation Identifier, Segment Name, Pick Identifier: An implementation may restrict the range but must at least provide all non-negative integers which are available at that implementation. Note: the default value for pick identifier is zero. 2) Workstation Type, Connection Identifier, Error File: The set of valid values is implementation dependent. The Connection Identifier and Error File may be logical unit numbers. 3) GDP Identifier, Escape Identifier: The set of legal values is described in the GKS standard. 4) Identification of GKS procedure: The range is shown under 'Enumeration Types'.
ENUMERATION	INTEGER Note: All values are mapped to the range zero to N-1, where N is the number of enumeration alternatives. The single exception is GKS LEVEL, which starts with -3 to ensure compatibility with an ISO GKS FORTRAN Binding. Except for null values, the order of the enumeration alternatives is the same as in the GKS document: null values always appear in the first position. If the integer value given by the application program is not in the range 0 to N-1, there is a language binding error condition (error 2000).
DATA RECORD	Represented as a set of scalar values and an array of type CHARACTER*80 containing the data. In addition, an INTEGER input parameter is used to dimension the array. Where the data record is an output parameter, an additional argument 'number of array elements of data record occupied' is needed. There are no scalar values except where the data record contains values which are compulsory in GKS. Note: Data can be read from and written into the data record with the FORTRAN READ and WRITE statements. Special utility functions are defined to pack INTEGER, REAL, and CHARACTER data into the data record and to unpack the data record to the individual data items (GPREC, GUREC). The content of the packed data records is implementation dependent, but GPREC must perform the inverse function to GUREC and vice versa.

The representation of CELL ARRAY, PIXEL ARRAY, and PATTERN allows the user of the routines requiring a cell array parameter to pass any portion of the array as an argument. Two examples should make this clear.

Certainly the user can pass an entire two-dimensional array. In this case the number of columns of the cell array is the same as the first dimension of the FORTRAN array:

```
INTEGER DIMX, DIMY, CELLS (DIMX,DIMY)
CALL GCA (X1, Y1, X2, Y2, DIMX, DIMY, 1, 1, DIMX, DIMY, CELLS)
```

(1,1)	(2,1)	(3,1)	. . .	(DIMX,1)
(1,2)	(2,2)	(3,2)	. . .	(DIMX,2)
:	:	:		:
(1,DIMY)	(2,DIMY)	(3,DIMY)	. . .	(DIMX,DIMY)

To use an arbitrary portion of an array the user passes the upper left corner of the portion as starting address and the first dimension of the entire array for the proper treatment of addresses. The area inside the small box is the cell array being passed:

```
INTEGER STARTX, STARTY, DX, DY, DIMX, DIMY, CELLS (DIMX,DIMY)
DATA STARTX/3/, STARTY/6/, DX/2/, DY/3/
CALL GCA (X1,Y1,X2,Y2,DIMX,DIMY,STARTX,STARTY,DX,DY,CELLS)
```

(1,1)	(2,1)	(3,1)	(4,1)	. . .	(DIMX,1)
(1,2)	(2,2)	(3,2)	(4,2)	. . .	(DIMX,2)
:	:	:	:		:
:	:				:
(1,6)	(2,6)	(3,6)	(4,6)	. . .	(DIMX,6)
(1,7)	(2,7)	(3,7)	(4,7)	. . .	(DIMX,7)
(1,8)	(2,8)	(3,8)	(4,8)	. . .	(DIMX,8)
:	:				:
:	:	:	:		:
(1,DIMY)	(2,DIMY)	(3,DIMY)	(4,DIMY)	. . .	(DIMX,DIMY)

6. Enumeration Types

All the enumeration types of GKS are mapped to FORTRAN INTEGERs. The correspondence between GKS scalars and FORTRAN INTEGERs is shown below in a list of symbolic FORTRAN constants which may be included in any application program. The following section contains a method of mapping GKS enumeration types to FORTRAN variable names. In a FORTRAN 77 Subset implementation, this mapping could be accomplished by the DATA statement. Also, a numbering of all GKS functions is given for use in the error handling procedures.

Mnemonic FORTRAN names and their values for GKS ENUMERATION type values:

```
aspect source bundled,        individual
           INTEGER        GBUNDL,     GINDIV
           PARAMETER ( GBUNDL=0,   GINDIV=1 )

clear control flag            conditionally, always
           INTEGER        GCONDI,     GALWAY
           PARAMETER ( GCONDI=0,   GALWAY=1 )

clipping indicator            noclip,     clip
           INTEGER        GNCLIP,     GCLIP
           PARAMETER ( GNCLIP=0,   GCLIP=1 )

colour available              monochrome, colour
           INTEGER        GMONOC,     GCOLOR
           PARAMETER ( GMONOC=0,   GCOLOR=1 )

coordinate switch             WC,         NDC
           INTEGER        GWC,        GNDC
           PARAMETER ( GWC=0,      GNDC=1 )

deferral mode                 ASAP,       BNIG,       BNIL,       ASTI
(see GKS 4.5.3)
           INTEGER        GASAP,      GBNIG,      GBNIL,      GASTI
           PARAMETER ( GASAP=0,    GBNIG=1,    GBNIL=2,    GASTI=3 )

detectability  undetectable,  detectable
           INTEGER        GUNDET,     GDETEC
           PARAMETER ( GUNDET=0,   GDETEC=1 )

device coordinate units       metres,     other
           INTEGER        GMETRE,     GOTHU
           PARAMETER ( GMETRE=0,   GOTHU=1 )

display surface empty         notempty,   empty
           INTEGER        GNEMPT,     GEMPTY
           PARAMETER ( GNEMPT=0,   GEMPTY=1 )

dynamic modification          IRG,        IMM
(see GKS 4.5.3)
           INTEGER        GIRG,       GIMM
           PARAMETER ( GIRG=0,     GIMM=1 )

echo switch  noecho,          echo
           INTEGER        GNECHO,     GECHO
           PARAMETER ( GNECHO=0,   GECHO=1 )

fill area interior style      hollow,     solid,      pattern,    hatch
           INTEGER        GHOLLO,     GSOLID,     GPATTR,     GHATCH
           PARAMETER ( GHOLLO=0,   GSOLID=1,   GPATTR=2,   GHATCH=3 )
```

highlighting	normal,	highlighted					
	INTEGER	GNORML,	GHILIT				
	PARAMETER (	GNORML=0,	GHILIT=1)				
input device status		none,	ok,	nopick,	nochoice		
	INTEGER	GNONE,	GOK,	GNPICK,	GNCHOI		
	PARAMETER (	GNONE=0,	GOK=1,	GNPICK=2,	GNCHOI=2)		
input class	none,	locator,	stroke,	valuator,	choice,	pick,	
		string					
	INTEGER	GNCLAS,	GLOCAT,	GSTROK,	GVALUA,	GCHOIC,	GPICK,
		GSTRIN					
	PARAMETER (	GNCLAS=0,	GLOCAT=1,	GSTROK=2,	GVALUA=3,	GCHOIC=4,	GPICK=5,
		GSTRIN=6)					
implicit regeneration mode		suppressed,	allowed				
	INTEGER	GSUPPD,	GALLOW				
	PARAMETER (	GSUPPD=0,	GALLOW=1)				
level of GKS	Lma,	Lmb,	Lmc,	L0a,	L0b,	L0c,	
		L1a,	L1b,	L1c,	L2a,	L2b,	L2c
	INTEGER	GLMA,	GLMB,	GLMC,	GL0A,	GL0B,	GL0C,
	*	GL1A,	GL1B,	GL1C,	GL2A,	GL2B,	GL2C
	PARAMETER (	GLMA=-3,	GLMB=-2,	GLMC=-1,	GL0A=0,	GL0B=1,	GL0C=2,
	*	GL1A=3,	GL1B=4,	GL1C=5,	GL2A=6,	GL2B=7,	GL2C=8)
new frame action necessary		no,	yes				
	INTEGER	GNO,	GYES				
	PARAMETER (	GNO=0,	GYES=1)				
operating mode		request,	sample,	event			
	INTEGER	GREQU,	GSAMPL,	GEVENT			
	PARAMETER (	GREQU=0,	GSAMPL=1,	GEVENT=2)			
operating state value (see GKS 4.11.1)		GKCL,	GKOP,	WSOP,	WSAC,	SGOP	
	INTEGER	GGKCL,	GGKOP,	GWSOP,	GWSAC,	GSGOP	
	PARAMETER (	GGKCL=0,	GGKOP=1,	GWSOP=2,	GWSAC=3,	GSGOP=4)	
presence of invalid values		absent,	present				
	INTEGER	GABSNT,	GPRSNT				
	PARAMETER (	GABSNT=0,	GPRSNT=1)				
regeneration flag		postpone,	perform				
	INTEGER	GPOSTP,	GPERFO				
	PARAMETER (	GPOSTP=0,	GPERFO=1)				
relative input priority		higher,	lower				
	INTEGER	GHIGHR,	GLOWER				
	PARAMETER (	GHIGHR=0,	GLOWER=1)				
simultaneous events flag		nomore,	more				
	INTEGER	GNMORE,	GMORE				
	PARAMETER (	GNMORE=0,	GMORE=1)				
text alignment horizontal		normal,	left,	center,	right		
	INTEGER	GAHNOR,	GALEFT,	GACENT,	GARITE		
	PARAMETER (	GAHNOR=0,	GALEFT=1,	GACENT=2,	GARITE=3)		
text alignment vertical		normal,	top,	cap,	half,	base,	bottom
	INTEGER	GAVNOR,	GATOP,	GACAP,	GAHALF,	GABASE,	GABOTT
	PARAMETER (	GAVNOR=0,	GATOP=1,	GACAP=2,	GAHALF=3,	GABASE=4,	GABOTT=5)

```
text path      right,            left,          up,            down
               INTEGER           GRIGHT,        GLEFT,         GUP,           GDOWN
               PARAMETER (       GRIGHT=0,      GLEFT=1,       GUP=2,         GDOWN=3 )

text precision                   string,        character,     stroke
               INTEGER           GSTRP,         GCHARP,        GSTRKP
               PARAMETER (       GSTRP=0,       GCHARP=1,      GSTRKP=2 )

type of returned values          set,           realized
               INTEGER           GSET,          GREALI
               PARAMETER (       GSET=0,        GREALI=1 )

update state   notpending,       pending
               INTEGER           GNPEND,        GPEND
               PARAMETER (       GNPEND=0,      GPEND=1 )

vector/raster/other type         vector,        raster,        other
               INTEGER           GVECTR,        GRASTR,        GOTHWK
               PARAMETER (       GVECTR=0,      GRASTR=1,      GOTHWK=2 )

visibility     invisible,        visible
               INTEGER           GINVIS,        GVISI
               PARAMETER (       GINVIS=0,      GVISI=1 )

workstation category             OUTPUT,        INPUT,         OUTIN,         WISS,          MO,            MI
(see GKS 4 5.1)
               INTEGER           GOUTPT,        GINPUT,        GOUTIN,        GWISS,         GMO,           GMI
               PARAMETER (       GOUTPT=0,      GINPUT=1,      GOUTIN=2,      GWISS=3,       GMO=4,         GMI=5 )

workstation state                inactive,      active
               INTEGER           GINACT,        GACTIV
               PARAMETER (       GINACT=0,      GACTIV=1 )

list of GDP attributes           polyline attribute,polymarker attribute,text attribute,fill area attribute

               INTEGER           GPLATT,        GPMATT,        GTXATT,        GFAATT
               PARAMETER (       GPLATT=0,      GPMATT=1,      GTXATT=2,      GFAATT=3 )

line type      solid,            dash,          dot,           dash-dot
               INTEGER           GLSOLI,        GLDASH,        GLDOT,         GLDASD
               PARAMETER (       GLSOLI=1,      GLDASH=2,      GLDOT=3,       GLDASD=4 )

marker type    '.',              '+',           '*',           'o',           'x'
               INTEGER           GPOINT,        GPLUS,         GAST,          GOMARK,        GXMARK
               PARAMETER (       GPOINT=1,      GPLUS=2,       GAST=3,        GOMARK=4,      GXMARK=5 )

attribute control flag           current,       specified
               INTEGER           GCURNT,        GSPEC
               PARAMETER (       GCURNT=0,      GSPEC=1 )

polyline/fill area control flag  polyline,      fill area
               INTEGER           GPLINE,        GFILLA
               PARAMETER (       GPLINE=0,      GFILLA=1 )

initial choice prompt flag       off,           on
               INTEGER           GPROFF,        GPRON
               PARAMETER (       GPROFF=0,      GPRON=1 )
```

GKS functions -
These names are used for error handling. The names are the same as the GKS function names except that the sentinel character 'G' is replaced by 'E'. The same function identification is used for both full FORTRAN 77 and FORTRAN 77 Subset.

```
INTEGER       EOPKS,       ECLKS,       EOPWK,       ECLWK,       EACWK
PARAMETER (   EOPKS =0,    ECLKS=1,     EOPWK=2,     ECLWK=3,     EACWK=4 )
INTEGER       EDAWK,       ECLRWK,      ERSGWK,      EUWK,        ESDS
PARAMETER (   EDAWK=5,     ECLRWK=6,    ERSGWK=7,    EUWK=8,      ESDS=9 )
INTEGER       EMSG,        EESC,        EPL,         EPM,         ETX
PARAMETER (   EMSG=10,     EESC=11,     EPL=12,      EPM=13,      ETX=14 )
INTEGER       EFA,         ECA,         EGDP,        ESPLI,       ESLN
PARAMETER (   EFA=15,      ECA=16,      EGDP=17,     ESPLI=18,    ESLN=19 )
INTEGER       ESLWSC,      ESPLCI,      ESPMI,       ESMK,        ESMKSC
PARAMETER (   ESLWSC=20,   ESPLCI=21,   ESPMI=22,    ESMK=23,     ESMKSC=24 )
INTEGER       ESPMCI,      ESTXI,       ESTXFP,      ESCHXP,      ESCHSP
PARAMETER (   ESPMCI=25,   ESTXI=26,    ESTXFP=27,   ESCHXP=28,   ESCHSP=29 )
INTEGER       ESTXCI,      ESCHH,       ESCHUP,      ESTXP,       ESTXAL
PARAMETER (   ESTXCI=30,   ESCHH=31,    ESCHUP=32,   ESTXP=33,    ESTXAL=34 )
INTEGER       ESFAI,       ESFAIS,      ESFASI,      ESFACI,      ESPA
PARAMETER (   ESFAI=35,    ESFAIS=36,   ESFASI=37,   ESFACI=38,   ESPA=39 )
INTEGER       ESPARF,      ESASF,       ESPKID,      ESPLR,       ESPMR
PARAMETER (   ESPARF=40,   ESASF=41,    ESPKID=42,   ESPLR=43,    ESPMR=44 )
INTEGER       ESTXR,       ESFAR,       ESPAR,       ESCR,        ESWN
PARAMETER (   ESTXR=45,    ESFAR=46,    ESPAR=47,    ESCR=48,     ESWN=49 )
INTEGER       ESVP,        ESVPIP,      ESELNT,      ESCLIP,      ESWKWN
PARAMETER (   ESVP=50,     ESVPIP=51,   ESELNT=52,   ESCLIP=53,   ESWKWN=54 )
INTEGER       ESWKVP,      ECRSG,       ECLSG,       ERENSG,      EDSG
PARAMETER (   ESWKVP=55,   ECRSG=56,    ECLSG=57,    ERENSG=58,   EDSG=59 )
INTEGER       EDSGWK,      EASGWK,      ECSGWK,      EINSG,       ESSGT
PARAMETER (   EDSGWK=60,   EASGWK=61,   ECSGWK=62,   EINSG=63,    ESSGT=64 )
INTEGER       ESVIS,       ESHLIT,      ESSGP,       ESDTEC,      EINLC
PARAMETER (   ESVIS=65,    ESHLIT=66,   ESSGP=67,    ESDTEC=68,   EINLC=69 )
INTEGER       EINSK,       EINVL,       EINCH,       EINPK,       EINST
PARAMETER (   EINSK=70,    EINVL=71,    EINCH=72,    EINPK=73,    EINST=74 )
INTEGER       ESLCM,       ESSKM,       ESVLM,       ESCHM,       ESPKM
PARAMETER (   ESLCM=75,    ESSKM=76,    ESVLM=77,    ESCHM=78,    ESPKM=79 )
INTEGER       ESSTM,       ERQLC,       ERQSK,       ERQVL,       ERQCH
PARAMETER (   ESSTM=80,    ERQLC=81,    ERQSK=82,    ERQVL=83,    ERQCH=84 )
INTEGER       ERQPK,       ERQST,       ESMLC,       ESMSK,       ESMVL
PARAMETER (   ERQPK=85,    ERQST=86,    ESMLC=87,    ESMSK=88,    ESMVL=89 )
INTEGER       ESMCH,       ESMPK,       ESMST,       EWAIT,       EFLUSH
PARAMETER (   ESMCH=90,    ESMPK=91,    ESMST=92,    EWAIT=93,    EFLUSH=94 )
INTEGER       EGTLC,       EGTSK,       EGTVL,       EGTCH,       EGTPK
PARAMETER (   EGTLC=95,    EGTSK=96,    EGTVL=97,    EGTCH=98,    EGTPK=99 )
INTEGER       EGTST,       EWITM,       EGTITM,      ERDITM,      EIITM
PARAMETER (   EGTST=100,   EWITM=101,   EGTITM=102,  ERDITM=103,  EIITM=104 )
INTEGER       EEVTM,       EACTM,       EPREC,       EUREC
PARAMETER (   EEVTM=105,   EACTM=106,   EPREC=107,   EUREC=108 )
```

7. List of the GKS Function Names and Levels

The complete list of GKS function names and their levels follows. Note that in nearly all cases the level matches that of the GKS document, but in some cases where one function in the GKS document has been mapped into many in the FORTRAN Binding, the levels may have been adjusted as appropriate.

7.1 List Ordered by Bound Names

GACTM	AC-T-M	1a	ACCUMULATE TRANSFORMATION MATRIX
GACWK	AC-WK	ma	ACTIVATE WORKSTATION
GASGWK	A-SG-WK	2a	ASSOCIATE SEGMENT WITH WORKSTATION
GCA	C-A	0a	CELL ARRAY
GCLKS	CL-KS	ma	CLOSE GKS
GCLRWK	CLR-WK	ma	CLEAR WORKSTATION
GCLSG	CL-SG	1a	CLOSE SEGMENT
GCLWK	CL-WK	ma	CLOSE WORKSTATION
GCRSG	CR-SG	1a	CREATE SEGMENT
GCSGWK	C-SG-WK	2a	COPY SEGMENT TO WORKSTATION
GDAWK	DA-WK	ma	DEACTIVATE WORKSTATION
GDSG	D-SG	1a	DELETE SEGMENT
GDSGWK	D-SG-WK	1a	DELETE SEGMENT FROM WORKSTATION
GECLKS	E-CL-KS	0a	EMERGENCY CLOSE GKS
GERHND	ER-HND	0a	ERROR HANDLING
GERLOG	ER-LOG	0a	ERROR LOGGING
GESC	ESC	ma	ESCAPE
GEVTM	EV-T-M	1a	EVALUATE TRANSFORMATION MATRIX
GFA	F-A	ma	FILL AREA
GFLUSH	FLUSH	mc	FLUSH DEVICE EVENTS
GGDP	G-D-P	ma	GENERALIZED DRAWING PRIMITIVE
GGTCH	GT-CH	mc	GET CHOICE
GGTITM	GT-ITM	0a	GET ITEM TYPE FROM GKSM
GGTLC	GT-LC	mc	GET LOCATOR
GGTPK	GT-PK	1c	GET PICK
GGTSK	GT-SK	mc	GET STROKE
GGTST	GT-ST	mc	GET STRING
GGTVL	GT-VL	mc	GET VALUATOR
GIITM	I-ITM	0a	INTERPRET ITEM
GINCH	IN-CH	mb	INITIALISE CHOICE
GINLC	IN-LC	mb	INITIALISE LOCATOR
GINPK	IN-PK	1b	INITIALISE PICK
GINSG	IN-SG	2a	INSERT SEGMENT
GINSK	IN-SK	mb	INITIALISE STROKE
GINST	IN-ST	mb	INITIALISE STRING
GINVL	IN-VL	mb	INITIALISE VALUATOR
GMSG	MSG	1a	MESSAGE
GMSGS	MSG-S	1a	MESSAGE (FORTRAN 77 SUBSET)
GOPKS	OP-KS	ma	OPEN GKS
GOPWK	OP-WK	ma	OPEN WORKSTATION
GPL	PL	ma	POLYLINE
GPM	PM	ma	POLYMARKER
GPREC	P-REC	0a	PACK DATA RECORD
GQACWK	Q-AC-WK	1a	INQUIRE SET member OF ACTIVE WORKSTATIONS
GQASF	Q-A-S-F	0a	INQUIRE ASPECT SOURCE FLAGS (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQASWK	Q-AS-WK	1a	INQUIRE SET member OF ASSOCIATED WORKSTATIONS
GQCF	Q-C-F	ma	INQUIRE COLOUR FACILITIES
GQCHB	Q-CH-B	0a	INQUIRE CHARACTER BASE VECTOR (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHH	Q-CH-H	ma	INQUIRE CHARACTER HEIGHT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHS	Q-CH-S	mb	INQUIRE CHOICE DEVICE STATE
GQCHSP	Q-CH-SP	0a	INQUIRE CHARACTER SPACING (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)

GQCHUP	Q-CH-UP	ma	INQUIRE CHARACTER UP VECTOR (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHW	Q-CH-W	0a	INQUIRE CHARACTER WIDTH (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHXP	Q-CH-XP	0a	INQUIRE CHARACTER EXPANSION FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQCLIP	Q-CLIP	ma	INQUIRE CLIPPING INDICATOR
GQCNTN	Q-C-N-T-N	ma	INQUIRE CURRENT NORMALIZATION TRANSFORMATION NUMBER
GQCR	Q-C-R	ma	INQUIRE COLOUR REPRESENTATION
GQDCH	Q-D-CH	mb	INQUIRE DEFAULT CHOICE DEVICE DATA
GQDDS	Q-D-D-S	1a	INQUIRE DEFAULT DEFERRAL STATE VALUES
GQDLC	Q-D-LC	mb	INQUIRE DEFAULT LOCATOR DEVICE DATA
GQDPK	Q-D-PK	1b	INQUIRE DEFAULT PICK DEVICE DATA
GQDSGA	Q-D-SG-A	1a	INQUIRE DYNAMIC MODIFICATION OF SEGMENT ATTRIBUTES
GQDSK	Q-D-SK	mb	INQUIRE DEFAULT STROKE DEVICE DATA
GQDSP	Q-D-SP	0a	INQUIRE DISPLAY SPACE SIZE
GQDST	Q-D-ST	mb	INQUIRE DEFAULT STRING DEVICE DATA
GQDVL	Q-D-VL	mb	INQUIRE DEFAULT VALUATOR DEVICE DATA
GQDWKA	Q-D-WK-A	1a	INQUIRE DYNAMIC MODIFICATION OF WORKSTATION ATTRIBUTES
GQECI	Q-E-C-I	ma	INQUIRE LIST element OF COLOUR INDICES
GQEFAI	Q-E-F-A-I	1a	INQUIRE LIST element OF FILL AREA INDICES
GQEGDP	Q-E-G-D-P	ma	INQUIRE LIST element OF AVAILABLE GENERALIZED DRAWING PRIMITIVES
GQENTN	Q-E-N-T-N	0a	INQUIRE LIST element OF NORMALIZATION TRANSFORMATION NUMBERS
GQEPAI	Q-E-PA-I	1a	INQUIRE LIST element OF PATTERN INDICES
GQEPLI	Q-E-PL-I	1a	INQUIRE LIST element OF POLYLINE INDICES
GQEPMI	Q-E-PM-I	1a	INQUIRE LIST element OF POLYMARKER INDICES
GQETXI	Q-E-TX-I	1a	INQUIRE LIST element OF TEXT INDICES
GQEWK	Q-E-WK	0a	INQUIRE LIST element OF AVAILABLE WORKSTATION TYPES
GQFACI	Q-F-A-C-I	ma	INQUIRE FILL AREA COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQFAF	Q-F-A-F	ma	INQUIRE FILL AREA FACILITIES
GQFAI	Q-F-A-I	0a	INQUIRE FILL AREA INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQFAIS	Q-F-A-I-S	ma	INQUIRE FILL AREA INTERIOR STYLE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQFAR	Q-F-A-R	1a	INQUIRE FILL AREA REPRESENTATION
GQFASI	Q-F-A-S-I	0a	INQUIRE FILL AREA STYLE INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQGDP	Q-G-D-P	0a	INQUIRE GENERALIZED DRAWING PRIMITIVE
GQIQOV	Q-I-Q-OV	mc	INQUIRE INPUT QUEUE OVERFLOW
GQLCS	Q-LC-S	mb	INQUIRE LOCATOR DEVICE STATE
GQLI	Q-L-I	mb	INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES
GQLN	Q-LN	ma	INQUIRE LINETYPE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQLVKS	Q-LV-KS	ma	INQUIRE LEVEL OF GKS
GQLWK	Q-L-WK	0a	INQUIRE MAXIMUM LENGTH OF WORKSTATION STATE TABLES
GQLWSC	Q-LW-SC	0a	INQUIRE LINEWIDTH SCALE FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQMK	Q-MK	ma	INQUIRE MARKERTYPE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQMKSC	Q-MK-SC	0a	INQUIRE MARKER SIZE SCALE FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQMNTN	Q-M-N-T-N	0a	INQUIRE MAXIMUM NORMALIZATION TRANSFORMATION NUMBER
GQNT	Q-N-T	ma	INQUIRE NORMALIZATION TRANSFORMATION
GQOPS	Q-OP-S	0a	INQUIRE OPERATING STATE VALUE
GQOPSG	Q-OP-SG	1a	INQUIRE NAME OF OPEN SEGMENT
GQOPWK	Q-OP-WK	0a	INQUIRE SET member OF OPEN WORKSTATIONS
GQPA	Q-PA	0a	INQUIRE PATTERN SIZE (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPAF	Q-PA-F	0a	INQUIRE PATTERN FACILITIES
GQPAR	Q-PA-R	1a	INQUIRE PATTERN REPRESENTATION

GQPARF	Q-PA-RF	0a	INQUIRE PATTERN REFERENCE POINT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPCR	Q-P-C-R	0a	INQUIRE PREDEFINED COLOUR REPRESENTATION
GQPFAR	Q-P-F-A-R	0a	INQUIRE PREDEFINED FILL AREA REPRESENTATION
GQPKID	Q-PK-ID	1b	INQUIRE PICK IDENTIFIER
GQPKS	Q-PK-S	1b	INQUIRE PICK DEVICE STATE
GQPLCI	Q-PL-C-I	ma	INQUIRE POLYLINE COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQPLF	Q-PL-F	ma	INQUIRE POLYLINE FACILITIES
GQPLI	Q-PL-I	0a	INQUIRE POLYLINE INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPLR	Q-PL-R	1a	INQUIRE POLYLINE REPRESENTATION
GQPMCI	Q-PM-C-I	ma	INQUIRE POLYMARKER COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQPMF	Q-PM-F	ma	INQUIRE POLYMARKER FACILITIES
GQPMI	Q-PM-I	0a	INQUIRE POLYMARKER INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPMR	Q-PM-R	1a	INQUIRE POLYMARKER REPRESENTATION
GQPPAR	Q-P-PA-R	0a	INQUIRE PREDEFINED PATTERN REPRESENTATION
GQPPLR	Q-P-PL-R	0a	INQUIRE PREDEFINED POLYLINE REPRESENTATION
GQPPMR	Q-P-PM-R	0a	INQUIRE PREDEFINED POLYMARKER REPRESENTATION
GQPTXR	Q-P-TX-R	0a	INQUIRE PREDEFINED TEXT REPRESENTATION
GQPX	Q-PX	0a	INQUIRE PIXEL
GQPXA	Q-PX-A	0a	INQUIRE PIXEL ARRAY
GQPXAD	Q-PX-A-D	0a	INQUIRE PIXEL ARRAY DIMENSIONS
GQSGA	Q-SG-A	1a	INQUIRE SEGMENT ATTRIBUTES
GQSGP	Q-SG-P	1a	INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED
GQSGUS	Q-SG-US	1a	INQUIRE SET member OF SEGMENT NAMES IN USE
GQSGWK	Q-SG-WK	1a	INQUIRE SET member OF SEGMENT NAMES ON WORKSTATION
GQSIM	Q-SIM	mc	INQUIRE MORE SIMULTANEOUS EVENTS
GQSKS	Q-SK-S	mb	INQUIRE STROKE DEVICE STATE
GQSTS	Q-ST-S	mb	INQUIRE STRING DEVICE STATE
GQTXAL	Q-TX-AL	ma	INQUIRE TEXT ALIGNMENT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXCI	Q-TX-C-I	ma	INQUIRE TEXT COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQTXF	Q-TX-F	ma	INQUIRE TEXT FACILITIES
GQTXFP	Q-TX-F-P	0a	INQUIRE TEXT FONT AND PRECISION (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQTXI	Q-TX-I	0a	INQUIRE TEXT INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXP	Q-TX-P	0a	INQUIRE TEXT PATH (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXR	Q-TX-R	1a	INQUIRE TEXT REPRESENTATION
GQTXX	Q-TX-X	ma	INQUIRE TEXT EXTENT
GQTXXS	Q-TX-X-S	ma	INQUIRE TEXT EXTENT (FORTRAN 77 SUBSET)
GQVLS	Q-VL-S	mb	INQUIRE VALUATOR DEVICE STATE
GQWKC	Q-WK-C	ma	INQUIRE WORKSTATION CONNECTION AND TYPE
GQWKCA	Q-WK-CA	0a	INQUIRE WORKSTATION CATEGORY
GQWKCL	Q-WK-CL	0a	INQUIRE WORKSTATION CLASSIFICATION
GQWKDU	Q-WK-D-U	0a	INQUIRE WORKSTATION DEFERRAL AND UPDATE STATES
GQWKM	Q-WK-M	1a	INQUIRE WORKSTATION MAXIMUM NUMBERS
GQWKS	Q-WK-S	0a	INQUIRE WORKSTATION STATE
GQWKT	Q-WK-T	ma	INQUIRE WORKSTATION TRANSFORMATION
GRDITM	RD-ITM	0a	READ ITEM FROM GKSM
GRENSG	REN-SG	1a	RENAME SEGMENT
GRQCH	RQ-CH	mb	REQUEST CHOICE
GRQLC	RQ-LC	mb	REQUEST LOCATOR
GRQPK	RQ-PK	1b	REQUEST PICK
GRQSK	RQ-SK	mb	REQUEST STROKE
GRQST	RQ-ST	mb	REQUEST STRING
GRQVL	RQ-VL	mb	REQUEST VALUATOR
GRSGWK	R-SG-WK	1a	REDRAW ALL SEGMENTS ON WORKSTATION
GSASF	S-A-S-F	0a	SET ASPECT SOURCE FLAGS
GSCHH	S-CH-H	ma	SET CHARACTER HEIGHT

GSCHM	S-CH-M	mb	SET CHOICE MODE
GSCHSP	S-CH-SP	0a	SET CHARACTER SPACING
GSCHUP	S-CH-UP	ma	SET CHARACTER UP VECTOR
GSCHXP	S-CH-XP	0a	SET CHARACTER EXPANSION FACTOR
GSCLIP	S-CLIP	ma	SET CLIPPING INDICATOR
GSCR	S-C-R	ma	SET COLOUR REPRESENTATION
GSDS	S-D-S	1a	SET DEFERRAL STATE
GSDTEC	S-DTEC	1b	SET DETECTABILITY
GSELNT	SEL-N-T	ma	SELECT NORMALIZATION TRANSFORMATION
GSFACI	S-F-A-C-I	ma	SET FILL AREA COLOUR INDEX
GSFAI	S-F-A-I	0a	SET FILL AREA INDEX
GSFAIS	S-F-A-I-S	ma	SET FILL AREA INTERIOR STYLE
GSFAR	S-F-A-R	1a	SET FILL AREA REPRESENTATION
GSFASI	S-F-A-S-I	0a	SET FILL AREA STYLE INDEX
GSHLIT	S-HLIT	1a	SET HIGHLIGHTING
GSLCM	S-LC-M	mb	SET LOCATOR MODE
GSLN	S-LN	ma	SET LINETYPE
GSLWSC	S-LW-SC	0a	SET LINEWIDTH SCALE FACTOR
GSMCH	SM-CH	mc	SAMPLE CHOICE
GSMK	S-MK	ma	SET MARKERTYPE
GSMKSC	S-MK-SC	0a	SET MARKER SIZE SCALE FACTOR
GSMLC	SM-LC	mc	SAMPLE LOCATOR
GSMPK	SM-PK	1c	SAMPLE PICK
GSMSK	SM-SK	mc	SAMPLE STROKE
GSMST	SM-ST	mc	SAMPLE STRING
GSMVL	SM-VL	mc	SAMPLE VALUATOR
GSPA	S-PA	0a	SET PATTERN SIZE
GSPAR	S-PA-R	1a	SET PATTERN REPRESENTATION
GSPARF	S-PA-RF	0a	SET PATTERN REFERENCE POINT
GSPKID	S-PK-ID	1b	SET PICK IDENTIFIER
GSPKM	S-PK-M	1b	SET PICK MODE
GSPLCI	S-PL-C-I	ma	SET POLYLINE COLOUR INDEX
GSPLI	S-PL-I	0a	SET POLYLINE INDEX
GSPLR	S-PL-R	1a	SET POLYLINE REPRESENTATION
GSPMCI	S-PM-C-I	ma	SET POLYMARKER COLOUR INDEX
GSPMI	S-PM-I	0a	SET POLYMARKER INDEX
GSPMR	S-PM-R	1a	SET POLYMARKER REPRESENTATION
GSSGP	S-SG-P	1a	SET SEGMENT PRIORITY
GSSGT	S-SG-T	1a	SET SEGMENT TRANSFORMATION
GSSKM	S-SK-M	mb	SET STROKE MODE
GSSTM	S-ST-M	mb	SET STRING MODE
GSTXAL	S-TX-AL	ma	SET TEXT ALIGNMENT
GSTXCI	S-TX-C-I	ma	SET TEXT COLOUR INDEX
GSTXFP	S-TX-F-P	0a	SET TEXT FONT AND PRECISION
GSTXI	S-TX-I	0a	SET TEXT INDEX
GSTXP	S-TX-P	0a	SET TEXT PATH
GSTXR	S-TX-R	1a	SET TEXT REPRESENTATION
GSVIS	S-VIS	1a	SET VISIBILITY
GSVLM	S-VL-M	mb	SET VALUATOR MODE
GSVP	S-VP	ma	SET VIEWPORT
GSVPIP	S-VP-I-P	mb	SET VIEWPORT INPUT PRIORITY
GSWKVP	S-WK-VP	ma	SET WORKSTATION VIEWPORT
GSWKWN	S-WK-WN	ma	SET WORKSTATION WINDOW
GSWN	S-WN	ma	SET WINDOW
GTX	TX	ma	TEXT
GTXS	TX-S	ma	TEXT (FORTRAN 77 SUBSET)
GUREC	U-REC	0a	UNPACK DATA RECORD
GUWK	U-WK	ma	UPDATE WORKSTATION
GWAIT	WAIT	mc	AWAIT EVENT
GWITM	W-ITM	0a	WRITE ITEM TO GKSM

7.2 List Ordered by GKS Function Names

GACTM	AC-T-M	1a	ACCUMULATE TRANSFORMATION MATRIX
GACWK	AC-WK	ma	ACTIVATE WORKSTATION
GASGWK	A-SG-WK	2a	ASSOCIATE SEGMENT WITH WORKSTATION
GWAIT	WAIT	mc	AWAIT EVENT
GCA	C-A	0a	CELL ARRAY
GCLRWK	CLR-WK	ma	CLEAR WORKSTATION
GCLKS	CL-KS	ma	CLOSE GKS
GCLSG	CL-SG	1a	CLOSE SEGMENT
GCLWK	CL-WK	ma	CLOSE WORKSTATION
GCSGWK	C-SG-WK	2a	COPY SEGMENT TO WORKSTATION
GCRSG	CR-SG	1a	CREATE SEGMENT
GDAWK	DA-WK	ma	DEACTIVATE WORKSTATION
GDSG	D-SG	1a	DELETE SEGMENT
GDSGWK	D-SG-WK	1a	DELETE SEGMENT FROM WORKSTATION
GECLKS	E-CL-KS	0a	EMERGENCY CLOSE GKS
GERHND	ER-HND	0a	ERROR HANDLING
GERLOG	ER-LOG	0a	ERROR LOGGING
GESC	ESC	ma	ESCAPE
GEVTM	EV-T-M	1a	EVALUATE TRANSFORMATION MATRIX
GFA	F-A	ma	FILL AREA
GFLUSH	FLUSH	mc	FLUSH DEVICE EVENTS
GGDP	G-D-P	ma	GENERALIZED DRAWING PRIMITIVE
GGTCH	GT-CH	mc	GET CHOICE
GGTITM	GT-ITM	0a	GET ITEM TYPE FROM GKSM
GGTLC	GT-LC	mc	GET LOCATOR
GGTPK	GT-PK	1c	GET PICK
GGTST	GT-ST	mc	GET STRING
GGTSK	GT-SK	mc	GET STROKE
GGTVL	GT-VL	mc	GET VALUATOR
GINCH	IN-CH	mb	INITIALISE CHOICE
GINLC	IN-LC	mb	INITIALISE LOCATOR
GINPK	IN-PK	1b	INITIALISE PICK
GINST	IN-ST	mb	INITIALISE STRING
GINSK	IN-SK	mb	INITIALISE STROKE
GINVL	IN-VL	mb	INITIALISE VALUATOR
GQASF	Q-A-S-F	0a	INQUIRE ASPECT SOURCE FLAGS (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQCHB	Q-CH-B	0a	INQUIRE CHARACTER BASE VECTOR (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHXP	Q-CH-XP	0a	INQUIRE CHARACTER EXPANSION FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQCHH	Q-CH-H	ma	INQUIRE CHARACTER HEIGHT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHSP	Q-CH-SP	0a	INQUIRE CHARACTER SPACING (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQCHUP	Q-CH-UP	ma	INQUIRE CHARACTER UP VECTOR (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHW	Q-CH-W	0a	INQUIRE CHARACTER WIDTH (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHS	Q-CH-S	mb	INQUIRE CHOICE DEVICE STATE
GQCLIP	Q-CLIP	ma	INQUIRE CLIPPING INDICATOR
GQCF	Q-C-F	ma	INQUIRE COLOUR FACILITIES
GQCR	Q-C-R	ma	INQUIRE COLOUR REPRESENTATION
GQCNTN	Q-C-N-T-N	ma	INQUIRE CURRENT NORMALIZATION TRANSFORMATION NUMBER
GQDCH	Q-D-CH	mb	INQUIRE DEFAULT CHOICE DEVICE DATA
GQDDS	Q-D-D-S	1a	INQUIRE DEFAULT DEFERRAL STATE VALUES
GQDLC	Q-D-LC	mb	INQUIRE DEFAULT LOCATOR DEVICE DATA
GQDPK	Q-D-PK	1b	INQUIRE DEFAULT PICK DEVICE DATA
GQDST	Q-D-ST	mb	INQUIRE DEFAULT STRING DEVICE DATA
GQDSK	Q-D-SK	mb	INQUIRE DEFAULT STROKE DEVICE DATA
GQDVL	Q-D-VL	mb	INQUIRE DEFAULT VALUATOR DEVICE DATA
GQDSP	Q-D-SP	0a	INQUIRE DISPLAY SPACE SIZE
GQDSGA	Q-D-SG-A	1a	INQUIRE DYNAMIC MODIFICATION OF SEGMENT ATTRIBUTES

GQDWKA	Q-D-WK-A	1a	INQUIRE DYNAMIC MODIFICATION OF WORKSTATION ATTRIBUTES
GQFACI	Q-F-A-C-I	ma	INQUIRE FILL AREA COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQFAF	Q-F-A-F	ma	INQUIRE FILL AREA FACILITIES
GQFAI	Q-F-A-I	0a	INQUIRE FILL AREA INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQFAIS	Q-F-A-I-S	ma	INQUIRE FILL AREA INTERIOR STYLE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQFAR	Q-F-A-R	1a	INQUIRE FILL AREA REPRESENTATION
GQFASI	Q-F-A-S-I	0a	INQUIRE FILL AREA STYLE INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQGDP	Q-G-D-P	0a	INQUIRE GENERALIZED DRAWING PRIMITIVE
GQIQOV	Q-I-Q-OV	mc	INQUIRE INPUT QUEUE OVERFLOW
GQLVKS	Q-LV-KS	ma	INQUIRE LEVEL OF GKS
GQLN	Q-LN	ma	INQUIRE LINETYPE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQLWSC	Q-LW-SC	0a	INQUIRE LINEWIDTH SCALE FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQEGDP	Q-E-G-D-P	ma	INQUIRE LIST element OF AVAILABLE GENERALIZED DRAWING PRIMITIVES
GQEWK	Q-E-WK	0a	INQUIRE LIST element OF AVAILABLE WORKSTATION TYPES
GQECI	Q-E-C-I	ma	INQUIRE LIST element OF COLOUR INDICES
GQEFAI	Q-E-F-A-I	1a	INQUIRE LIST element OF FILL AREA INDICES
GQENTN	Q-E-N-T-N	0a	INQUIRE LIST element OF NORMALIZATION TRANSFORMATION NUMBERS
GQEPAI	Q-E-PA-I	1a	INQUIRE LIST element OF PATTERN INDICES
GQEPLI	Q-E-PL-I	1a	INQUIRE LIST element OF POLYLINE INDICES
GQEPMI	Q-E-PM-I	1a	INQUIRE LIST element OF POLYMARKER INDICES
GQETXI	Q-E-TX-I	1a	INQUIRE LIST element OF TEXT INDICES
GQLCS	Q-LC-S	mb	INQUIRE LOCATOR DEVICE STATE
GQMKSC	Q-MK-SC	0a	INQUIRE MARKER SIZE SCALE FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQMK	Q-MK	ma	INQUIRE MARKERTYPE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQLWK	Q-L-WK	0a	INQUIRE MAXIMUM LENGTH OF WORKSTATION STATE TABLES
GQMNTN	Q-M-N-T-N	0a	INQUIRE MAXIMUM NORMALIZATION TRANSFORMATION NUMBER
GQSIM	Q-SIM	mc	INQUIRE MORE SIMULTANEOUS EVENTS
GQOPSG	Q-OP-SG	1a	INQUIRE NAME OF OPEN SEGMENT
GQNT	Q-N-T	ma	INQUIRE NORMALIZATION TRANSFORMATION
GQLI	Q-L-I	mb	INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES
GQSGP	Q-SG-P	1a	INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED
GQOPS	Q-OP-S	0a	INQUIRE OPERATING STATE VALUE
GQPAF	Q-PA-F	0a	INQUIRE PATTERN FACILITIES
GQPARF	Q-PA-RF	0a	INQUIRE PATTERN REFERENCE POINT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPAR	Q-PA-R	1a	INQUIRE PATTERN REPRESENTATION
GQPA	Q-PA	0a	INQUIRE PATTERN SIZE (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPKS	Q-PK-S	1b	INQUIRE PICK DEVICE STATE
GQPKID	Q-PK-ID	1b	INQUIRE PICK IDENTIFIER
GQPX	Q-PX	0a	INQUIRE PIXEL
GQPXA	Q-PX-A	0a	INQUIRE PIXEL ARRAY
GQPXAD	Q-PX-A-D	0a	INQUIRE PIXEL ARRAY DIMENSIONS
GQPLCI	Q-PL-C-I	ma	INQUIRE POLYLINE COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQPLF	Q-PL-F	ma	INQUIRE POLYLINE FACILITIES
GQPLI	Q-PL-I	0a	INQUIRE POLYLINE INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPLR	Q-PL-R	1a	INQUIRE POLYLINE REPRESENTATION
GQPMCI	Q-PM-C-I	ma	INQUIRE POLYMARKER COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQPMF	Q-PM-F	ma	INQUIRE POLYMARKER FACILITIES

GQPMI	Q-PM-I	0a	INQUIRE POLYMARKER INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPMR	Q-PM-R	1a	INQUIRE POLYMARKER REPRESENTATION
GQPCR	Q-P-C-R	0a	INQUIRE PREDEFINED COLOUR REPRESENTATION
GQPFAR	Q-P-F-A-R	0a	INQUIRE PREDEFINED FILL AREA REPRESENTATION
GQPPAR	Q-P-PA-R	0a	INQUIRE PREDEFINED PATTERN REPRESENTATION
GQPPLR	Q-P-PL-R	0a	INQUIRE PREDEFINED POLYLINE REPRESENTATION
GQPPMR	Q-P-PM-R	0a	INQUIRE PREDEFINED POLYMARKER REPRESENTATION
GQPTXR	Q-P-TX-R	0a	INQUIRE PREDEFINED TEXT REPRESENTATION
GQSGA	Q-SG-A	1a	INQUIRE SEGMENT ATTRIBUTES
GQACWK	Q-AC-WK	1a	INQUIRE SET member OF ACTIVE WORKSTATIONS
GQASWK	Q-AS-WK	1a	INQUIRE SET member OF ASSOCIATED WORKSTATIONS
GQOPWK	Q-OP-WK	0a	INQUIRE SET member OF OPEN WORKSTATIONS
GQSGUS	Q-SG-US	1a	INQUIRE SET member OF SEGMENT NAMES IN USE
GQSGWK	Q-SG-WK	1a	INQUIRE SET member OF SEGMENT NAMES ON WORKSTATION
GQSTS	Q-ST-S	mb	INQUIRE STRING DEVICE STATE
GQSKS	Q-SK-S	mb	INQUIRE STROKE DEVICE STATE
GQTXAL	Q-TX-AL	ma	INQUIRE TEXT ALIGNMENT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXCI	Q-TX-C-I	ma	INQUIRE TEXT COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQTXX	Q-TX-X	ma	INQUIRE TEXT EXTENT
GQTXXS	Q-TX-X-S	ma	INQUIRE TEXT EXTENT (FORTRAN 77 SUBSET)
GQTXF	Q-TX-F	ma	INQUIRE TEXT FACILITIES
GQTXFP	Q-TX-F-P	0a	INQUIRE TEXT FONT AND PRECISION (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQTXI	Q-TX-I	0a	INQUIRE TEXT INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXP	Q-TX-P	0a	INQUIRE TEXT PATH (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXR	Q-TX-R	1a	INQUIRE TEXT REPRESENTATION
GQVLS	Q-VL-S	mb	INQUIRE VALUATOR DEVICE STATE
GQWKCA	Q-WK-CA	0a	INQUIRE WORKSTATION CATEGORY
GQWKCL	Q-WK-CL	0a	INQUIRE WORKSTATION CLASSIFICATION
GQWKC	Q-WK-C	ma	INQUIRE WORKSTATION CONNECTION AND TYPE
GQWKDU	Q-WK-D-U	0a	INQUIRE WORKSTATION DEFERRAL AND UPDATE STATES
GQWKM	Q-WK-M	1a	INQUIRE WORKSTATION MAXIMUM NUMBERS
GQWKS	Q-WK-S	0a	INQUIRE WORKSTATION STATE
GQWKT	Q-WK-T	ma	INQUIRE WORKSTATION TRANSFORMATION
GINSG	IN-SG	2a	INSERT SEGMENT
GIITM	I-ITM	0a	INTERPRET ITEM
GMSG	MSG	1a	MESSAGE
GMSGS	MSG-S	1a	MESSAGE (FORTRAN 77 SUBSET)
GOPKS	OP-KS	ma	OPEN GKS
GOPWK	OP-WK	ma	OPEN WORKSTATION
GPREC	P-REC	0a	PACK DATA RECORD
GPL	PL	ma	POLYLINE
GPM	PM	ma	POLYMARKER
GRDITM	RD-ITM	0a	READ ITEM FROM GKSM
GRSGWK	R-SG-WK	1a	REDRAW ALL SEGMENTS ON WORKSTATION
GRENSG	REN-SG	1a	RENAME SEGMENT
GRQCH	RQ-CH	mb	REQUEST CHOICE
GRQLC	RQ-LC	mb	REQUEST LOCATOR
GRQPK	RQ-PK	1b	REQUEST PICK
GRQST	RQ-ST	mb	REQUEST STRING
GRQSK	RQ-SK	mb	REQUEST STROKE
GRQVL	RQ-VL	mb	REQUEST VALUATOR
GSMCH	SM-CH	mc	SAMPLE CHOICE
GSMLC	SM-LC	mc	SAMPLE LOCATOR
GSMPK	SM-PK	1c	SAMPLE PICK
GSMST	SM-ST	mc	SAMPLE STRING
GSMSK	SM-SK	mc	SAMPLE STROKE
GSMVL	SM-VL	mc	SAMPLE VALUATOR
GSELNT	SEL-N-T	ma	SELECT NORMALIZATION TRANSFORMATION
GSASF	S-A-S-F	0a	SET ASPECT SOURCE FLAGS

GSCHXP	S-CH-XP	0a	SET CHARACTER EXPANSION FACTOR
GSCHH	S-CH-H	ma	SET CHARACTER HEIGHT
GSCHSP	S-CH-SP	0a	SET CHARACTER SPACING
GSCHUP	S-CH-UP	ma	SET CHARACTER UP VECTOR
GSCHM	S-CH-M	mb	SET CHOICE MODE
GSCLIP	S-CLIP	ma	SET CLIPPING INDICATOR
GSCR	S-C-R	ma	SET COLOUR REPRESENTATION
GSDS	S-D-S	1a	SET DEFERRAL STATE
GSDTEC	S-DTEC	1b	SET DETECTABILITY
GSFACI	S-F-A-C-I	ma	SET FILL AREA COLOUR INDEX
GSFAI	S-F-A-I	0a	SET FILL AREA INDEX
GSFAIS	S-F-A-I-S	ma	SET FILL AREA INTERIOR STYLE
GSFAR	S-F-A-R	1a	SET FILL AREA REPRESENTATION
GSFASI	S-F-A-S-I	0a	SET FILL AREA STYLE INDEX
GSHLIT	S-HLIT	1a	SET HIGHLIGHTING
GSLN	S-LN	ma	SET LINETYPE
GSLWSC	S-LW-SC	0a	SET LINEWIDTH SCALE FACTOR
GSLCM	S-LC-M	mb	SET LOCATOR MODE
GSMKSC	S-MK-SC	0a	SET MARKER SIZE SCALE FACTOR
GSMK	S-MK	ma	SET MARKERTYPE
GSPARF	S-PA-RF	0a	SET PATTERN REFERENCE POINT
GSPAR	S-PA-R	1a	SET PATTERN REPRESENTATION
GSPA	S-PA	0a	SET PATTERN SIZE
GSPKID	S-PK-ID	1b	SET PICK IDENTIFIER
GSPKM	S-PK-M	1b	SET PICK MODE
GSPLCI	S-PL-C-I	ma	SET POLYLINE COLOUR INDEX
GSPLI	S-PL-I	0a	SET POLYLINE INDEX
GSPLR	S-PL-R	1a	SET POLYLINE REPRESENTATION
GSPMCI	S-PM-C-I	ma	SET POLYMARKER COLOUR INDEX
GSPMI	S-PM-I	0a	SET POLYMARKER INDEX
GSPMR	S-PM-R	1a	SET POLYMARKER REPRESENTATION
GSSGP	S-SG-P	1a	SET SEGMENT PRIORITY
GSSGT	S-SG-T	1a	SET SEGMENT TRANSFORMATION
GSSTM	S-ST-M	mb	SET STRING MODE
GSSKM	S-SK-M	mb	SET STROKE MODE
GSTXAL	S-TX-AL	ma	SET TEXT ALIGNMENT
GSTXCI	S-TX-C-I	ma	SET TEXT COLOUR INDEX
GSTXFP	S-TX-F-P	0a	SET TEXT FONT AND PRECISION
GSTXI	S-TX-I	0a	SET TEXT INDEX
GSTXP	S-TX-P	0a	SET TEXT PATH
GSTXR	S-TX-R	1a	SET TEXT REPRESENTATION
GSVLM	S-VL-M	mb	SET VALUATOR MODE
GSVP	S-VP	ma	SET VIEWPORT
GSVPIP	S-VP-I-P	mb	SET VIEWPORT INPUT PRIORITY
GSVIS	S-VIS	1a	SET VISIBILITY
GSWN	S-WN	ma	SET WINDOW
GSWKVP	S-WK-VP	ma	SET WORKSTATION VIEWPORT
GSWKWN	S-WK-WN	ma	SET WORKSTATION WINDOW
GTX	TX	ma	TEXT
GTXS	TX-S	ma	TEXT (FORTRAN 77 SUBSET)
GUREC	U-REC	0a	UNPACK DATA RECORD
GUWK	U-WK	ma	UPDATE WORKSTATION
GWITM	W-ITM	0a	WRITE ITEM TO GKSM

7.3 List Ordered by Levels

GACWK	AC-WK	ma	ACTIVATE WORKSTATION
GCLKS	CL-KS	ma	CLOSE GKS
GCLRWK	CLR-WK	ma	CLEAR WORKSTATION
GCLWK	CL-WK	ma	CLOSE WORKSTATION
GDAWK	DA-WK	ma	DEACTIVATE WORKSTATION
GESC	ESC	ma	ESCAPE
GFA	F-A	ma	FILL AREA
GGDP	G-D-P	ma	GENERALIZED DRAWING PRIMITIVE
GOPKS	OP-KS	ma	OPEN GKS
GOPWK	OP-WK	ma	OPEN WORKSTATION

GPL	PL	ma	POLYLINE
GPM	PM	ma	POLYMARKER
GQCF	Q-C-F	ma	INQUIRE COLOUR FACILITIES
GQCHH	Q-CH-H	ma	INQUIRE CHARACTER HEIGHT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHUP	Q-CH-UP	ma	INQUIRE CHARACTER UP VECTOR (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCLIP	Q-CLIP	ma	INQUIRE CLIPPING INDICATOR
GQCNTN	Q-C-N-T-N	ma	INQUIRE CURRENT NORMALIZATION TRANSFORMATION NUMBER
GQCR	Q-C-R	ma	INQUIRE COLOUR REPRESENTATION
GQECI	Q-E-C-I	ma	INQUIRE LIST element OF COLOUR INDICES
GQEGDP	Q-E-G-D-P	ma	INQUIRE LIST element OF AVAILABLE GENERALIZED DRAWING PRIMITIVES
GQFAF	Q-F-A-F	ma	INQUIRE FILL AREA FACILITIES
GQLN	Q-LN	ma	INQUIRE LINETYPE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQLVKS	Q-LV-KS	ma	INQUIRE LEVEL OF GKS
GQMK	Q-MK	ma	INQUIRE MARKERTYPE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQNT	Q-N-T	ma	INQUIRE NORMALIZATION TRANSFORMATION
GQPLCI	Q-PL-C-I	ma	INQUIRE POLYLINE COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQPLF	Q-PL-F	ma	INQUIRE POLYLINE FACILITIES
GQPMF	Q-PM-F	ma	INQUIRE POLYMARKER FACILITIES
GQTXAL	Q-TX-AL	ma	INQUIRE TEXT ALIGNMENT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXCI	Q-TX-C-I	ma	INQUIRE TEXT COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQTXF	Q-TX-F	ma	INQUIRE TEXT FACILITIES
GQTXX	Q-TX-X	ma	INQUIRE TEXT EXTENT
GQTXXS	Q-TX-X-S	ma	INQUIRE TEXT EXTENT (FORTRAN 77 SUBSET)
GQWKC	Q-WK-C	ma	INQUIRE WORKSTATION CONNECTION AND TYPE
GQWKT	Q-WK-T	ma	INQUIRE WORKSTATION TRANSFORMATION
GSCHH	S-CH-H	ma	SET CHARACTER HEIGHT
GSCHUP	S-CH-UP	ma	SET CHARACTER UP VECTOR
GSCLIP	S-CLIP	ma	SET CLIPPING INDICATOR
GSCR	S-C-R	ma	SET COLOUR REPRESENTATION
GSELNT	SEL-N-T	ma	SELECT NORMALIZATION TRANSFORMATION
GSFACI	S-F-A-C-I	ma	SET FILL AREA COLOUR INDEX
GSFAIS	S-F-A-I-S	ma	SET FILL AREA INTERIOR STYLE
GSLN	S-LN	ma	SET LINETYPE
GSMK	S-MK	ma	SET MARKERTYPE
GSPLCI	S-PL-C-I	ma	SET POLYLINE COLOUR INDEX
GSPMCI	S-PM-C-I	ma	SET POLYMARKER COLOUR INDEX
GSTXAL	S-TX-AL	ma	SET TEXT ALIGNMENT
GSTXCI	S-TX-C-I	ma	SET TEXT COLOUR INDEX
GSVP	S-VP	ma	SET VIEWPORT
GSWKVP	S-WK-VP	ma	SET WORKSTATION VIEWPORT
GSWKWN	S-WK-WN	ma	SET WORKSTATION WINDOW
GSWN	S-WN	ma	SET WINDOW
GTX	TX	ma	TEXT
GTXS	TX-S	ma	TEXT (FORTRAN 77 SUBSET)
GUWK	U-WK	ma	UPDATE WORKSTATION
GINCH	IN-CH	mb	INITIALISE CHOICE
GINLC	IN-LC	mb	INITIALISE LOCATOR
GINSK	IN-SK	mb	INITIALISE STROKE
GINST	IN-ST	mb	INITIALISE STRING
GINVL	IN-VL	mb	INITIALISE VALUATOR
GQCHS	Q-CH-S	mb	INQUIRE CHOICE DEVICE STATE
GQDCH	Q-D-CH	mb	INQUIRE DEFAULT CHOICE DEVICE DATA
GQDLC	Q-D-LC	mb	INQUIRE DEFAULT LOCATOR DEVICE DATA
GQDSK	Q-D-SK	mb	INQUIRE DEFAULT STROKE DEVICE DATA
GQDST	Q-D-ST	mb	INQUIRE DEFAULT STRING DEVICE DATA
GQDVL	Q-D-VL	mb	INQUIRE DEFAULT VALUATOR DEVICE DATA

GQFACI	Q-F-A-C-I	ma	INQUIRE FILL AREA COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQFAIS	Q-F-A-I-S	ma	INQUIRE FILL AREA INTERIOR STYLE (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQLCS	Q-LC-S	mb	INQUIRE LOCATOR DEVICE STATE
GQLI	Q-L-I	mb	INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES
GQPMCI	Q-PM-C-I	ma	INQUIRE POLYMARKER COLOUR INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQSKS	Q-SK-S	mb	INQUIRE STROKE DEVICE STATE
GQSTS	Q-ST-S	mb	INQUIRE STRING DEVICE STATE
GQVLS	Q-VL-S	mb	INQUIRE VALUATOR DEVICE STATE
GRQCH	RQ-CH	mb	REQUEST CHOICE
GRQLC	RQ-LC	mb	REQUEST LOCATOR
GRQSK	RQ-SK	mb	REQUEST STROKE
GRQST	RQ-ST	mb	REQUEST STRING
GRQVL	RQ-VL	mb	REQUEST VALUATOR
GSCHM	S-CH-M	mb	SET CHOICE MODE
GSLCM	S-LC-M	mb	SET LOCATOR MODE
GSSKM	S-SK-M	mb	SET STROKE MODE
GSSTM	S-ST-M	mb	SET STRING MODE
GSVLM	S-VL-M	mb	SET VALUATOR MODE
GSVPIP	S-VP-I-P	mb	SET VIEWPORT INPUT PRIORITY
GFLUSH	FLUSH	mc	FLUSH DEVICE EVENTS
GGTCH	GT-CH	mc	GET CHOICE
GGTLC	GT-LC	mc	GET LOCATOR
GGTSK	GT-SK	mc	GET STROKE
GGTST	GT-ST	mc	GET STRING
GGTVL	GT-VL	mc	GET VALUATOR
GQIQOV	Q-I-Q-OV	mc	INQUIRE INPUT QUEUE OVERFLOW
GQSIM	Q-SIM	mc	INQUIRE MORE SIMULTANEOUS EVENTS
GSMCH	SM-CH	mc	SAMPLE CHOICE
GSMLC	SM-LC	mc	SAMPLE LOCATOR
GSMSK	SM-SK	mc	SAMPLE STROKE
GSMST	SM-ST	mc	SAMPLE STRING
GSMVL	SM-VL	mc	SAMPLE VALUATOR
GWAIT	WAIT	mc	AWAIT EVENT
GCA	C-A	0a	CELL ARRAY
GECLKS	E-CL-KS	0a	EMERGENCY CLOSE GKS
GERHND	ER-HND	0a	ERROR HANDLING
GERLOG	ER-LOG	0a	ERROR LOGGING
GGTITM	GT-ITM	0a	GET ITEM TYPE FROM GKSM
GIITM	I-ITM	0a	INTERPRET ITEM
GPREC	P-REC	0a	PACK DATA RECORD
GQASF	Q-A-S-F	0a	INQUIRE ASPECT SOURCE FLAGS (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQCHB	Q-CH-B	0a	INQUIRE CHARACTER BASE VECTOR (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHSP	Q-CH-SP	0a	INQUIRE CHARACTER SPACING (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQCHW	Q-CH-W	0a	INQUIRE CHARACTER WIDTH (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQCHXP	Q-CH-XP	0a	INQUIRE CHARACTER EXPANSION FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQDSP	Q-D-SP	0a	INQUIRE DISPLAY SPACE SIZE
GQENTN	Q-E-N-T-N	0a	INQUIRE LIST element OF NORMALIZATION TRANSFORMATION NUMBERS
GQEWK	Q-E-WK	0a	INQUIRE LIST element OF AVAILABLE WORKSTATION TYPES
GQFAI	Q-F-A-I	0a	INQUIRE FILL AREA INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQFASI	Q-F-A-S-I	0a	INQUIRE FILL AREA STYLE INDEX (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQGDP	Q-G-D-P	0a	INQUIRE GENERALIZED DRAWING PRIMITIVE
GQLWK	Q-L-WK	0a	INQUIRE MAXIMUM LENGTH OF WORKSTATION STATE TABLES

GQLWSC	Q-LW-SC	0a	INQUIRE LINEWIDTH SCALE FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQMKSC	Q-MK-SC	0a	INQUIRE MARKER SIZE SCALE FACTOR (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQMNTN	Q-M-N-T-N	0a	INQUIRE MAXIMUM NORMALIZATION TRANSFORMATION NUMBER
GQOPS	Q-OP-S	0a	INQUIRE OPERATING STATE VALUE
GQOPWK	Q-OP-WK	0a	INQUIRE SET member OF OPEN WORKSTATIONS
GQPA	Q-PA	0a	INQUIRE PATTERN SIZE (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPAF	Q-PA-F	0a	INQUIRE PATTERN FACILITIES
GQPARF	Q-PA-RF	0a	INQUIRE PATTERN REFERENCE POINT (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPCR	Q-P-C-R	0a	INQUIRE PREDEFINED COLOUR REPRESENTATION
GQPFAR	Q-P-F-A-R	0a	INQUIRE PREDEFINED FILL AREA REPRESENTATION
GQPLI	Q-PL-I	0a	INQUIRE POLYLINE INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPMI	Q-PM-I	0a	INQUIRE POLYMARKER INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQPPAR	Q-P-PA-R	0a	INQUIRE PREDEFINED PATTERN REPRESENTATION
GQPPLR	Q-P-PL-R	0a	INQUIRE PREDEFINED POLYLINE REPRESENTATION
GQPPMR	Q-P-PM-R	0a	INQUIRE PREDEFINED POLYMARKER REPRESENTATION
GQPTXR	Q-P-TX-R	0a	INQUIRE PREDEFINED TEXT REPRESENTATION
GQPX	Q-PX	0a	INQUIRE PIXEL
GQPXA	Q-PX-A	0a	INQUIRE PIXEL ARRAY
GQPXAD	Q-PX-A-D	0a	INQUIRE PIXEL ARRAY DIMENSIONS
GQTXFP	Q-TX-F-P	0a	INQUIRE TEXT FONT AND PRECISION (INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
GQTXI	Q-TX-I	0a	INQUIRE TEXT INDEX (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQTXP	Q-TX-P	0a	INQUIRE TEXT PATH (INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
GQWKCA	Q-WK-CA	0a	INQUIRE WORKSTATION CATEGORY
GQWKCL	Q-WK-CL	0a	INQUIRE WORKSTATION CLASSIFICATION
GQWKDU	Q-WK-D-U	0a	INQUIRE WORKSTATION DEFERRAL AND UPDATE STATES
GQWKS	Q-WK-S	0a	INQUIRE WORKSTATION STATE
GRDITM	RD-ITM	0a	READ ITEM FROM GKSM
GSASF	S-A-S-F	0a	SET ASPECT SOURCE FLAGS
GSCHSP	S-CH-SP	0a	SET CHARACTER SPACING
GSCHXP	S-CH-XP	0a	SET CHARACTER EXPANSION FACTOR
GSFAI	S-F-A-I	0a	SET FILL AREA INDEX
GSFASI	S-F-A-S-I	0a	SET FILL AREA STYLE INDEX
GSLWSC	S-LW-SC	0a	SET LINEWIDTH SCALE FACTOR
GSMKSC	S-MK-SC	0a	SET MARKER SIZE SCALE FACTOR
GSPA	S-PA	0a	SET PATTERN SIZE
GSPARF	S-PA-RF	0a	SET PATTERN REFERENCE POINT
GSPLI	S-PL-I	0a	SET POLYLINE INDEX
GSPMI	S-PM-I	0a	SET POLYMARKER INDEX
GSTXFP	S-TX-F-P	0a	SET TEXT FONT AND PRECISION
GSTXI	S-TX-I	0a	SET TEXT INDEX
GSTXP	S-TX-P	0a	SET TEXT PATH
GUREC	U-REC	0a	UNPACK DATA RECORD
GWITM	W-ITM	0a	WRITE ITEM TO GKSM
GACTM	AC-T-M	1a	ACCUMULATE TRANSFORMATION MATRIX
GCLSG	CL-SG	1a	CLOSE SEGMENT
GCRSG	CR-SG	1a	CREATE SEGMENT
GDSG	D-SG	1a	DELETE SEGMENT
GDSGWK	D-SG-WK	1a	DELETE SEGMENT FROM WORKSTATION
GEVTM	EV-T-M	1a	EVALUATE TRANSFORMATION MATRIX
GMSG	MSG	1a	MESSAGE
GMSGS	MSG-S	1a	MESSAGE (FORTRAN 77 SUBSET)
GQACWK	Q-AC-WK	1a	INQUIRE SET member OF ACTIVE WORKSTATIONS
GQASWK	Q-AS-WK	1a	INQUIRE SET member OF ASSOCIATED WORKSTATIONS
GQDDS	Q-D-D-S	1a	INQUIRE DEFAULT DEFERRAL STATE VALUES
GQDSGA	Q-D-SG-A	1a	INQUIRE DYNAMIC MODIFICATION OF SEGMENT ATTRIBUTES

GQDWKA	Q-D-WK-A	1a	INQUIRE DYNAMIC MODIFICATION OF WORKSTATION ATTRIBUTES
GQEFAI	Q-E-F-A-I	1a	INQUIRE LIST element OF FILL AREA INDICES
GQEPAI	Q-E-PA-I	1a	INQUIRE LIST element OF PATTERN INDICES
GQEPLI	Q-E-PL-I	1a	INQUIRE LIST element OF POLYLINE INDICES
GQEPMI	Q-E-PM-I	1a	INQUIRE LIST element OF POLYMARKER INDICES
GQETXI	Q-E-TX-I	1a	INQUIRE LIST element OF TEXT INDICES
GQFAR	Q-F-A-R	1a	INQUIRE FILL AREA REPRESENTATION
GQOPSG	Q-OP-SG	1a	INQUIRE NAME OF OPEN SEGMENT
GQPAR	Q-PA-R	1a	INQUIRE PATTERN REPRESENTATION
GQPLR	Q-PL-R	1a	INQUIRE POLYLINE REPRESENTATION
GQPMR	Q-PM-R	1a	INQUIRE POLYMARKER REPRESENTATION
GQSGA	Q-SG-A	1a	INQUIRE SEGMENT ATTRIBUTES
GQSGP	Q-SG-P	1a	INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED
GQSGUS	Q-SG-US	1a	INQUIRE SET member OF SEGMENT NAMES IN USE
GQSGWK	Q-SG-WK	1a	INQUIRE SET member OF SEGMENT NAMES ON WORKSTATION
GQTXR	Q-TX-R	1a	INQUIRE TEXT REPRESENTATION
GQWKM	Q-WK-M	1a	INQUIRE WORKSTATION MAXIMUM NUMBERS
GRENSG	REN-SG	1a	RENAME SEGMENT
GRSGWK	R-SG-WK	1a	REDRAW ALL SEGMENTS ON WORKSTATION
GSDS	S-D-S	1a	SET DEFERRAL STATE
GSFAR	S-F-A-R	1a	SET FILL AREA REPRESENTATION
GSHLIT	S-HLIT	1a	SET HIGHLIGHTING
GSPAR	S-PA-R	1a	SET PATTERN REPRESENTATION
GSPLR	S-PL-R	1a	SET POLYLINE REPRESENTATION
GSPMR	S-PM-R	1a	SET POLYMARKER REPRESENTATION
GSSGP	S-SG-P	1a	SET SEGMENT PRIORITY
GSSGT	S-SG-T	1a	SET SEGMENT TRANSFORMATION
GSTXR	S-TX-R	1a	SET TEXT REPRESENTATION
GSVIS	S-VIS	1a	SET VISIBILITY
GINPK	IN-PK	1b	INITIALISE PICK
GQDPK	Q-D-PK	1b	INQUIRE DEFAULT PICK DEVICE DATA
GQPKID	Q-PK-ID	1b	INQUIRE PICK IDENTIFIER
GQPKS	Q-PK-S	1b	INQUIRE PICK DEVICE STATE
GRQPK	RQ-PK	1b	REQUEST PICK
GSDTEC	S-DTEC	1b	SET DETECTABILITY
GSPKID	S-PK-ID	1b	SET PICK IDENTIFIER
GSPKM	S-PK-M	1b	SET PICK MODE
GGTPK	GT-PK	1c	GET PICK
GSMPK	SM-PK	1c	SAMPLE PICK
GASGWK	A-SG-WK	2a	ASSOCIATE SEGMENT WITH WORKSTATION
GCSGWK	C-SG-WK	2a	COPY SEGMENT TO WORKSTATION
GINSG	IN-SG	2a	INSERT SEGMENT

8. GKS Errors Specific to the FORTRAN Binding

Certain features of the FORTRAN language make additional errors (beyond the ones described in the GKS document) possible. Specifically, these new errors are defined:

2000 Enumeration type out of range -- the INTEGER passed as a GKS enumerated type is not within the range of valid values.

2001 Output parameter size insufficient -- a FORTRAN array or string being passed as an output parameter is too small to contain the returned information.

2002 List element or set member not available -- for a non-empty list or set, a value less than zero or greater than the size of a list or set was passed as the requested list element or set member in an inquiry routine.

2003 Invalid data record -- the data record cannot be decoded, or there was a problem encountered when GKS was creating a data record, making the result invalid.

9. The GKS Function Interface

9.1 General Principles

For each GKS function the corresponding FORTRAN SUBROUTINE declaration is given. The name of the GKS function is listed, followed by its FORTRAN name and the corresponding parameters. After that, the list of parameters is described by type and a brief identifying phrase.

For the mapping of ENUMERATION types see above.

For GENERALIZED DRAWING PRIMITIVE and ESCAPE, subroutines GGDP and GESC are defined. Each GDP identifier that is in the ISO International Register of Graphical Items may, in addition, be accessed by a subroutine of the form GDpqrs, where pqrs is related to the appropriate GDP identifier. The parameters are derived from those of GGDP as follows: N, PXA, PYA are required; PRIMID is absent; the data record is specified by parameters appropriate to the particular GDP identifier. Similarly, each specific ESCAPE function that is in the ISO International Register of Graphical Items may, in addition, be accessed by a subroutine of the form GEpqrs. The parameters are derived from those of GESC as follows: FCTID is absent and the data record is specified by parameters appropriate to the specific ESCAPE function. For both GDP and ESCAPE, it is possible to define each separate subroutine using GGDP and GESC.

9.2 Control Functions

OPEN GKS Lma

SUBROUTINE GOPKS (ERRFIL,BUFA)

Input Parameters:

INTEGER ERRFIL	error message file
INTEGER BUFA	amount of memory units (implementation dependent; if -1, use implementation dependent default)

CLOSE GKS Lma

SUBROUTINE GCLKS

OPEN WORKSTATION Lma

SUBROUTINE GOPWK (WKID,CONID,WTYPE)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER CONID	connection identifier
INTEGER WTYPE	workstation type

CLOSE WORKSTATION Lma

SUBROUTINE GCLWK (WKID)

Input Parameters:

INTEGER WKID	workstation identifier

ACTIVATE WORKSTATION Lma

SUBROUTINE GACWK (WKID)

Input Parameters:

INTEGER WKID	workstation identifier

DEACTIVATE WORKSTATION Lma

SUBROUTINE GDAWK (WKID)

Input Parameters:

INTEGER WKID	workstation identifier

CLEAR WORKSTATION Lma

SUBROUTINE GCLRWK (WKID,COFL)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER COFL	control flag (GCONDI,GALWAY)

REDRAW ALL SEGMENTS ON WORKSTATION L1a

SUBROUTINE GRSGWK (WKID)

Input Parameters:	
INTEGER WKID	workstation identifier

UPDATE WORKSTATION Lma

SUBROUTINE GUWK (WKID,REGFL)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER REGFL	update regeneration flag (GPOSTP,GPERFO)

SET DEFERRAL STATE L1a

SUBROUTINE GSDS (WKID,DEFMOD,REGMOD)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER DEFMOD	deferral mode (GASAP,GBNIG,GBNIL,GASTI)
INTEGER REGMOD	implicit regeneration mode (GSUPPD,GALLOW)

MESSAGE L1a
Full FORTRAN 77 version

SUBROUTINE GMSG (WKID,MESS)

Input Parameters:	
INTEGER WKID	workstation identifier
CHARACTER*(*) MESS	message

MESSAGE L1a

FORTRAN 77 Subset version

SUBROUTINE GMSGS (WKID,LSTR,MESS)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER LSTR	length of string (in characters)
CHARACTER*80 MESS	message

ESCAPE Lma

SUBROUTINE GESC (FCTID,LIDR,IDR,MLODR,LODR,ODR)

Input Parameters:	
INTEGER FCTID	function identification
INTEGER LIDR	dimension of input data record array
CHARACTER*80 IDR (LIDR)	input data record
INTEGER MLODR	maximum length of output data record
Output Parameters:	
INTEGER LODR	number of array elements occupied in ODR
CHARACTER*80 ODR(MLODR)	output data record

9.3 Output Functions

POLYLINE Lma

SUBROUTINE GPL (N,PXA,PYA)

Input Parameters:

INTEGER N	number of points
REAL PXA (N), PYA (N)	coordinates of points in world coordinates

POLYMARKER Lma

SUBROUTINE GPM (N,PXA,PYA)

Input Parameters:

INTEGER N	number of points
REAL PXA (N), PYA (N)	coordinates of points in world coordinates

TEXT Lma
Full FORTRAN 77 version

SUBROUTINE GTX (PX,PY,CHARS)

Input Parameters:

REAL PX, PY	text position in world coordinates
CHARACTER*(*) CHARS	string of characters

TEXT Lma
FORTRAN 77 Subset version

SUBROUTINE GTXS (PX,PY,LSTR,CHARS)

Input Parameters:

REAL PX, PY	text position in world coordinates
INTEGER LSTR	length of string (in characters)
CHARACTER*80 CHARS	string of characters

FILL AREA Lma

SUBROUTINE GFA (N,PXA,PYA)

Input Parameters:

INTEGER N	number of points
REAL PXA (N), PYA (N)	coordinates of points in world coordinates

CELL ARRAY L0a

SUBROUTINE GCA (PX,PY,QX,QY,DIMX,DIMY,ISC,ISR,DX,DY,COLIA)

Input Parameters:

REAL PX, PY, QX, QY	two points (P, Q) in world coordinates
INTEGER DIMX, DIMY	the dimensions of COLIA which contains the cell array
INTEGER ISC, ISR	indices of start column, start row
INTEGER DX, DY	number of columns, number of rows
INTEGER COLIA (DIMX,DIMY)	colour index array

GENERALIZED DRAWING PRIMITIVE Lma

SUBROUTINE GGDP (N,PXA,PYA,PRIMID,LDR,DATREC)

Input Parameters:

INTEGER N	number of points (≥ 0)
REAL PXA (*), PYA (*)	coordinates of points in world coordinates
INTEGER PRIMID	GDP identifier
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

9.4 Output Attributes

9.4.1 Workstation Independent Primitive Attributes

SET POLYLINE INDEX L0a

SUBROUTINE GSPLI (PLI)

Input Parameters:

INTEGER PLI	polyline index

SET LINETYPE Lma

SUBROUTINE GSLN (LTYPE)

Input Parameters:

INTEGER LTYPE	linetype

SET LINEWIDTH SCALE FACTOR L0a

SUBROUTINE GSLWSC (LWIDTH)

Input Parameters:

REAL LWIDTH	linewidth scale factor

SET POLYLINE COLOUR INDEX Lma

SUBROUTINE GSPLCI (COLI)

Input Parameters:

INTEGER COLI	polyline colour index

SET POLYMARKER INDEX L0a

SUBROUTINE GSPMI (PMI)

Input Parameters:

INTEGER PMI	polymarker index

SET MARKER TYPE Lma

SUBROUTINE GSMK (MTYPE)

Input Parameters:

INTEGER MTYPE	marker type

SET MARKER SIZE SCALE FACTOR L0a

SUBROUTINE GSMKSC (MSZSF)

Input Parameters:

REAL MSZSF	marker size scale factor

SET POLYMARKER COLOUR INDEX Lma

SUBROUTINE GSPMCI (COLI)

Input Parameters:

INTEGER COLI	polymarker colour index

SET TEXT INDEX L0a

SUBROUTINE GSTXI (TXI)

Input Parameters:

INTEGER TXI	text index

SET TEXT FONT AND PRECISION L0a

SUBROUTINE GSTXFP (FONT,PREC)

Input Parameters:

INTEGER FONT	text font
INTEGER PREC	text precision (GSTRP,GCHARP,GSTRKP)

SET CHARACTER EXPANSION FACTOR L0a

SUBROUTINE GSCHXP (CHXP)

Input Parameters:

REAL CHXP	character expansion factor

SET CHARACTER SPACING L0a

SUBROUTINE GSCHSP (CHSP)

Input Parameters:

REAL CHSP	character spacing

SET TEXT COLOUR INDEX Lma

SUBROUTINE GSTXCI (COLI)

Input Parameters:	
INTEGER COLI	text colour index

SET CHARACTER HEIGHT Lma

SUBROUTINE GSCHH (CHH)

Input Parameters:	
REAL CHH	character height

SET CHARACTER UP VECTOR Lma

SUBROUTINE GSCHUP (CHUX,CHUY)

Input Parameters:	
REAL CHUX, CHUY	character up vector (WC)

SET TEXT PATH L0a

SUBROUTINE GSTXP (TXP)

Input Parameters:	
INTEGER TXP	text path (GRIGHT,GLEFT,GUP,GDOWN)

SET TEXT ALIGNMENT Lma

SUBROUTINE GSTXAL (TXALH,TXALV)

Input Parameters:	
INTEGER TXALH	text alignment horizontal (GAHNOR,GALEFT,GACENT,GARITE)
INTEGER TXALV	text alignment vertical (GAVNOR,GATOP,GACAP,GAHALF, GABASE,GABOTT)

SET FILL AREA INDEX L0a

SUBROUTINE GSFAI (FAI)

Input Parameters:	
INTEGER FAI	fill area index

SET FILL AREA INTERIOR STYLE Lma

SUBROUTINE GSFAIS (INTS)

Input Parameters:	
INTEGER INTS	fill area interior style (GHOLLO,GSOLID,GPATTR,GHATCH)

SET FILL AREA STYLE INDEX L0a

SUBROUTINE GSFASI (STYLI)

Input Parameters:	
INTEGER STYLI	fill area style index

SET FILL AREA COLOUR INDEX Lma

SUBROUTINE GSFACI (COLI)

Input Parameters:	
INTEGER COLI	fill area colour index

SET PATTERN SIZE L0a

SUBROUTINE GSPA (SZX,SZY)

Input Parameters:	
REAL SZX, SZY	pattern size

SET PATTERN REFERENCE POINT L0a

SUBROUTINE GSPARF (RFX,RFY)

Input Parameters:	
REAL RFX, RFY	pattern reference point

SET ASPECT SOURCE FLAGS L0a

SUBROUTINE GSASF (LASF)

Input Parameters:	
INTEGER LASF (13)	list of aspect source flags (GBUNDL,GINDIV)
	1 linetype ASF
	2 linewidth scale factor ASF
	3 polyline colour index ASF
	4 marker type ASF
	5 marker size scale factor ASF
	6 polymarker colour index ASF
	7 text font and precision ASF
	8 character expansion factor ASF
	9 character spacing ASF
	10 text colour index ASF
	11 fill area interior style ASF
	12 fill area style index ASF
	13 fill area colour index ASF

SET PICK IDENTIFIER L1b

SUBROUTINE GSPKID (PKID)

Input Parameters:	
INTEGER PKID	pick identifier

9.4.2 Workstation Attributes (Representations)

SET POLYLINE REPRESENTATION L1a

SUBROUTINE GSPLR (WKID,PLI,LTYPE,LWIDTH,COLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER PLI	polyline index
INTEGER LTYPE	linetype
REAL LWIDTH	linewidth scale factor
INTEGER COLI	colour index

SET POLYMARKER REPRESENTATION L1a

SUBROUTINE GSPMR (WKID,PMI,MTYPE,MSZSF,COLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER PMI	polymarker index
INTEGER MTYPE	marker type
REAL MSZSF	marker size scale factor
INTEGER COLI	colour index

SET TEXT REPRESENTATION L1a

```
SUBROUTINE GSTXR (WKID,TXI,FONT,PREC,CHXP,CHSP,COLI)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER TXI	text index
INTEGER FONT	text font
INTEGER PREC	text precision (GSTRP,GCHARP,GSTRKP)
REAL CHXP	character expansion factor
REAL CHSP	character spacing
INTEGER COLI	colour index

SET FILL AREA REPRESENTATION L1a

```
SUBROUTINE GSFAR (WKID,FAI,INTS,STYLI,COLI)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER FAI	fill area index
INTEGER INTS	interior style (HOLLOW,SOLID,PATTERN,HATCH)
INTEGER STYLI	style index
INTEGER COLI	colour index

SET PATTERN REPRESENTATION L1a

```
SUBROUTINE GSPAR (WKID,PAI,DIMX,DIMY,ISC,ISR,DX,DY,COLIA)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER PAI	pattern index
INTEGER DIMX, DIMY	the dimensions of COLIA which contains the pattern array
INTEGER ISC, ISR	indices to start column, start row
INTEGER DX, DY	number of columns, number of rows used
INTEGER COLIA (DIMX,DIMY)	pattern array

SET COLOUR REPRESENTATION Lma

```
SUBROUTINE GSCR (WKID,CI,CR,CG,CB)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER CI	colour index
REAL CR, CG, CB	colour intensities (red/green/blue)

9.5 Transformation Functions

9.5.1 Normalization Transformation

SET WINDOW Lma

SUBROUTINE GSWN (TNR,XMIN,XMAX,YMIN,YMAX)

Input Parameters:

INTEGER TNR	transformation number
REAL XMIN,XMAX,YMIN,YMAX	window limits in world coordinates

SET VIEWPORT Lma

SUBROUTINE GSVP (TNR,XMIN,XMAX,YMIN,YMAX)

Input Parameters:

INTEGER TNR	transformation number
REAL XMIN,XMAX,YMIN,YMAX	viewport limits in normalized device coordinates

SET VIEWPORT INPUT PRIORITY Lmb

SUBROUTINE GSVPIP (TNR,RTNR,RELPRI)

Input Parameters:

INTEGER TNR	transformation number
INTEGER RTNR	reference transformation number
INTEGER RELPRI	relative priority (GHIGHR,GLOWER)

SELECT NORMALIZATION TRANSFORMATION Lma

SUBROUTINE GSELNT (TNR)

Input Parameters:

INTEGER TNR	transformation number

SET CLIPPING INDICATOR Lma

SUBROUTINE GSCLIP (CLSW)

Input Parameters:

INTEGER CLSW	clipping indicator (GNCLIP,GCLIP)

9.5.2 Workstation Transformation

SET WORKSTATION WINDOW Lma

SUBROUTINE GSWKWN (WKID,XMIN,XMAX,YMIN,YMAX)

Input Parameters:

INTEGER WKID	workstation identifier
REAL XMIN,XMAX,YMIN,YMAX	workstation window limits in normalized device coordinates

SET WORKSTATION VIEWPORT Lma

SUBROUTINE GSWKVP (WKID,XMIN,XMAX,YMIN,YMAX)

Input Parameters:

INTEGER WKID	workstation identifier
REAL XMIN,XMAX,YMIN,YMAX	workstation viewport limits in device coordinates

9.6 Segment Functions

9.6.1 Segment Manipulation Functions

CREATE SEGMENT L1a

SUBROUTINE GCRSG (SGNA)

Input Parameters:

INTEGER SGNA	segment name

CLOSE SEGMENT L1a

SUBROUTINE GCLSG

RENAME SEGMENT L1a

SUBROUTINE GRENSG (OLD,NEW)

Input Parameters:

INTEGER OLD	old segment name
INTEGER NEW	new segment name

DELETE SEGMENT L1a

SUBROUTINE GDSG (SGNA)

Input Parameters:

INTEGER SGNA	segment name

DELETE SEGMENT FROM WORKSTATION L1a

SUBROUTINE GDSGWK (WKID,SGNA)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER SGNA	segment name

ASSOCIATE SEGMENT WITH WORKSTATION L2a

SUBROUTINE GASGWK (WKID,SGNA)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER SGNA	segment name

COPY SEGMENT TO WORKSTATION L2a

SUBROUTINE GCSGWK (WKID,SGNA)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER SGNA	segment name

INSERT SEGMENT L2a

SUBROUTINE GINSG (SGNA,M)

Input Parameters:	
INTEGER SGNA	segment name
REAL M(2,3)	transformation matrix (M(1,1) M(1,2) M(1,3)) (M(2,1) M(2,2) M(2,3))

9.6.2 Segment Attributes

SET SEGMENT TRANSFORMATION L1a

SUBROUTINE GSSGT (SGNA,M)

Input Parameters:	
INTEGER SGNA	segment name
REAL M(2,3)	transformation matrix (M(1,1) M(1,2) M(1,3)) (M(2,1) M(2,2) M(2,3))

SET VISIBILITY L1a

SUBROUTINE GSVIS (SGNA,VIS)

Input Parameters:	
INTEGER SGNA	segment name
INTEGER VIS	visiblity (GINVIS,GVISI)

SET HIGHLIGHTING L1a

SUBROUTINE GSHLIT (SGNA,HIL)

Input Parameters:	
INTEGER SGNA	segment name
INTEGER HIL	highlighting (GNORML,GHILIT)

SET SEGMENT PRIORITY L1a

SUBROUTINE GSSGP (SGNA,PRIOR)

Input Parameters:	
INTEGER SGNA	segment name
REAL PRIOR	segment priority

SET DETECTABILITY L1b

SUBROUTINE GSDTEC (SGNA,DET)

Input Parameters:	
INTEGER SGNA	segment name
INTEGER DET	detectability (GUNDET,GDETEC)

9.7 Input Functions

9.7.1 Initialisation of Input Devices

INITIALISE LOCATOR Lmb

```
SUBROUTINE GINLC (WKID,LCDNR,TNR,IPX,IPY,PET,XMIN,XMAX,YMIN,
*YMAX,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER LCDNR	locator device number
INTEGER TNR	initial normalization transformation number
REAL IPX,IPY	initial locator position (WC)
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

GPREC parameters to build LOCATOR INPUT DATA RECORD for PET = 4:

IL=7 (or 1 if attribute control flag=GCURNT)
IA=(attribute control flag[, linetype ASF, linewidth scale)
RL=1 (or 0 if attribute control flag=GCURNT)
RA=([linewidth scale factor])
SL=0
LSTR=()
STR=()

GPREC parameters to build LOCATOR INPUT DATA RECORD for PET = 5 and polyline/fill area flag=GPLINE:

IL=8 (or 2 if attribute control flag=GCURNT)
IA=(polyline/fill area control flag, attribute control flag)
RL=1 (or 0 if attribute control flag=GCURNT)
RA=([linewidth scale factor])
SL=0
LSTR=()
STR=()

GPREC parameters to build LOCATOR INPUT DATA RECORD for PET = 5 and polyline/fill area flag=GFILLA:

IL=8 (or 2 if attribute control flag=GCURNT)
IA=(polyline/fill area control flag, attribute control flag)
RL=0
RA=()
SL=0
LSTR=()
STR=()

INITIALISE STROKE

Lmb

```
SUBROUTINE GINSK (WKID,SKDNR,TNR,N,IPX,IPY,PET,XMIN,XMAX,
*YMIN,YMAX,BUFLEN,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER SKDNR	stroke device number
INTEGER TNR	initial normalization transformation number
INTEGER N	number of points in initial stroke
REAL IPX (*), IPY (*)	points in initial stroke (WC) (the actual arguments are dimensioned by at least MAX(1,N))
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
INTEGER BUFLEN	input buffer size
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

GPREC parameters to build STROKE INPUT DATA RECORD for PET = 1 or 2:

IL=0
IA=()
RL=3
RA=(x interval, y interval, time interval in seconds)
SL=0
LSTR=()
STR=()

GPREC parameters to build STROKE INPUT DATA RECORD for PET = 3:

IL=5 (or 1 if attribute control flag=GCURNT)
IA=(attribute control flag[, marker size scale factor ASF)
RL=4 (or 3 if attribute control flag=GCURNT)
RA=(x interval, y interval, time interval in seconds)
SL=0
LSTR=()
STR=()

GPREC parameters to build STROKE INPUT DATA RECORD for PET = 4:

IL=7 (or 1 if attribute control flag=GCURNT)
IA=(attribute control flag[, linetype ASF, linewidth scale)
RL=4 (or 3 if attribute control flag=GCURNT)
RA=(x interval, y interval, time interval in seconds)
SL=0
LSTR=()
STR=()

INITIALISE VALUATOR

Lmb

```
SUBROUTINE GINVL (WKID,VLDNR,IVAL,PET,XMIN,XMAX,YMIN,YMAX,
*LOVAL,HIVAL,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER VLDNR	valuator device number
REAL IVAL	initial value
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
REAL LOVAL, HIVAL	minimal and maximal value
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

INITIALISE CHOICE Lmb

```
SUBROUTINE GINCH (WKID,CHDNR,ISTAT,ICHNR,PET,XMIN,XMAX,YMIN,
*YMAX,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER CHDNR	choice device number
INTEGER ISTAT	initial status (GOK,GNCHOI)
INTEGER ICHNR	initial choice number
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

GPREC parameters to build CHOICE INPUT DATA RECORD for PET = 2:
IL=number of choice alternatives
IA=(array of prompts)
RL=0
RA=()
SL=0
LSTR=()
STR=()

GPREC parameters to build CHOICE INPUT DATA RECORD for PET = 3 or 4:
IL=0
IA=()
RL=0
RA=()
SL=number of choice strings
LSTR=(array of lengths of choice strings)
STR=(array of strings)

GPREC parameters to build CHOICE INPUT DATA RECORD for PET = 5:
IL=1
IA=(segment name)
RL=0
RA=()
SL=0
LSTR=()
STR=()

INITIALISE PICK

L1b

```
SUBROUTINE GINPK (WKID,PKDNR,ISTAT,ISGNA,IPKID,PET,XMIN,XMAX,
*YMIN,YMAX,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER PKDNR	pick device number
INTEGER ISTAT	initial status (GOK,GNPICK)
INTEGER ISGNA	initial segment name
INTEGER IPKID	initial pick identifier
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

INITIALISE STRING

Lmb

Full FORTRAN 77 version

```
SUBROUTINE GINST (WKID,STDNR,LSTR,ISTR,PET,XMIN,XMAX,YMIN,
*YMAX,BUFLEN,INIPOS,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number
INTEGER LSTR	length of the initial string (≥ 0). The number of characters actually used is the minimum of LSTR and the length of ISTR.
CHARACTER*(*) ISTR	initial string
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
INTEGER BUFLEN	input buffer size
INTEGER INIPOS	initial cursor position
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

INITIALISE STRING Lmb

FORTRAN 77 Subset version

```
SUBROUTINE GINST (WKID,STDNR,LSTR,ISTR,PET,XMIN,XMAX,YMIN,
*YMAX,BUFLEN,INIPOS,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number
INTEGER LSTR	length of the initial string
CHARACTER*80 ISTR	initial string
INTEGER PET	prompt/echo type
REAL XMIN,XMAX,YMIN,YMAX	echo area in device coordinates
INTEGER BUFLEN	buffer length of string
INTEGER INIPOS	initial cursor position
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

9.7.2 Setting Mode of Input Devices

SET LOCATOR MODE Lmb

```
SUBROUTINE GSLCM (WKID,LCDNR,MODE,ESW)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER LCDNR	locator device number
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)

SET STROKE MODE Lmb

```
SUBROUTINE GSSKM (WKID,SKDNR,MODE,ESW)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER SKDNR	stroke device number
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)

SET VALUATOR MODE Lmb

```
SUBROUTINE GSVLM (WKID,VLDNR,MODE,ESW)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER VLDNR	valuator device number
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)

SET CHOICE MODE Lmb

SUBROUTINE GSCHM (WKID,CHDNR,MODE,ESW)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER CHDNR	choice device number
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)

SET PICK MODE L1b

SUBROUTINE GSPKM (WKID,PKDNR,MODE,ESW)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER PKDNR	pick device number
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)

SET STRING MODE Lmb

SUBROUTINE GSSTM (WKID,STDNR,MODE,ESW)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER STDNR	string device number
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)

9.7.3 Request Input Functions

REQUEST LOCATOR Lmb

SUBROUTINE GRQLC (WKID,LCDNR,STAT,TNR,PX,PY)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER LCDNR	locator device number

Output Parameters:	
INTEGER STAT	status (GNONE,GOK)
INTEGER TNR	normalization transformation number
REAL PX,PY	locator position

REQUEST STROKE Lmb

SUBROUTINE GRQSK (WKID,SKDNR,N,STAT,TNR,NP,PXA,PYA)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER SKDNR	stroke device number
INTEGER N	maximum number of points

Output Parameters:

INTEGER STAT	status (GNONE,GOK)
INTEGER TNR	normalization transformation number
INTEGER NP	number of points
REAL PXA (N), PYA (N)	points in stroke (WC)

REQUEST VALUATOR Lmb

SUBROUTINE GRQVL (WKID,VLDNR,STAT,VAL)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER VLDNR	valuator device number

Output Parameters:

INTEGER STAT	status (GNONE,GOK)
REAL VAL	value

REQUEST CHOICE Lmb

SUBROUTINE GRQCH (WKID,CHDNR,STAT,CHNR)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER CHDNR	choice device number

Output Parameters:

INTEGER STAT	status (GNONE,GOK,GNCHOI)
INTEGER CHNR	choice number

REQUEST PICK L1b

SUBROUTINE GRQPK (WKID,PKDNR,STAT,SGNA,PKID)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER PKDNR	pick device number

Output Parameters:

INTEGER STAT	status (GNONE,GOK,GNPICK)
INTEGER SGNA	segment name
INTEGER PKID	pick identifier

REQUEST STRING Lmb
Full FORTRAN 77 version

SUBROUTINE GRQST (WKID,STDNR,STAT,LOSTR,STR)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number

Output Parameters:

INTEGER STAT	status (GNONE,GOK)
INTEGER LOSTR	number of characters returned
CHARACTER*(*) STR	character string

REQUEST STRING Lmb
FORTRAN 77 Subset version

SUBROUTINE GRQST (WKID,STDNR,STAT,LOSTR,STR)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number

Output Parameters:

INTEGER STAT	status (GNONE,GOK)
INTEGER LOSTR	number of characters returned
CHARACTER*80 STR	character string

9.7.4 Sample Input Functions

SAMPLE LOCATOR Lmc

SUBROUTINE GSMLC (WKID,LCDNR,TNR,LPX,LPY)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER LCDNR	locator device number

Output Parameters:

INTEGER TNR	normalization transformation number
REAL LPX,LPY	locator position in WC

SAMPLE STROKE Lmc

SUBROUTINE GSMSK (WKID,SKDNR,N,TNR,NP,PXA,PYA)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER SKDNR	stroke device number
INTEGER N	maximum number of points
Output Parameters:	
INTEGER TNR	normalization transformation number
INTEGER NP	number of points
REAL PXA (N), PYA (N)	points in stroke (WC)

SAMPLE VALUATOR Lmc

SUBROUTINE GSMVL (WKID,VLDNR,VAL)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER VLDNR	valuator device number
Output Parameters:	
REAL VAL	value

SAMPLE CHOICE Lmc

SUBROUTINE GSMCH (WKID,CHDNR,STAT,CHNR)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER CHDNR	choice device number
Output Parameters:	
INTEGER STAT	status (GOK,GNCHOI)
INTEGER CHNR	choice number

SAMPLE PICK L1c

SUBROUTINE GSMPK (WKID,PKDNR,STAT,SGNA,PKID)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER PKDNR	pick device number
Output Parameters:	
INTEGER STAT	status (GOK,GNPICK)
INTEGER SGNA	segment name
INTEGER PKID	pick identifier

SAMPLE STRING Lmc
Full FORTRAN 77 version

SUBROUTINE GSMST (WKID,STDNR,LOSTR,STR)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number

Output Parameters:

INTEGER LOSTR	number of characters returned
CHARACTER*(*) STR	string

SAMPLE STRING Lmc
FORTRAN 77 Subset version

SUBROUTINE GSMST (WKID,STDNR,LOSTR,STR)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number

Output Parameters:

INTEGER LOSTR	number of characters returned
CHARACTER*80 STR	string

9.7.5 Event Input Functions

AWAIT EVENT Lmc

SUBROUTINE GWAIT (TOUT,WKID,ICL,IDNR)

Input Parameters:

REAL TOUT	time out (seconds)

Output Parameters:

INTEGER WKID	workstation identifier
INTEGER ICL	input class (GNCLAS,GLOCAT,GSTROK, GVALUA,GCHOIC,GPICK,GSTRIN)
INTEGER IDNR	logical input device number

FLUSH DEVICE EVENTS Lmc

SUBROUTINE GFLUSH (WKID,ICL,IDNR)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER ICL	input class (GLOCAT,GSTROK,GVALUA, GCHOIC,GPICK,GSTRIN)
INTEGER IDNR	logical input device number

GET LOCATOR Lmc

SUBROUTINE GGTLC (TNR,LPX,LPY)

Output Parameters:

INTEGER TNR	normalization transformation number
REAL LPX,LPY	locator position in world coordinates

GET STROKE Lmc

SUBROUTINE GGTSK (N,TNR,NP,PXA,PYA)

Input Parameters:

INTEGER N	maximum number of points

Output Parameters:

INTEGER TNR	normalization transformation number
INTEGER NP	number of points
REAL PXA (N), PYA (N)	points in stroke in world coordinates

GET VALUATOR Lmc

SUBROUTINE GGTVL (VAL)

Output Parameters:

REAL VAL	value

GET CHOICE Lmc

SUBROUTINE GGTCH (STAT,CHNR)

Output Parameters:

INTEGER STAT	status (GOK,GNCHOI)
INTEGER CHNR	choice number

GET PICK L1c

SUBROUTINE GGTPK (STAT,SGNA,PKID)

Output Parameters:

INTEGER STAT	status (GOK,GNPICK)
INTEGER SGNA	segment name
INTEGER PKID	pick identifier

GET STRING Lmc
Full FORTRAN 77 version

SUBROUTINE GGTST (LOSTR,STR)

Output Parameters:

INTEGER LOSTR	number of characters returned
CHARACTER*(*) STR	string

GET STRING Lmc
FORTRAN 77 Subset version

SUBROUTINE GGTST (LOSTR,STR)

Output Parameters:

INTEGER LOSTR	number of characters returned
CHARACTER*80 STR	string

9.8 Metafile Functions

WRITE ITEM TO GKSM L0a

```
SUBROUTINE GWITM (WKID,TYPE,IDRL,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER TYPE	item type
INTEGER IDRL	item data record length (number of characters in the data record array)
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

GET ITEM TYPE FROM GKSM L0a

```
SUBROUTINE GGTITM (WKID,TYPE,IDRL)
```

Input Parameters:

INTEGER WKID	workstation identifier

Output Parameters:

INTEGER TYPE	item type
INTEGER IDRL	item data record length (this may be passed to GRDITM (MIDRL))

READ ITEM FROM GKSM L0a

```
SUBROUTINE GRDITM (WKID,MIDRL,MLDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER MIDRL	maximum item data record length (number of characters in the data record array). Range is 0...IDRL. If =0, then skip the record; if < IDRL, the excess is lost; if = IDRL, a full record is read. (IDRL is returned by GGTITM.)
INTEGER MLDR	dimension of item data record

Output Parameters:

CHARACTER*80 DATREC(MLDR)	data record

INTERPRET ITEM

L0a

SUBROUTINE GIITM (TYPE,IDRL,LDR,DATREC)

Input Parameters:

INTEGER TYPE	item type
INTEGER IDRL	item data record length (number of characters in the data record array)
INTEGER LDR	dimension of data record array
CHARACTER*80 DATREC(LDR)	data record

9.9 Inquiry Functions

9.9.1 Inquiry Function for Operating State Value

INQUIRE OPERATING STATE VALUE L0a

SUBROUTINE GQOPS (OPSTA)

Output Parameters:	
INTEGER OPSTA	operating state value (GGKCL,GGKOP,GWSOP,GWSAC,GSGOP)

9.9.2 Inquiry Functions for GKS Description Table

INQUIRE LEVEL OF GKS Lma

SUBROUTINE GQLVKS (ERRIND,LEVEL)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER LEVEL	level of GKS (LMA,LMB,LMC, L0A,L0B,L0C,L1A,L1B,L1C,L2A,L2B,L2C)

INQUIRE LIST element OF AVAILABLE WORKSTATION TYPES L0a

SUBROUTINE GQEWK (N,ERRIND,NUMBER,WKTYP)

Input Parameters:	
INTEGER N	list element requested
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER NUMBER	number of workstation types
INTEGER WKTYP	Nth element of list of av. workstation types

INQUIRE WORKSTATION MAXIMUM NUMBERS L1a

SUBROUTINE GQWKM (ERRIND,MXOPWK,MXACWK,MXWKAS)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER MXOPWK	maximum number of simultaneously open workstations
INTEGER MXACWK	maximum number of simultaneously active workstaions
INTEGER MXWKAS	maximum number of workstations associated with segment

INQUIRE MAXIMUM NORMALIZATION TRANSFORMATION NUMBER L0a

SUBROUTINE GQMNTN (ERRIND,MAXTNR)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER MAXTNR	maximum normalization transformation number

9.9.3 Inquiry Functions for GKS State List

INQUIRE SET member OF OPEN WORKSTATIONS L0a

SUBROUTINE GQOPWK (N,ERRIND,OL,WKID)

Input Parameters:	
INTEGER N	set member requested

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of open workstations
INTEGER WKID	Nth member of set of open workstations

INQUIRE SET member OF ACTIVE WORKSTATIONS L1a

SUBROUTINE GQACWK (N,ERRIND,OL,WKID)

Input Parameters:	
INTEGER N	set member requested

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of active workstations
INTEGER WKID	Nth member of set of active workstations

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE POLYLINE INDEX L0a

SUBROUTINE GQPLI (ERRIND,PLI)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER PLI	polyline index

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE POLYMARKER INDEX L0a

SUBROUTINE GQPMI (ERRIND,PMI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER PMI	polymarker index

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE TEXT INDEX L0a

SUBROUTINE GQTXI (ERRIND,TXI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER TXI	text index

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE CHARACTER HEIGHT Lma

SUBROUTINE GQCHH (ERRIND,CHH)

Output Parameters:

INTEGER ERRIND	error indicator
REAL CHH	character height

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE CHARACTER UP VECTOR Lma

SUBROUTINE GQCHUP (ERRIND,CHUX,CHUY)

Output Parameters:

INTEGER ERRIND	error indicator
REAL CHUX, CHUY	character up vector (WC)

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE CHARACTER WIDTH L0a

SUBROUTINE GQCHW (ERRIND,CHW)

Output Parameters:

INTEGER ERRIND	error indicator
REAL CHW	character width

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE CHARACTER BASE VECTOR L0a

SUBROUTINE GQCHB (ERRIND,CHBX,CHBY)

Output Parameters:

INTEGER ERRIND	error indicator
REAL CHBX,CHBY	character base vector

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE TEXT PATH L0a

SUBROUTINE GQTXP (ERRIND,TXP)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER TXP	text path (GRIGHT,GLEFT,GUP,GDOWN)

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE TEXT ALIGNMENT Lma

SUBROUTINE GQTXAL (ERRIND,TXALH,TXALV)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER TXALH	text alignment horizontal (GAHNOR,GALEFT,GACENT,GARITE)
INTEGER TXALV	text alignment vertical (GAVNOR,GATOP,GACAP,GAHALF, GABASE,GABOTT)

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE FILL AREA INDEX L0a

SUBROUTINE GQFAI (ERRIND,FAI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER FAI	fill area index

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE PATTERN SIZE L0a

SUBROUTINE GQPA (ERRIND,PWX,PWY,PHX,PHY)

Output Parameters:

INTEGER ERRIND	error indicator
REAL PWX, PWY	pattern width vector
REAL PHX, PHY	pattern height vector

(INQUIRE CURRENT PRIMITIVE ATTRIBUTE VALUES)
INQUIRE PATTERN REFERENCE POINT L0a

SUBROUTINE GQPARF (ERRIND,RFX,RFY)

Output Parameters:

INTEGER ERRIND	error indicator
REAL RFX, RFY	pattern reference point

INQUIRE CURRENT PICK IDENTIFIER L1b

SUBROUTINE GQPKID (ERRIND,PKID)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER PKID	pick identifier

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE LINETYPE Lma

SUBROUTINE GQLN (ERRIND,LTYPE)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER LTYPE	linetype

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE LINEWIDTH SCALE FACTOR L0a

SUBROUTINE GQLWSC (ERRIND,LWIDTH)

Output Parameters:

INTEGER ERRIND	error indicator
REAL LWIDTH	linewidth scale factor

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE POLYLINE COLOUR INDEX Lma

SUBROUTINE GQPLCI (ERRIND,COLI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER COLI	polyline colour index

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE MARKERTYPE Lma

SUBROUTINE GQMK (ERRIND,MTYPE)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MTYPE	marker type

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE MARKER SIZE SCALE FACTOR L0a

SUBROUTINE GQMKSC (ERRIND,MSZSF)

Output Parameters:

INTEGER ERRIND	error indicator
REAL MSZSF	marker size scale factor

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE POLYMARKER COLOUR INDEX Lma

SUBROUTINE GQPMCI (ERRIND,COLI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER COLI	polymarker colour index

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE TEXT FONT AND PRECISION L0a

SUBROUTINE GQTXFP (ERRIND,FONT,PREC)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER FONT	text font
INTEGER PREC	text precision (GSTRP,GCHARP,GSTRKP)

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE CHARACTER EXPANSION FACTOR L0a

SUBROUTINE GQCHXP (ERRIND,CHXP)

Output Parameters:

INTEGER ERRIND	error indicator
REAL CHXP	character expansion factor

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE CHARACTER SPACING L0a

SUBROUTINE GQCHSP (ERRIND,CHSP)

Output Parameters:

INTEGER ERRIND	error indicator
REAL CHSP	character spacing

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE TEXT COLOUR INDEX Lma

SUBROUTINE GQTXCI (ERRIND,COLI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER COLI	text colour index

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE FILL AREA INTERIOR STYLE Lma

SUBROUTINE GQFAIS (ERRIND,INTS)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER INTS	fill area interior style (GHOLLO,GSOLID,GPATTR,GHATCH)

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE FILL AREA STYLE INDEX L0a

SUBROUTINE GQFASI (ERRIND,STYLI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER STYLI	fill area style index

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES)
INQUIRE FILL AREA COLOUR INDEX Lma

SUBROUTINE GQFACI (ERRIND,COLI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER COLI	fill area colour index

(INQUIRE CURRENT INDIVIDUAL ATTRIBUTE VALUES) INQUIRE ASPECT SOURCE FLAGS L0a

SUBROUTINE GQASF (ERRIND,LASF)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER LASF (13)	list of aspect source flags (GBUNDL,GINDIV)
	1 linetype ASF
	2 linewidth scale factor ASF
	3 polyline colour index ASF
	4 marker type ASF
	5 marker size scale factor ASF
	6 polymarker colour index ASF
	7 text font and precision ASF
	8 character expansion factor ASF
	9 character spacing ASF
	10 text colour index ASF
	11 fill area interior style ASF
	12 fill area style index ASF
	13 fill area colour index ASF

INQUIRE CURRENT NORMALIZATION TRANSFORMATION NUMBER Lma

SUBROUTINE GQCNTN (ERRIND,CTNR)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER CTNR	current transformation number

INQUIRE LIST element OF NORMALIZATION TRANSFORMATION NUMBERS L0a

SUBROUTINE GQENTN (N,ERRIND,OL,TNR)

Input Parameters:	
INTEGER N	list element requested
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	length of list
INTEGER TNR	Nth element of list of transformation numbers, ordered by decreasing viewport input priority

INQUIRE NORMALIZATION TRANSFORMATION Lma

SUBROUTINE GQNT (NTNR,ERRIND,WINDOW,VIEWPT)

Input Parameters:

INTEGER NTNR	normalization transformation number

Output Parameters:

INTEGER ERRIND	error indicator
REAL WINDOW(4)	window limits in world coordinates WXMIN, WXMAX, WYMIN, WYMAX
REAL VIEWPT(4)	viewport limits in normalized device coordinates VXMIN, VXMAX, VYMIN, VYMAX

INQUIRE CLIPPING Lma

SUBROUTINE GQCLIP (ERRIND,CLSW,CLRECT)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER CLSW	clipping indicator (GNCLIP,GCLIP)
REAL CLRECT(4)	clipping rectangle

INQUIRE NAME OF OPEN SEGMENT L1a

SUBROUTINE GQOPSG (ERRIND,SGNA)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER SGNA	name of open segment

INQUIRE SET member OF SEGMENT NAMES IN USE L1a

SUBROUTINE GQSGUS (N,ERRIND,OL,SGNA)

Input Parameters:

INTEGER N	set member requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER OL	number of segment names
INTEGER SGNA	Nth member of set of segment names in use

INQUIRE MORE SIMULTANEOUS EVENTS Lmc

SUBROUTINE GQSIM (ERRIND,FLAG)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER FLAG	more simultaneous events (GNMORE,GMORE)

9.9.4 Inquiry Functions for Workstation State List

INQUIRE WORKSTATION CONNECTION AND TYPE Lma

SUBROUTINE GQWKC (WKID,ERRIND,CONID,WTYPE)

Input Parameters:

INTEGER WKID	workstation identifier

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER CONID	connection identifier
INTEGER WTYPE	workstation type

INQUIRE WORKSTATION STATE L0a

SUBROUTINE GQWKS (WKID,ERRIND,STATE)

Input Parameters:

INTEGER WKID	workstation identifier

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER STATE	workstation state (GINACT,GACTIV)

INQUIRE WORKSTATION DEFERRAL AND UPDATE STATES L0a

SUBROUTINE GQWKDU (WKID,ERRIND,DEFMOD,REGMOD,DEMPTY,
*NFRAME)

Input Parameters:

INTEGER WKID	workstation identifier

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER DEFMOD	deferral mode (GASAP,GBNIG,GBNIL,GASTI)
INTEGER REGMOD	implicit regeneration mode (GSUPPD,GALLOW)
INTEGER DEMPTY	display surface empty (GNEMPT,GEMPTY)
INTEGER NFRAME	new frame action necessary at update (GNO,GYES)

INQUIRE LIST element OF POLYLINE INDICES L1a

SUBROUTINE GQEPLI (WKID,N,ERRIND,OL,PLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER N	list element requested
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of polyline bundle table entries
INTEGER PLI	Nth element of list of defined polyline indices

INQUIRE POLYLINE REPRESENTATION L1a

SUBROUTINE GQPLR (WKID,PLI,TYPE,ERRIND,LTYPE,LWIDTH,COLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER PLI	polyline index
INTEGER TYPE	type of returned values (GSET,GREALI)
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER LTYPE	linetype
REAL LWIDTH	linewidth scale factor
INTEGER COLI	polyline colour index

INQUIRE LIST element OF POLYMARKER INDICES L1a

SUBROUTINE GQEPMI (WKID,N,ERRIND,OL,PMI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER N	list element requested
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of polymarker bundle table entries
INTEGER PMI	Nth element of list of defined polymarker indices

INQUIRE POLYMARKER REPRESENTATION L1a

SUBROUTINE GQPMR (WKID,PMI,TYPE,ERRIND,MTYPE,MSZSF,COLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER PMI	polymarker index
INTEGER TYPE	type of returned values (GSET,GREALI)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER MTYPE	marker type
REAL MSZSF	marker size scale factor
INTEGER COLI	polymarker colour index

INQUIRE LIST element OF TEXT INDICES L1a

SUBROUTINE GQETXI (WKID,N,ERRIND,OL,TXI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER N	list element requested

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of text bundle table entries
INTEGER TXI	Nth element of list of defined text indices

INQUIRE TEXT REPRESENTATION L1a

SUBROUTINE GQTXR (WKID,TXI,TYPE,ERRIND,FONT,PREC,CHXP,CHSP,
*COLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER TXI	text index
INTEGER TYPE	type of returned values (GSET,GREALI)

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER FONT	text font
INTEGER PREC	text precision (GSTRP,GCHARP,GSTRKP)
REAL CHXP	character expansion factor
REAL CHSP	character spacing
INTEGER COLI	text colour index

INQUIRE TEXT EXTENT Lma
Full FORTRAN 77 version

```
SUBROUTINE GQTXX (WKID,PX,PY,STR,ERRIND,CPX,CPY,
*TXEXPX,TXEXPY)
```

Input Parameters:

INTEGER WKID	workstation identifier
REAL PX,PY	text position in world coordinates
CHARACTER*(*) STR	character string

Output Parameters:

INTEGER ERRIND	error indicator
REAL CPX,CPY	concatenation point in world coordinates
REAL TXEXPX (4), TXEXPY (4)	text extent rectangle

INQUIRE TEXT EXTENT Lma
FORTRAN 77 Subset version

```
SUBROUTINE GQTXXS (WKID,PX,PY,LSTR,STR,ERRIND,CPX,CPY,
*TXEXPX,TXEXPY)
```

Input Parameters:

INTEGER WKID	workstation identifier
REAL PX,PY	text position in world coordinates
INTEGER LSTR	length of string (in characters)
CHARACTER*80 STR	character string

Output Parameters:

INTEGER ERRIND	error indicator
REAL CPX,CPY	concatenation point in world coordinates
REAL TXEXPX (4), TXEXPY (4)	text extent rectangle

INQUIRE LIST element OF FILL AREA INDICES L1a

```
SUBROUTINE GQEFAI (WKID,N,ERRIND,OL,FAI)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER N	list element requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER OL	number of fill area bundle table entries
INTEGER FAI	Nth element of list of defined fill area indices

INQUIRE FILL AREA REPRESENTATION L1a

SUBROUTINE GQFAR (WKID,FAI,TYPE,ERRIND,INTS,STYLI,COLI)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER FAI	fill area index
INTEGER TYPE	type of returned values (GSET,GREALI)

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER INTS	fill area interior style (GHOLLO,GSOLID,GPATTR,GHATCH)
INTEGER STYLI	fill area style index
INTEGER COLI	fill area colour index

INQUIRE LIST element OF PATTERN INDICES L1a

SUBROUTINE GQEPAI (WKID,N,ERRIND,OL,PAI)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER N	list element requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER OL	number of pattern table entries
INTEGER PAI	Nth element of list of pattern indices

INQUIRE PATTERN REPRESENTATION L1a

SUBROUTINE GQPAR (WKID,PAI,TYPE,DIMX,DIMY,ERRIND,DX,DY,COLIA)

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER PAI	pattern index
INTEGER TYPE	type of returned values (GSET,GREALI)
INTEGER DIMX,DIMY	maximum pattern array dimensions

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER DX,DY	pattern array dimensions
INTEGER COLIA (DIMX,DIMY)	pattern array

INQUIRE LIST element OF COLOUR INDICES Lma

SUBROUTINE GQECI (WKID,N,ERRIND,OL,COLI)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER N	list element requested
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of colour table entries
INTEGER COLI	Nth element of list of colour indices

INQUIRE COLOUR REPRESENTATION Lma

SUBROUTINE GQCR(WKID,COLI,TYPE,ERRIND,CR,CG,CB)

Input Parameters:	
INTEGER WKID	workstation identifier
INTEGER COLI	colour index
INTEGER TYPE	type of returned values (GSET,GREALI)
Output Parameters:	
INTEGER ERRIND	error indicator
REAL CR,CG,CB	colour (red/green/blue intensities)

INQUIRE WORKSTATION TRANSFORMATION Lma

SUBROUTINE GQWKT (WKID,ERRIND,TUS,RWINDO,CWINDO,
*RVIEWP,CVIEWP)

Input Parameters:	
INTEGER WKID	workstation identifier
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER TUS	workstation transformation update state (GNPEND,GPEND)
REAL RWINDO(4)	requested workstation window in NDC RWXMIN, RWXMAX, RWYMIN, RWYMAX
REAL CWINDO(4)	current workstation window in NDC CWXMIN, CWXMAX, CWYMIN, CWYMAX
REAL RVIEWP(4)	requested workstation viewport in DC RVXMIN, RVXMAX, RVYMIN, RVYMAX
REAL CVIEWP(4)	current workstation viewport in DC CVXMIN, CVXMAX, CVYMIN, CVYMAX

INQUIRE SET member OF SEGMENT NAMES ON WORKSTATION — L1a

```
SUBROUTINE GQSGWK (WKID,N,ERRIND,OL,SGNA)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER N	set member requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER OL	number of segment names
INTEGER SGNA	Nth set member of set of stored segments for workstation

INQUIRE LOCATOR DEVICE STATE — Lmb

```
SUBROUTINE GQLCS(WKID,LCDNR,TYPE,MLDR,ERRIND,MODE,ESW,TNR,
*IPX,IPY,PET,EAREA,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER LCDNR	locator device number
INTEGER TYPE	type of returned values (GSET,GREALI)
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
INTEGER TNR	initial normalization transformation number
REAL IPX, IPY	initial locator position in world coordinates
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE STROKE DEVICE STATE

Lmb

```
SUBROUTINE GQSKS(WKID,SKDNR,TYPE,N,MLDR,ERRIND,MODE,ESW,ITNR,
*NP,PXA,PYA,PET,EAREA,BUFLEN,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER SKDNR	stroke device number
INTEGER TYPE	type of returned values (GSET,GREALI)
INTEGER N	maximum number of points
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
INTEGER ITNR	initial normalization transformation number
INTEGER NP	number of points
REAL PXA(N), PYA(N)	initial points in stroke in world coordinates
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER BUFLEN	input buffer size
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE VALUATOR DEVICE STATE

Lmb

```
SUBROUTINE GQVLS (WKID,VLDNR,MLDR,ERRIND,MODE,ESW,IVAL,PET,
*EAREA,LOVAL,HIVAL,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER VLDNR	valuator device number
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
REAL IVAL	initial value
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
REAL LOVAL, HIVAL	minimal and maximal value
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE CHOICE DEVICE STATE Lmb

```
SUBROUTINE GQCHS (WKID,CHDNR,MLDR,ERRIND,MODE,ESW,ISTAT,
*ICHNR,PET,EAREA,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER CHDNR	choice device number
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
INTEGER ISTAT	initial status (GOK,GNCHOI)
INTEGER ICHNR	initial choice number
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE PICK DEVICE STATE L1b

```
SUBROUTINE GQPKS (WKID,PKDNR,TYPE,MLDR,ERRIND,MODE,ESW,ISTAT,
*ISGNA,IPKID,PET,EAREA,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER PKDNR	pick device number
INTEGER TYPE	type of returned values (GSET,GREALI)
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
INTEGER ISTAT	initial status (GOK,GNPICK)
INTEGER ISGNA	initial segment
INTEGER IPKID	initial pick identifier
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE STRING DEVICE STATE Lmb

Full FORTRAN 77 version

```
SUBROUTINE GQSTS (WKID,STDNR,MLDR,ERRIND,MODE,ESW,LOSTR,ISTR,
*PET,EAREA,BUFLEN,INIPOS,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
INTEGER LOSTR	number of characters returned
CHARACTER*(*) ISTR	initial string
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER BUFLEN	input buffer size
INTEGER INIPOS	initial cursor position
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE STRING DEVICE STATE Lmb

FORTRAN 77 Subset version

```
SUBROUTINE GQSTS (WKID,STDNR,MLDR,ERRIND,MODE,ESW,
*LOSTR,ISTR,PET,EAREA,BUFLEN,INIPOS,LDR,DATREC)
```

Input Parameters:

INTEGER WKID	workstation identifier
INTEGER STDNR	string device number
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MODE	operating mode (GREQU,GSAMPL,GEVENT)
INTEGER ESW	echo switch (GNECHO,GECHO)
INTEGER LOSTR	number of characters returned
CHARACTER*80 ISTR	initial string
INTEGER PET	prompt/echo type
REAL EAREA(4)	echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER BUFLEN	input buffer size
INTEGER INIPOS	initial cursor position
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

9.9.5 Inquiry Functions for Workstation Description Table

INQUIRE WORKSTATION CATEGORY L0a

SUBROUTINE GQWKCA (WTYPE,ERRIND,WKCAT)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER WKCAT	workstation category (GOUTPT,GINPUT, GOUTIN,GWISS,GMO,GMI)

INQUIRE WORKSTATION CLASSIFICATION L0a

SUBROUTINE GQWKCL (WTYPE,ERRIND,VRTYPE)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER VRTYPE	vector/raster/other type (GVECTR,GRASTR,GOTHWK)

INQUIRE DISPLAY SPACE SIZE L0a

SUBROUTINE GQDSP (WTYPE,ERRIND,DCUNIT,RX,RY,LX,LY)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER DCUNIT	device coordinate units (GMETRE,GOTHU)
REAL RX,RY	maximum display surface size (DC)
INTEGER LX,LY	maximum display surface size (raster units)

INQUIRE DYNAMIC MODIFICATION OF WORKSTATION ATTRIBUTES L1a

SUBROUTINE GQDWKA (WTYPE,ERRIND,PLBUN,PMBUN,TXBUN,FABUN,
*PAREP,COLREP,WKTR)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER PLBUN	polyline representation changeable (GIRG,GIMM)
INTEGER PMBUN	polymarker representation changeable (GIRG,GIMM)
INTEGER TXBUN	text representation changeable (GIRG,GIMM)
INTEGER FABUN	fill area representation changeable (GIRG,GIMM)
INTEGER PAREP	pattern representation changeable (GIRG,GIMM)
INTEGER COLREP	colour representation changeable (GIRG,GIMM)
INTEGER WKTR	workstation transformation changeable (GIRG,GIMM)

INQUIRE DEFAULT DEFERRAL STATE VALUES L1a

SUBROUTINE GQDDS (WTYPE,ERRIND,DEFMOD,REGMOD)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER DEFMOD	default value for deferral mode (GASAP,GBNIG,GBNIL,GASTI)
INTEGER REGMOD	default value for implicit regeneration mode (GSUPPD,GALLOW)

INQUIRE POLYLINE FACILITIES — Lma

```
SUBROUTINE GQPLF (WTYPE,N,ERRIND,NLT,LT,NLW,NOMLW,
*RLWMIN,RLWMAX,NPPLI)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER N	list element requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NLT	number of available linetypes
INTEGER LT	Nth element of list of available linetypes
INTEGER NLW	number of available linewidths
REAL NOMLW	nominal linewidth
REAL RLWMIN, RWLMAX	range of linewidths
INTEGER NPPLI	number of predefined polyline indices

INQUIRE PREDEFINED POLYLINE REPRESENTATION — L0a

```
SUBROUTINE GQPPLR (WTYPE,PLI,ERRIND,LTYPE,LWIDTH,COLI)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER PLI	predefined polyline index

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER LTYPE	linetype
REAL LWIDTH	linewidth scale factor
INTEGER COLI	polyline colour index

INQUIRE POLYMARKER FACILITIES — Lma

```
SUBROUTINE GQPMF (WTYPE,N,ERRIND,NMT,MT,NMS,NOMMS,
*RMSMIN,RMSMAX,NPPMI)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER N	list element requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NMT	number of available marker types
INTEGER MT	Nth element of list of available marker types
INTEGER NMS	number of available marker sizes
REAL NOMMS	nominal marker size
REAL RMSMIN, RMSMAX	range of marker sizes
INTEGER NPPMI	number of predefined polymarker indices

INQUIRE PREDEFINED POLYMARKER REPRESENTATION L0a

SUBROUTINE GQPPMR (WTYPE,PMI,ERRIND,MTYPE,MSZSF,COLI)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER PMI	predefined polymarker index

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MTYPE	marker type
REAL MSZSF	marker size scale factor
INTEGER COLI	polymarker colour index

INQUIRE TEXT FACILITIES Lma

SUBROUTINE GQTXF (WTYPE,N,ERRIND,NFPP,FONT,PREC,NCHH,MINCHH,
*MAXCHH,NCHX,MINCHX,MAXCHX,NPTXI)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER N	list element requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NFPP	number of text font and precision pairs
INTEGER FONT	Nth element of list of text fonts
INTEGER PREC	Nth element of list of text precisions (GSTRP,GCHARP,GSTRKP)
INTEGER NCHH	number of available character heights
REAL MINCHH	minimum character height (DC)
REAL MAXCHH	maximum character height (DC)
INTEGER NCHX	number of available character expansion factors
REAL MINCHX	minimum character expansion factor
REAL MAXCHX	maximum character expansion factor
INTEGER NPTXI	number of predefined text indices

INQUIRE PREDEFINED TEXT REPRESENTATION L0a

SUBROUTINE GQPTXR (WTYPE,PTXI,ERRIND,FONT,PREC,CHXP,CHSP,
*COLI)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER PTXI	predefined text index

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER FONT	text font
INTEGER PREC	text precision (GSTRP,GCHARP,GSTRKP)
REAL CHXP	character expansion factor
REAL CHSP	character spacing
INTEGER COLI	text colour index

INQUIRE FILL AREA FACILITIES Lma

SUBROUTINE GQFAF (WTYPE,NI,NH,ERRIND,NIS,IS,NHS,HS,NPFAI)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER NI	list element of interior styles requested
INTEGER NH	list element of hatch styles requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NIS	number of available fill area interior styles
INTEGER IS	NIth element of list of available fill area interior styles (GHOLLO,GSOLID,GPATTR,GHATCH)
INTEGER NHS	number of available fill area hatch styles
INTEGER HS	NHth element of list of available fill area hatch style indices
INTEGER NPFAI	number of predefined fill area indices

INQUIRE PREDEFINED FILL AREA REPRESENTATION L0a

SUBROUTINE GQPFAR (WTYPE,PFAI,ERRIND,INTS,STYLI,COLI)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER PFAI	predefined fill area index

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER INTS	fill area interior style (GHOLLO,GSOLID,GPATTR,GHATCH)
INTEGER STYLI	fill area style index
INTEGER COLI	fill area colour index

INQUIRE PATTERN FACILITIES L0a

SUBROUTINE GQPAF (WTYPE,ERRIND,NPPAI)

Input Parameters:	
INTEGER WTYPE	workstation type
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER NPPAI	number of predefined pattern indices

INQUIRE PREDEFINED PATTERN REPRESENTATION L0a

SUBROUTINE GQPPAR (WTYPE,PPAI,DIMX,DIMY,ERRIND,DX,DY,COLIA)

Input Parameters:	
INTEGER WTYPE	workstation type
INTEGER PPAI	predefined pattern index
INTEGER DIMX,DIMY	maximum pattern array dimensions
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER DX,DY	pattern array dimensions
INTEGER COLIA (DIMX,DIMY)	pattern array

INQUIRE COLOUR FACILITIES Lma

SUBROUTINE GQCF (WTYPE,ERRIND,NCOLI,COLA,NPCI)

Input Parameters:	
INTEGER WTYPE	workstation type
Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER NCOLI	number of colours
INTEGER COLA	colour available (GMONOC,GCOLOR)
INTEGER NPCI	number of predefined colour indices

INQUIRE PREDEFINED COLOUR REPRESENTATION L0a

SUBROUTINE GQPCR (WTYPE,PCI,ERRIND,CR,CG,CB)

Input Parameters:	
INTEGER WTYPE	workstation type
INTEGER PCI	predefined colour index
Output Parameters:	
INTEGER ERRIND	error indicator
REAL CR, CG, CB	colour intensities (red/green/blue)

INQUIRE LIST element OF AVAILABLE GENERALIZED DRAWING PRIMITIVESLma

SUBROUTINE GQEGDP (WTYPE,N,ERRIND,NGDP,GDPL)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER N	list element requested

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NGDP	number of available generalized drawing primitives
INTEGER GDPL	Nth element of list of GDP identifiers

INQUIRE GENERALIZED DRAWING PRIMITIVE L0a

SUBROUTINE GQGDP (WTYPE,GDP,ERRIND,NBND,BNDL)

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER GDP	GDP identifier

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NBND	number of sets of attributes used
INTEGER BNDL(4)	list of sets of attributes used (GPLBND,GPMBND,GTXBND,GFABND)

INQUIRE MAXIMUM LENGTH OF WORKSTATION STATE TABLES L0a

SUBROUTINE GQLWK (WTYPE,ERRIND,MPLBTE,MPMBTE,MTXBTE,MFABTE,
*MPAI,MCOLI)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MPLBTE	maximum number of polyline bundle table entries
INTEGER MPMBTE	maximum number of polymarker bundle table entries
INTEGER MTXBTE	maximum number of text bundle table entries
INTEGER MFABTE	maximum number of fill area bundle table entries
INTEGER MPAI	maximum number of pattern indices
INTEGER MCOLI	maximum number of colour indices

INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED L1a

SUBROUTINE GQSGP (WTYPE,ERRIND,NSG)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NSG	number of segment priorities supported

INQUIRE DYNAMIC MODIFICATION OF SEGMENT ATTRIBUTES L1a

SUBROUTINE GQDSGA (WTYPE,ERRIND,SGTR,VONOFF,VOFFON,HIGH,
*SGPR,ADD,SGDEL)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER SGTR	segment transformation changeable (GIRG,GIMM)
INTEGER VONOFF	visibility changeable from on to off (GIRG,GIMM)
INTEGER VOFFON	visibility changeable from off to on (GIRG,GIMM)
INTEGER HIGH	highlighting changeable (GIRG,GIMM)
INTEGER SGPR	segment priority changeable (GIRG,GIMM)
INTEGER ADD	adding primitives to the open segment (GIRG,GIMM)
INTEGER SGDEL	segment deletion immediately visible (GIRG,GIMM)

INQUIRE NUMBER OF AVAILABLE LOGICAL INPUT DEVICES Lmb

SUBROUTINE GQLI (WTYPE,ERRIND,NLCD,NSKD,NVLD,NCHD,NPKD,NSTD)

Input Parameters:

INTEGER WTYPE	workstation type

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER NLCD	number of locator devices
INTEGER NSKD	number of stroke devices
INTEGER NVLD	number of valuator devices
INTEGER NCHD	number of choice devices
INTEGER NPKD	number of pick devices
INTEGER NSTD	number of string devices

INQUIRE DEFAULT LOCATOR DEVICE DATA Lmb

```
      SUBROUTINE GQDLC (WTYPE,DEVNO,N,MLDR,ERRIND,DPX,DPY,
     *OL,PET,EAREA,LDR,DATREC)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER DEVNO	logical input device number
INTEGER N	list element requested
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
REAL DPX,DPY	default initial locator position
INTEGER OL	number of available prompt/echo types
INTEGER PET	Nth element of list of available prompt/echo types
REAL EAREA(4)	default echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE DEFAULT STROKE DEVICE DATA Lmb

```
      SUBROUTINE GQDSK (WTYPE,DEVNO,N,MLDR,ERRIND,DBUFSK,
     *OL,PET,EAREA,BUFLEN,LDR,DATREC)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER DEVNO	logical input device number
INTEGER N	list element requested
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER DBUFSK	maximum input buffer size
INTEGER OL	number of available prompt/echo types
INTEGER PET	Nth element of list of available prompt/echo types
REAL EAREA(4)	default echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER BUFLEN	buffer length for stroke
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE DEFAULT VALUATOR DEVICE DATA Lmb

```
SUBROUTINE GQDVL (WTYPE,DEVNO,N,MLDR,ERRIND,DVAL,
*OL,PET,EAREA,LOVAL,HIVAL,LDR,DATREC)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER DEVNO	logical input device number
INTEGER N	list element requested
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
REAL DVAL	default initial value
INTEGER OL	number of available prompt/echo types
INTEGER PET	Nth element of list of available prompt/echo types
REAL EAREA(4)	default echo area in device coordinates XMIN, XMAX, YMIN, YMAX
REAL LOVAL, HIVAL	minimal and maximal value
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE DEFAULT CHOICE DEVICE DATA Lmb

```
SUBROUTINE GQDCH (WTYPE,DEVNO,N,MLDR,ERRIND,MALT,
*OL,PET,EAREA,LDR,DATREC)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER DEVNO	logical input device number
INTEGER N	list element requested
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MALT	maximum number of alternatives
INTEGER OL	number of available prompt/echo types
INTEGER PET	Nth element of list of available prompt/echo types
REAL EAREA(4)	default echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE DEFAULT PICK DEVICE DATA L1b

```
SUBROUTINE GQDPK (WTYPE,DEVNO,N,MLDR,ERRIND,
*OL,PET,EAREA,LDR,DATREC)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER DEVNO	logical input device number
INTEGER N	list element rquested
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER OL	number of available prompt/echo types
INTEGER PET	Nth element of list of available prompt/echo types
REAL EAREA(4)	default echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

INQUIRE DEFAULT STRING DEVICE DATA Lmb

```
SUBROUTINE GQDST (WTYPE,DEVNO,N,MLDR,ERRIND,MBUFF,
*OL,PET,EAREA,BUFLEN,LDR,DATREC)
```

Input Parameters:

INTEGER WTYPE	workstation type
INTEGER DEVNO	logical input device number
INTEGER N	list element requested
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER MBUFF	maximum string buffer size
INTEGER OL	number of available prompt/echo types
INTEGER PET	Nth element of list of available prompt/echo types
REAL EAREA(4)	default echo area in device coordinates XMIN, XMAX, YMIN, YMAX
INTEGER BUFLEN	buffer length of string
INTEGER LDR	number of array elements used in data record
CHARACTER*80 DATREC(MLDR)	data record

9.9.6 Inquiry Functions for Segment State List

INQUIRE SET member OF ASSOCIATED WORKSTATIONS L1a

SUBROUTINE GQASWK (SGNA,N,ERRIND,OL,WKID)

Input Parameters:	
INTEGER SGNA	segment name
INTEGER N	set member requested

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER OL	number of associated workstations
INTEGER WKID	Nth member of set of associated workstations

INQUIRE SEGMENT ATTRIBUTES L1a

SUBROUTINE GQSGA (SGNA,ERRIND,SEGTM,VIS,HIGH,SGPR,DET)

Input Parameters:	
INTEGER SGNA	segment name

Output Parameters:	
INTEGER ERRIND	error indicator
REAL SEGTM(2,3)	segment transformation matrix (SEGTM(1,1) SEGTM(1,2) SEGTM(1,3)) (SEGTM(2,1) SEGTM(2,2) SEGTM(2,3))
INTEGER VIS	visibility (GINVIS,GVISI)
INTEGER HIGH	highlighting (GNORML,GHILIT)
REAL SGPR	segment priority
INTEGER DET	detectability (GUNDET,GDETEC)

9.9.7 Pixel Inquiries

INQUIRE PIXEL ARRAY DIMENSIONS L0a

SUBROUTINE GQPXAD (WKID,PX,PY,QX,QY,ERRIND,N,M)

Input Parameters:	
INTEGER WKID	workstation identifier
REAL PX, PY, QX, QY	upper left, lower right corners in world coordinates

Output Parameters:	
INTEGER ERRIND	error indicator
INTEGER N,M	dimensions of pixel array

INQUIRE PIXEL ARRAY L0a

```
SUBROUTINE GQPXA (WKID,PX,PY,DIMX,DIMY,ISC,ISR,DX,DY,
*ERRIND,INVVAL,COLIA)
```

Input Parameters:

INTEGER WKID	workstation identifier
REAL PX, PY	upper left corner (WC)
INTEGER DIMX, DIMY	the dimensions of colour index array
INTEGER ISC, ISR	start column, start row
INTEGER DX, DY	size of requested pixel array

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER INVVAL	presence of invalid values (GABSNT,GPRSNT)
INTEGER COLIA (DIMX,DIMY)	colour index array

INQUIRE PIXEL L0a

```
SUBROUTINE GQPX (WKID,PX,PY,ERRIND,COLI)
```

Input Parameters:

INTEGER WKID	workstation identifier
REAL PX,PY	point in world coordinates

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER COLI	colour index

9.9.8 Inquiry Function for GKS Error State List

INQUIRE INPUT QUEUE OVERFLOW Lmc

```
SUBROUTINE GQIQOV (ERRIND,WKID,ICL,IDN)
```

Output Parameters:

INTEGER ERRIND	error indicator
INTEGER WKID	workstation identifier
INTEGER ICL	input class (GLOCAT,GSTROK,GVALUA,GCHOIC, GPICK,GSTRIN)
INTEGER IDN	input device number

9.10 Utility Functions

EVALUATE TRANSFORMATION MATRIX L1a

SUBROUTINE GEVTM (X0,Y0,DX,DY,PHI,FX,FY,SW,MOUT)

Input Parameters:

REAL X0, Y0	fixed point
REAL DX, DY	shift vector
REAL PHI	rotation angle in radians
REAL FX, FY	scale factors
INTEGER SW	coordinate switch (GWC,GNDC)

Output Parameters:

REAL MOUT(2,3)	segment transformation matrix (MOUT(1,1) MOUT(1,2) MOUT(1,3)) (MOUT(2,1) MOUT(2,2) MOUT(2,3))

ACCUMULATE TRANSFORMATION MATRIX L1a

SUBROUTINE GACTM (MINP,X0,Y0,DX,DY,PHI,FX,FY,SW,MOUT)

Input Parameters:

REAL MINP(2,3)	segment transformation matrix (MINP(1,1) MINP(1,2) MINP(1,3)) (MINP(2,1) MINP(2,2) MINP(2,3))
REAL X0, Y0	fixed point
REAL DX, DY	shift vector
REAL PHI	rotation angle in radians
REAL FX, FY	scale factors
INTEGER SW	coordinate switch (GWC,GNDC)

Output Parameters:

REAL MOUT(2,3)	segment transformation matrix (MOUT(1,1) MOUT(1,2) MOUT(1,3)) (MOUT(2,1) MOUT(2,2) MOUT(2,3))

9.11 Error Handling

EMERGENCY CLOSE GKS L0a

SUBROUTINE GECLKS

ERROR HANDLING L0a

SUBROUTINE GERHND (ERRNR,FCTID,ERRFIL)

Input Parameters:

INTEGER ERRNR	error number
INTEGER FCTID	function identification (see Section 6)
INTEGER ERRFIL	error file

ERROR LOGGING L0a

SUBROUTINE GERLOG (ERRNR,FCTID,ERRFIL)

Input Parameters:

INTEGER ERRNR	error number
INTEGER FCTID	function identification (see Section 6)
INTEGER ERRFIL	error file

10. Utility Functions not defined in GKS

The mechanism used for providing the error indicator of these utilities is the same as that used by the inquiry functions. The following language binding dependent errors may occur: 2001 and 2003. Note: implementation dependent errors may occur also.

PACK DATA RECORD L0a

Full FORTRAN 77 version

SUBROUTINE GPREC(IL,IA,RL,RA,SL,LSTR,STR,MLDR,ERRIND,LDR,DATREC)

Input Parameters:

INTEGER IL	number of integer entries (≥ 0)
INTEGER IA (*)	array containing integer entries
INTEGER RL	number of real entries (≥ 0)
REAL RA (*)	array containing real entries
INTEGER SL	number of character string entries (≥ 0)
INTEGER LSTR(*)	lengths of each character string entry (≥ 0)
CHARACTER*(*) STR(*)	character string entries
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator (zero if no error)
INTEGER LDR	number of array elements used in DATREC
CHARACTER*80 DATREC(MLDR)	data record

PACK DATA RECORD L0a

FORTRAN 77 Subset version

SUBROUTINE GPREC (IL,IA,RL,RA,SL,LSTR,STR,MLDR,ERRIND,LDR,DATREC)

Input Parameters:

INTEGER IL	number of integer entries (≥ 0)
INTEGER IA (*)	array containing integer entries
INTEGER RL	number of real entries (≥ 0)
REAL RA (*)	array containing real entries
INTEGER SL	number of character string entries (≥ 0)
INTEGER LSTR(*)	lengths of each character string entry (≥ 0)
CHARACTER*80 STR(*)	character string entries
INTEGER MLDR	dimension of data record array

Output Parameters:

INTEGER ERRIND	error indicator (zero if no error)
INTEGER LDR	number of array elements used in DATREC
CHARACTER*80 DATREC(MLDR)	data record

UNPACK DATA RECORD L0a

Full FORTRAN 77 version

```
SUBROUTINE GUREC (LDR,DATREC,IIL,IRL,ISL,ERRIND,IL,IA,RL,RA,
*SL,LSTR,STR)
```

Input Parameters:

INTEGER LDR	number of array elements used in DATREC
CHARACTER*80 DATREC(LDR)	data record
INTEGER IIL	dimension of integer array
INTEGER IRL	dimension of real array
INTEGER ISL	dimension of character array

Output Parameters:

INTEGER ERRIND	error indicator (zero if no error)
INTEGER IL	number of integer entries
INTEGER IA (IIL)	array containing integer entries
INTEGER RL	number of real entries
REAL RA (IRL)	array containing real entries
INTEGER SL	number of character string entries
INTEGER LSTR(ISL)	length of each character string entry
CHARACTER*(*) STR(ISL)	character string entries

UNPACK DATA RECORD L0a

FORTRAN 77 Subset version

```
SUBROUTINE GUREC (LDR,DATREC,IIL,IRL,ISL,ERRIND,IL,IA,RL,RA,
*SL,LSTR,STR)
```

Input Parameters:

INTEGER LDR	number of array elements used in DATREC
CHARACTER*80 DATREC(LDR)	data record
INTEGER IIL	dimension of integer array
INTEGER IRL	dimension of real array
INTEGER ISL	dimension of character array

Output Parameters:

INTEGER ERRIND	error indicator (zero if no error)
INTEGER IL	number of integer entries
INTEGER IA (IIL)	array containing integer entries
INTEGER RL	number of real entries
REAL RA (IRL)	array containing real entries
INTEGER SL	number of character string entries
INTEGER LSTR(ISL)	length of each character string entry
CHARACTER*80 STR(ISL)	character string entries

Appendix A FORTRAN Examples

This appendix is not part of the Standard, but provides additional information.

The following sample programs, using the GKS FORTRAN binding, illustrate the use of GKS functions.

Example 1:

```
C     PROGRAM STAR
C
C     DESCRIPTION:
C       This program draws a yellow star on a blue background and writes
C       the title 'Star' in green in under the star.
C     CONFORMANCE:
C       GKS level: ma
C       FORTRAN-77 binding with FORTRAN-77 Subset comments.
C       At least one output or outin workstation.
C
C     Define GKS constants.
C
      INTEGER GSOLID
      PARAMETER ( GSOLID = 1 )
      INTEGER GACENT,GAHALF
      PARAMETER ( GACENT = 2, GAHALF = 3 )
C
C     Implementation dependent constants.
C
      INTEGER ERROUT,TTOUT,WSTYPE,NBYTES
      PARAMETER ( ERROUT = 1, TTOUT = 5, WSTYPE = 0, NBYTES = -1 )
C
C     Define coordinates for drawing the star.
C
      REAL STARX( 5 ),STARY( 5 )
      DATA STARX / 0.951057, -0.951057, 0.587785, 0.0, -0.587785 /
      DATA STARY / 0.309017, 0.309017, -0.951057, 1.0, -0.951057 /
C
C     Perform implementation dependent initialization.
C
      OPEN ( TTOUT,STATUS='NEW' )
C
C     Open GKS and activate a workstation.
C
      CALL GOPKS ( ERROUT,NBYTES )
      CALL GOPWK ( 1,TTOUT,WSTYPE )
      CALL GACWK ( 1 )
C
C     Center the window around the origin.
C
      CALL GSWN ( 1,-1.25,1.25,-1.25,1.25 )
      CALL GSELNT ( 1 )
C
C     Define the colors we'll be using.
C
      CALL GSCR ( 1,0,0.0,0.0,1.0 )
      CALL GSCR ( 1,1,1.0,1.0,0.0 )
      CALL GSCR ( 1,2,1.0,1.0,1.0 )
```

```
C
C     Fill the star with solid yellow.
C
      CALL GSFAIS ( GSOLID )
      CALL GSFACI ( 1 )
C
C     Draw the star.
C
      CALL GFA ( 5,STARX,STARY )
C
C     Select large characters centered under the star.
C
      CALL GSCHH ( 0.15 )
      CALL GSTXAL ( GACENT,GAHALF )
      CALL GSTXCI ( 2 )
C
C     Draw the title.
C
      CALL GTX ( 0.0,-1.1,'Star' )
C
C     FORTRAN 77 subset version.
C     CALL GTXS ( 0.0,-1.1,4,'Star' )
C
C     Close the workstation and shut down GKS.
C
      CALL GDAWK ( 1 )
      CALL GCLWK ( 1 )
      CALL GCLKS
      STOP
      END
```

Example 2:

```
C     PROGRAM IRON
C
C     DESCRIPTION:
C       This program draws a horizontal bar chart illustrating costs within
C       the iron industry. The user can select the data to be displayed using
C       a GKS choice device. The plot is adapted from 'Scientific American'
C       May 1984 page 39.
C     CONFORMANCE:
C       GKS level: 0b
C       Choice device must support prompt and echo type 3
C
C     GKS constants:
C
      INTEGER GBUNDL,GINDIV
      PARAMETER ( GBUNDL = 0, GINDIV = 1 )
      INTEGER GOK,GNCHOI
      PARAMETER ( GOK = 0, GNCHOI = 1 )
C
C     Implementation dependent constants:
C
      INTEGER ERROUT,TTOUT,WSTYPE,NBYTES
      PARAMETER ( ERROUT = 5,TTOUT = 5, WSTYPE = 0, NBYTES = -1 )
C
C     Aspect source flags:
C
      INTEGER ASFLST( 13 )
C
C     Returned data from inquire choice device state:
C
      INTEGER ERRIND,MODE,ESW,ISTAT,ICHNR,PET,LDR
      REAL EAREA( 4 )
      CHARACTER*80 DATREC( 10 )
C
C     Data for inititializing choice device state:
C
      CHARACTER*12 CHSTRS( 4 )
      INTEGER CHLENS( 4 )
      INTEGER IDUMMY
      REAL RDUMMY
      INTEGER STATUS,CHOICE
C
C     Arrays for plot data:
C
      REAL USDAT1( 6 ),USDAT2( 6 ),GDAT1( 6 ),GDAT2( 6 ),JDAT1( 6 ),
     1        JDAT2( 6 )
C
C     Initialize the prompt data:
C
      DATA CHSTRS / 'U.S.', 'W. GERMANY', 'JAPAN', 'EXIT' /
      DATA CHLENS / 4, 10, 5, 4 /
C
C     Set the asf list to individual except for fill area interiors.
```

```
C
      DATA ASFLST / GINDIV,GINDIV,GINDIV,GINDIV,GINDIV,GINDIV,
     1              GINDIV,GINDIV,GINDIV,GINDIV,GBUNDL,GBUNDL,GINDIV /
C
C     Data to plot:
C
      DATA USDAT1 / 69.0, 50.0, 15.0, 53.0, 57.0, 150.0 /
      DATA USDAT2 / 72.0, 50.0, 103.0, 0.0, 0.0, 56.0 /
      DATA GDAT1 / 65.0, 42.0, 3.0, 89.0, 52.0, 93.0 /
      DATA GDAT2 / 70.0, 53.0, 102.0, 0.0, 0.0, 49.0 /
      DATA JDAT1 / 65.0, 47.0, 2.0, 60.0, 52.0, 55.0 /
      DATA JDAT2 / 70.0, 57.0, 105.0, 0.0, 0.0, 41.0 /
C
C     Open GKS and activate a workstation.
C
      CALL GOPKS ( ERROUT,NBYTES )
      CALL GOPWK ( 1,TTOUT,WSTYPE )
      CALL GACWK ( 1 )
C
C     Specify the window onto chart.
C
      CALL GSWN ( 1,-115.0,160.0,-2.0,14.0 )
      CALL GSELNT ( 1 )
C
C     Define the colors we'll be using.
C
      CALL GSCR ( 1,1,0.0,1.0,0.0 )
      CALL GSCR ( 1,2,1.0,0.0,0.0 )
C
C     Use bundled attributes except for fill area interior style and index.
C
      CALL GSASF ( ASFLST )
C
C     Initialize the choice device.
C
      CALL GQCHS ( 1,1,10,ERRIND,MODE,ESW,ISTAT,ICHNR,PET,EAREA,
     1                 LDR,DATREC )
      CALL GPREC ( 0,IDUMMY,0,RDUMMY,4,CHLENS,CHSTRS,10,ERRIND,
     1                 LDR,DATREC )
      CALL GINCH ( 1,1,GOK,1,3,EAREA( 1 ),EAREA( 2 ),EAREA( 3 ),
     1                 EAREA( 4 ),LDR,DATREC )
C
C     Get the users choice (u.s, w. germany, japan, or exit ).
C
   20 CONTINUE
      CALL GRQCH ( 1,1,STATUS,CHOICE )
C
C     Display data depending on the choice.
C
      IF ( CHOICE.EQ.1 ) THEN
         CALL DRAW ( USDAT1,USDAT2,CHSTRS(1) )
      ELSE IF ( CHOICE.EQ.2 ) THEN
         CALL DRAW ( GDAT1,GDAT2,CHSTRS(2) )
      ELSE IF ( CHOICE.EQ.3 ) THEN
```

```
         CALL DRAW ( JDAT1,JDAT2,CHSTRS(3) )
      ELSE
         GO TO 29
      ENDIF
      GO TO 20
 29   CONTINUE
C
C     Close the workstation and shut down GKS.
C
      CALL GDAWK ( 1 )
      CALL GCLWK ( 1 )
      CALL GCLKS
      STOP
      END

      SUBROUTINE DRAW ( DAT1,DAT2,NATION )
      CHARACTER*(*) NATION
      REAL DAT1( 6 ),DAT2( 6 )
C
C     Draw the border of the graph and plot the two sets of data associated
C     with this country.
C
C     Y-coordinate of the current data bar:
C
      REAL POS
C
C     Draw the border.
C
      CALL BORDER( NATION )
C
C     Draw the black bars.
C
      CALL GSFACI ( 1 )
      CALL GSTXCI ( 1 )
      CALL GSFAI ( 1 )
      DO 11 I = 1,6
         POS = 2.0 * FLOAT( I - 1 ) + 1.6
         CALL BAR( DAT1( I ),POS )
 11   CONTINUE
C
C     Draw the red bars.
C
      CALL GSFACI ( 2 )
      CALL GSTXCI ( 2 )
      CALL GSFAI ( 2 )
      DO 21 I = 1,6
         POS = 2.0 * FLOAT ( I - 1 ) + 0.8
         CALL BAR( DAT2( I ),POS )
 21   CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE BORDER( NATION )
      CHARACTER*(*) NATION
C
C     Draw the border surrounding the data.
C
C     GKS constants:
C
      INTEGER GCONDI
      PARAMETER ( GCONDI = 0 )
      INTEGER GALEFT,GACENT,GAHALF,GATOP,GABOTT,GACAP
      PARAMETER ( GALEFT = 1, GACENT = 2, GAHALF = 3, GATOP = 1 )
      PARAMETER ( GABOTT = 5, GACAP = 2 )
C
C     Coordinates of box surrounding bars:
C
      REAL BOXX( 5 ),BOXY( 5 )
C
C     Labels for the bars:
C
      CHARACTER*16 LABEL( 6 )
      DATA LABEL / 'LABOR', 'IRON ORE', 'COKE OR COAL',
     1             'PURCHASED SCRAP', 'OTHER COSTS', 'OTHER ENERGY' /
C
C     Initialize the box surrounding the bars:
C
      DATA BOXX / 0.0, 150.0, 150.0, 0.0, 0.0 /
      DATA BOXY / 0.0, 0.0, 12.0, 12.0, 0.0 /
C
C     Clear the screen (if not already clear).
C
      CALL GCLRWK ( 1,GCONDI )
C
C     Draw the box surrounding the chart area.
C
      CALL GPL ( 5,BOXX,BOXY )
C
C     Draw the labels centered on the bar and flush left.
C
      CALL GSTXAL ( GALEFT,GAHALF )
      CALL GSCHH ( 0.5 )
      CALL GSTXCI ( 1 )
      DO 11 I = 1,6
         POSY = 2.0 * FLOAT( I - 1 ) + 1.2
         CALL GTX ( -114.0,POSY,LABEL( I ) )
 11   CONTINUE
C
C     Draw the top and bottom tick marks (bottom in red).
C
      CALL GSTXAL ( GACENT,GABOTT )
      CALL TICKS ( 12.0,12.2 )
      CALL GSTXAL ( GACENT,GATOP )
      CALL GSTXCI ( 2 )
      CALL TICKS ( 0.0,-0.2 )
C
```

```
C     Draw the title text in bigger characters.
C
      CALL GSTXCI ( 1 )
      CALL GSTXAL ( GACENT,GABOTT )
      CALL GTX ( 0.0,-2.0,'PRODUCTION COST' )
      CALL GSCHH ( 0.7 )
      CALL GSTXAL ( GACENT,GATOP )
      CALL GTX ( 0.0,14.0,NATION )
      CALL GSCHH ( 0.5 )
      RETURN
      END

      SUBROUTINE TICKS ( TSTART,TEND )
      REAL TSTART,TEND
C
C     Draw the tick mark along the edges.
C
C     Tick mark coordinates:
C
      REAL TICKX( 2 ),TICKY( 2 )
C
C     Determine the direction of the tick.
C
      TICKX( 1 ) = 0.0
      TICKX( 2 ) = 0.0
      TICKY( 1 ) = TSTART
      TICKY( 2 ) = TEND
C
C     Draw each tick mark.
C
      DO 11 I = 1,4
         CALL GPL ( 2,TICKX,TICKY )
         TICKX( 1 ) = TICKX( 1 ) + 50.0
         TICKX( 2 ) = TICKX( 2 ) + 50.0
 11   CONTINUE
C
C     Draw the tick mark labels.
C
      CALL GTX ( 0.0,TSTART,'0' )
      CALL GTX ( 50.0,TSTART,'50' )
      CALL GTX ( 100.0,TSTART,'100' )
      CALL GTX ( 150.0,TSTART,'150' )
C
      RETURN
      END

      SUBROUTINE BAR ( LENGTH,POS )
      REAL LENGTH,POS
C
C     This subroutine draws a horizontal bar of the specified length and
C     at position pos.
C
C     GKS constants:
C
```

```
      INTEGER GALEFT,GACENT,GAHALF,GATOP,GABOTT
      PARAMETER ( GALEFT = 1, GACENT = 2, GAHALF = 3, GATOP = 1 )
      PARAMETER ( GABOTT = 5 )
C
C     Coordinates of the bar:
C
      REAL BARX( 4 ),BARY( 4 )
C
C     If the value is too small, print a zero.
C
      IF ( LENGTH.LE.0.0 ) THEN
         CALL GSTXAL ( GALEFT,GAHALF )
         CALL GTX ( 0.0,POS,'0' )
      ELSE
C
C     Otherwise draw the bar.
C
         BARX( 1 ) = 0.0
         BARX( 2 ) = LENGTH
         BARX( 3 ) = LENGTH
         BARX( 4 ) = 0.0
         BARY( 1 ) = POS + 0.4
         BARY( 2 ) = POS + 0.4
         BARY( 3 ) = POS - 0.4
         BARY( 4 ) = POS - 0.4
         CALL GFA ( 4,BARX,BARY )
      ENDIF
C
      RETURN
      END
```

Example 3:

```
C     PROGRAM USMAP
C
C     DESCRIPTION:
C       This program reads a GKS metafile to draw a map of the U.S. The
C       primitives in each state are in a separate segment. The user can
C       then use a pick device to select the various states. A sampled
C       choice device determines the action taken with the selected state.
C       The choice number assignments are:
C           1. highlight the state
C           2. turn off highlighting
C           3. make the state visible
C           4. make the state invisible
C           5. exit
C     CONFORMANCE:
C       GKS level: 1c
C       The implementation must support at least one workstation of
C       category outin and one of category mi (metafile input). The
C       default choice device must support at least five choices.
C
C     GKS constants:
C
      INTEGER GOK,GNECHO,GSAMPL
      PARAMETER ( GOK = 1, GNECHO = 0, GSAMPL = 1 )
      INTEGER GNORML,GHILIT,GINVIS,GVISI
      PARAMETER ( GNORML = 0, GHILIT = 1, GINVIS = 0, GVISI = 1 )
C
C     Implementation dependent constants:
C
      INTEGER ERROUT,TTOUT,WSTYPE,NBYTES
      PARAMETER ( ERROUT = 5,TTOUT = 5, WSTYPE = 0, NBYTES = -1 )
      INTEGER MI,MILUN
      PARAMETER ( MI = 7, MILUN = 2 )
C
C     Metafile item type, lenght and data record:
C
      INTEGER MLDR,MAXLEN
      PARAMETER ( MAXLEN = 500,MLDR = 500 )
      INTEGER ITYPE,IDRL
      CHARACTER*80 DATREC(MLDR)
C
C     Input device status and values:
C
      INTEGER STAT,SEG,PKID,CHNR
C
C     Implementation dependent file open.
C
      OPEN ( MILUN,STATUS='OLD' )
C
C     Open GKS and activate a workstation.
C
      CALL GOPKS ( ERROUT,NBYTES )
      CALL GOPWK ( 1,TTOUT,WSTYPE )
```

```
      CALL GACWK ( 1 )
C
C     Set the choice device to sample mode.
C
      CALL GSCHM ( 1,1,GSAMPL,GNECHO )
C
C     Open the metafile input workstation.
C
      CALL GOPWK ( 2,MILUN,MI )
C
C     Interpret items until eof item is read.
C
 10   CONTINUE
         CALL GGTITM ( 2,ITYPE,IDRL )
         IF ( ITYPE.EQ.0 ) GO TO 19
         CALL GRDITM ( 2,IDRL,MLDR,DATREC )
         CALL GIITM ( ITYPE,IDRL,DATREC )
      GO TO 10
 19   CONTINUE
C
C     Close the metafile.
C
      CALL GCLWK ( 2 )
C
C     Allow the user to select states until they select the 'exit' choice.
C
 20   CONTINUE
         CALL GRQPK ( 1,1,STAT,SEG,PKID )
         IF ( STAT.NE.GOK ) GO TO 20
C
C        See which choice is in effect.
C
         CALL GSMCH ( 1,1,STAT,CHNR )
         IF ( STAT.NE.GOK ) GO TO 20
         GO TO ( 21,22,23,24,29 ) CHNR
 21      CALL GSHLIT ( SEG,GHILIT )
         GO TO 20
 22      CALL GSHLIT ( SEG,GNORML )
         GO TO 20
 23      CALL GSVIS ( SEG,GINVIS )
         GO TO 20
 24      CALL GSVIS ( SEG,GVISI )
 29   CONTINUE
C
C     Close the workstation and shut down GKS.
C
      CALL GDAWK ( 1 )
      CALL GCLWK ( 1 )
      CALL GCLKS
      STOP
      END
```

X3.113-1987 Programming Language FULL BASIC
X3.114-1984 Alphanumeric Machines; Coded Character Sets for Keyboard Arrangements in ANSI X4.23-1982 and X4.22-1983
X3.115-1984 Unformatted 80 Megabyte Trident Pack for Use at 370 tpi and 6000 bpi (General, Physical, and Magnetic Characteristics)
X3.116-1986 Recorded Magnetic Tape Cartridge, 4-Track, Serial 0.250 Inch (6.30 mm) 6400 bpi (252 bpmm), Inverted Modified Frequency Modulation Encoded
X3.117-1984 Printable/Image Areas for Text and Facsimile Communication Equipment
X3.118-1984 Financial Services — Personal Identification Number — PIN Pad
X3.119-1984 Contact Start/Stop Storage Disk, 158361 Flux Transitions per Track, 8.268 Inch (210 mm) Outer Diameter and 3.937 inch (100 mm) Inner Diameter
X3.120-1984 Contact Start/Stop Storage Disk
X3.121-1984 Two-Sided, Unformatted, 8-Inch (200-mm), 48-tpi, Double-Density, Flexible Disk Cartridge for 13 262 ftpr Two-Headed Application
X3.122-1986 Computer Graphics Metafile for the Storage and Transfer of Picture Description Information
X3.124-1985 Graphical Kernel System (GKS) Functional Description
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X3.124.2-1988 Graphical Kernel System (GKS) PASCAL Binding
X3.125-1985 Two-Sided, Double-Density, Unformatted 5.25-Inch (130-mm), 48-tpi (1,9-tpmm), Flexible Disk Cartridge for 7958 bpr Use
X3.126-1986 One- or Two-Sided Double-Density Unformatted 5.25-Inch (130-mm), 96 Tracks per Inch, Flexible Disk Cartridge
X3.127-1987 Unrecorded Magnetic Tape Cartridge for Information Interchange
X3.128-1986 Contact Start-Stop Storage Disk — 83 000 Flux Transitions per Track, 130-mm (5.118-Inch) Outer Diameter and 40-mm (1.575-Inch) Inner Diameter
X3.129-1986 Intelligent Peripheral Interface, Physical Level
X3.130-1986 Intelligent Peripheral Interface, Logical Device Specific Command Sets for Magnetic Disk Drive
X3.131-1986 Small Computer Systems Interface
X3.132-1987 Intelligent Peripheral Interface — Logical Device Generic Command Set for Optical and Magnetic Disks
X3.133-1986 Database Language — NDL
X3.135-1986 Database Language — SQL
X3.136-1988 Serial Recorded Magnetic Tape Cartridge for Information Interchange, Four and Nine Track
X3.137-1988 Unformatted Flexible Disk Cartridge, 90 mm (3.5 Inch) 5.3 tpmm (135 tpi) for 7958 bpr Use
X3.138-1988 Information Resource Dictionary System (IRDS)
X3.139-1987 Fiber Distributed Data Interface (FDDI) Token Ring Media Access Control (MAC)
X3.140-1986 Open Systems Interconnection — Connection Oriented Transport Layer Protocol Specification
X3.141-1987 Data Communication Systems and Services — Measurement Methods for User-Oriented Performance Evaluation
X3.146-1987 Device Level Interface for Streaming Cartridge and Cassette Tape Drives
X3.147-1988 Intelligent Peripheral Interface — Device Generic Command Set for Magnetic Tape Drives
X3.148-1988 Fiber Distributed Data Interface (FDDI) — Token Ring Physical Layer Protocol (PHY)
X3.153-1987 Open Systems Interconnection — Basic Connection Oriented Session Protocol Specification
X3.156-1987 Nominal 8-Inch Rigid Disk Removable Cartridge
X3.157-1987 Recorded Magnetic Tape for Information Interchange, 3200 CPI
X3.158-1987 Serial Recorded Magnetic Tape Cassette for Information Interchange, 0.150 Inch (3.81 mm), 8000 bpi (315 bpmm), Group Code Recording
X3.162-1988 Two-Sided, High-Density, Unformatted, 5.25-Inch (130-mm), 96 tpi, Flexible Disk Cartridge for 13 262 ftpr Use
X3.163-1988 Contact Start-Stop Metallic Film Storage Disk—83 333 Flux Transitions per Track, 130-mm (5.118-in) Outer Diameter and 40-mm (1.575-in) Inner Diameter
X3.165-1988 Programming Language DIBOL
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X3.9-1978 Programming Language FORTRAN
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X3.15-1976 Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission
X3.16-1976 Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.17-1981 Character Set for Optical Character Recognition (OCR-A)
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X3.19-1974 Eleven-Sixteenths-Inch Perforated Paper Tape
X3.20-1967 Take-Up Reels for One-Inch Perforated Tape
X3.21-1967 Rectangular Holes in Twelve-Row Punched Cards
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X3.26-1980 Hollerith Punched Card Code
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X3.28-1976 Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
X3.29-1971 Specifications for Properties of Unpunched Oiled Paper Perforator Tape
X3.30-1986 Representation for Calendar Date and Ordinal Date
X3.31-1988 Identification of the Counties of the United States
X3.32-1973 Graphic Representation of the Control Characters of American National Standard Code for Information Interchange
X3.34-1972 Interchange Rolls of Perforated Tape
X3.37-1987 Programming Language APT
X3.38-1988 Identification of States of the United States (Including the District of Columbia)
X3.39-1986 Recorded Magnetic Tape (1600 CPI, PE)
X3.40-1983 Unrecorded Magnetic Tape (9-Track 800 CPI, NRZI; 1600 CPI, PE; and 6250 CPI, GCR)
X3.41-1974 Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange
X3.42-1975 Representation of Numeric Values in Character Strings
X3.43-1986 Representations of Local Time of Day
X3.44-1974 Determination of the Performance of Data Communication Systems
X3.45-1982 Character Set for Handprinting
X3.46-1974 Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)
X3.47-1988 Identification of Named Populated Places, Primary County Divisions, and Other Locational Entities of the United States
X3.48-1986 Magnetic Tape Cassettes (3.81-mm [0.150-Inch] Tape at 32 bpmm [800 bpi], PE)
X3.49-1975 Character Set for Optical Character Recognition (OCR-B)
X3.50-1986 Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets
X3.51-1986 Representations of Universal Time, Local Time Differentials, and United States Time Zone References
X3.52-1976 Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI) (General, Physical, and Magnetic Requirements)
X3.53-1976 Programming Language PL/I
X3.54-1986 Recorded Magnetic Tape (6250 CPI, Group Coded Recording)
X3.55-1982 Unrecorded Magnetic Tape Cartridge, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
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X3.57-1977 Structure for Formatting Message Headings Using the American National Standard Code for Information Interchange for Data Communication Systems Control
X3.58-1977 Unrecorded Eleven-Disk Pack (General, Physical, and Magnetic Requirements)
X3.60-1978 Programming Language Minimal BASIC
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X3.62-1987 Paper Used in Optical Character Recognition (OCR) Systems
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X3.64-1979 Additional Controls for Use with American National Standard Code for Information Interchange
X3.66-1979 Advanced Data Communication Control Procedures (ADCCP)
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X3.73-1980 Single-Sided Unformatted Flexible Disk Cartridge (for 6631-BPR Use)
X3.74-1981 Programming Language PL/I, General-Purpose Subset
X3.76-1981 Unformatted Single-Disk Cartridge (Top Loading, 200 tpi 4400 bpi) (General, Physical, and Magnetic Requirements)
X3.77-1980 Representation of Pocket Select Characters
X3.78-1981 Representation of Vertical Carriage Positioning Characters in Information Interchange
X3.79-1981 Determination of Performance of Data Communications Systems That Use Bit-Oriented Communication Procedures
X3.80-1988 Interface between Flexible Disk Cartridge Drives and Their Host Controllers
X3.82-1980 One-Sided Single-Density Unformatted 5.25-Inch Flexible Disk Cartridge (for 3979-BPR Use)
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X3.86-1980 Optical Character Recognition (OCR) Inks
X3.88-1981 Computer Program Abstracts
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X3.92-1981 Data Encryption Algorithm
X3.93M-1981 OCR Character Positioning
X3.94-1985 Programming Language PANCM
X3.95-1982 Microprocessors — Hexadecimal Input/Output, Using 5-Bit and 7-Bit Teleprinters
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X3.98-1983 Text Information Interchange in Page Image Format (PIF)
X3.99-1983 Print Quality Guideline for Optical Character Recognition (OCR)
X3.100-1983 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Packet Mode Operation with Packet Switched Data Communications Network
X3.101-1984 Interfaces Between Rigid Disk Drive(s) and Host(s)
X3.102-1983 Data Communication Systems and Services — User-Oriented Performance Parameters
X3.103-1983 Unrecorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 Inch)
X3.104-1983 Recorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in), Phase Encoded
X3.105-1983 Data Link Encryption
X3.106-1983 Modes of Operation for the Data Encryption Algorithm
X3.108-1988 Physical Layer Interface for Local Distributed Data Interfaces to a Nonbranching Coaxial Cable Bus
X3.110-1983 Videotex/Teletext Presentation Level Protocol Syntax
X3.111-1986 Optical Character Recognition (OCR) Matrix Character Sets for OCR-M
X3.112-1984 14-in (356-mm) Diameter Low-Surface-Friction Magnetic Storage Disk

(Continued on reverse)

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