RUTHERFORD & APPLETON LABORATORIES
COMPUTING DIVISION

Starlink Project

S T A R L I N K   U S E R   N O T E   11.1

Reference Note for GKS on the VAX

15 June 1981

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GKS is the device-independent graphics system provided on Starlink. It is
an implementation of the Draft International Standard GKS 6.2.

The ISO document (reference [1]) is deliberately written as a
language-independent document. A GKS user currently would use the ISO
document and use this note to find out details of the Starlink
implementation. There is in production a GKS Reference Manual that needs no
cross-reference to the ISO document and has the FORTRAN details in it.

New GKS users may prefer initially to use the Primer [2]. This too is
written in terms of FORTRAN.

Having the ISO document, the user at an installation needs to know:

  (a) to what degree certain functions are implemented (section 1),

  (b) about the workstations (section 2)

  (c) the names of the subroutines and arguments in the implementation
      language. The language of this implementation is FORTRAN 66 and the
      list of subroutines and arguments is provided in Appendix A: in that
      Appendix, the subroutine names (which there all begin with G and
      continue with up to 5 characters) are in the form used for
      transporting GKS. However on Starlink:

          the initial G is replaced by GKS_ (4 characters)

      thus, the routine for drawing a polyline is GKS_POLYL not GPOLYL,

  (d) the method of producing a runnable program (section 3) and

  (e) run time details, including file connections and errors (section 4
      and Appendix C).

References appear in Appendix D.

This implementation was written at the Technische Hochschule, Darmstadt in West Germany.

GKS is a comprehensive system suited to many graphical needs. A small collection of routines is to be produced, to sit on top of GKS and intended to satisfy programs with simple graphical requirements.

1. IMPLEMENTATION OF GKS FUNCTIONS

GKS on Starlink is up to level 3 [1 p26].

GKS allows flexibility in the extent to which some facilities are provided on an installation & on workstations within an installation. The facilities provided on the Starlink installation are at a very early stage. What is actually available on a workstation at a particular time can be discovered by calling the appropriate inquiry function. However some guidelines about the Starlink installation are provided here for convenience.

Text
All workstations produce text. The reply given by the inquiry function in this case (INQUIRE TEXT FACILITIES) refers to the maximum precision implemented by the workstation itself and is in all cases zero. Darmstadt GKS simulates precisions 1 and 2 and hence these precisions are available to the application program on all workstations.

Although GKS 6.2 allows a text number to be represented by different precisions on different workstations, future versions will set precision independently of workstation. It is therefore preferable to avoid this facility. Certain high level routines (documented separately) only produce text sensibly if precision is the same on all workstations.

Text should be passed in an INTEGER array or as a literal text string. FORTRAN-77 CHARACTER variables are currently not supported.

Polymarker
This allows marker precision 0 only -- marker size has no effect. Only marker type 1 is currently implemented, except on the ARGS where the full set (1 to 5) is available.

Generalised Draw Primitive
Not implemented on any workstation.

Fill Area
Only simulated by a border.

Pixel Array
Not implemented on any workstation yet.

Pens
Currently there is no variability of line-width and line-type.

On the ARGS, the colour associated with a pen number PEN is accessed via index MOD(PEN,256) into the ARGS colour table.

Predefined pens on the workstation are such that: (a) pen 1 is a solid line at full brightness and (b) pens on an image display (the ARGS) represent a greyscale from near background at 2 up to full intensity at the maximum predefined pen value.

gmentation
Segmenting is currently simulated in GKS, not implemented at the workstation level. Therefore certain facilities such as segment highlighting and priority are not supported at all and other facilities such as transformation are supported by GKS redrawing a segment. Note that the default state of the implicit regeneration flag on each workstation implies that (for example) segment changes are not immediately seen.

Input
Not available yet on any workstation.

2. WORKSTATIONS

The GKS workstations on the R&AL Starlink VAX are: Tektronix 4010, Sigma GOC 5670 and the Sigma ARGS. There is a dummy workstation and also segment storage and metafile are implemented as workstations.

The "workstation sequence number" required on the call to OPEN WORKSTATION (see [1 p32]) for each workstation is:

ARGS	1
GOC T5670	2
Tektronix 4010	3
Dummy	7
Metafile output	100
Metafile input	200
Segment storage	300

The "connection identifier", also required in the call to OPEN WORKSTATION, is as follows:

ARGS	any positive integer: ARGS is selected by logical name ARGS_DEVICE
GOC T5670	any positive integer (GKS uses TT: regardless)
T4010	as GOC
dummy	FORTRAN stream number
metafile output	FORTRAN stream number
metafile input	FORTRAN stream number
segment storage	FORTRAN stream number (currently must be 31)

Note that a stream number over which the application programmer has control should be under 30 (this is a Starlink recommendation to avoid clashes with system streams).

3. GENERATING A RUNNABLE PROGRAM

The following parameter should be included when linking a GKS application program:

    GKSLINK   [GKSLINK is a logical name]

GKS is big and currently not shared. Therefore an executable image file is likely to occupy more than 350 disc blocks.

4. RUN-TIME DETAILS

This section contains information on stream numbers and errors.

4.1 Streams

The stream numbers used by Starlink GKS are as follows (note that an assignment to stream 30 is always required):

	stream number	usage	recommended assignment
(T)	1	Read tracing control parameters.	TT:
(T)	2	Output of requests to an interactive user by the tracing system.	TT:
	22 (convention)	Error messages. The number is set in the call to OPEN GKS.	TT: or an output file
(MO)	23 (convention)	Metafile output. This number is the connection identifier of the metafile output workstation (section 2).	Output file
(MI)	24 (convention)	Metafile input. This number is the connection identifier of the metafile input workstation (section 2).	A metafile or TT: if patient!
	30	Workstation Description Table. This is read by every GKS program when OPEN GKS is called.	GKSWDT
	31	Segment storage. This is workspace and should not exist before or after execution.	automatic
(T)	any	This is for tracing output. The number is set when the user types tracing control parameters.	Output file
(T)	any	Output from dummy driver. This number is the connection identifier of the dummy driver workstation (section 2).	Output file or TT:

Those entries marked with letter(s) in parentheses are required in the following situations:

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```
(T)    iff the trace control routine GKTRAC is called
(MI)   iff the metafile input workstation is opened
(MO)   iff the metafile output workstation is opened
(D)    iff the dummy workstation is opened
```

4.2 Error messages

GKS error messages go to the stream specified in the call to OPEN GKS and
may be directed to a file or TT: (the terminal). GKS allows the program
to continue after an error has been reported, but the function being
obeyed may be performed incompletely or not at all.

The format of a GKS error message is:

```
GKS-ERROR IN ROUTINE routinename / n   n   n   ..... n
                                   1   2   3         k

- m message
```

where:

m   is the error number. This is defined in the ISO document
        [1 pp84-86]. However some additional numbers are defined in this
        implementation and are defined in Appendix C.

message   is the text of the message (it will usually therefore be
        unnecessary to look up the error number).

routinename   is the routine directly called by the application program.

n_i (for i=1...k) is a subroutine number. The list of numbers in the
        message refers to the GKS subroutine calls active at the time the
        error was detected. The list begins with the GKS routine called
        by 'routinename' and ends with the routine where the error
        was actually detected. In all cases, the subroutine can be
        identified by consulting the list in Appendix B.
        This list of numbers is normally of no immediate concern to the
        user, but should be reported along with the other output if a GKS
        bug is suspected.

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```

This appendix contains the FORTRAN calls corresponding to the functions defined in GKS 6.2. The sequence follows the ISO document. Following the subroutine names is a list of the parameter names with the type in each case.


CONTROL FUNCTIONS

    GOPKS (ERRFIL)
    OPEN GKS

    GCLKS
    CLOSE GKS

    GOPWK (WKID, CONID,WS)
    OPEN WORKSTATION

    GCLWK (WKID)
    CLOSE WORKSTATION

    GACWK (WKID)
    ACTIVATE WORKSTATION

    GDAWK (WKID)
    DEACTIVATE WORKSTATION

    GUPDTE (WKID)
    UPDATE

    GCLRWK (WKID)
    CLEAR WORKSTATION

    GRSGWK (WKID)
    REDRAW ALL SEGMENTS ON WORKSTATION

    GMESS (WKID,LSTR,STR)
    MESSAGE


TRANSFORMATION FUNCTIONS

    GSW (WXP,WYP,WXQ,WYQ)
    SET WINDOW

    GSVW (VWXP,VWYP,VWXQ,VWYQ)
    SET VIEWPORT

    GSCLIN (CLSW)
    SET CLIPPING INDICATOR

```
GSWKW  (WKID,WKWXP,WKWYP,WKWXQ,WKWYQ)
SET WORKSTATION WINDOW

GSWKVW  (WKID,U,V)
SET WORKSTATION VIEWPORT SIZE
```

ATTRIBUTE SETTING FUNCTIONS

```
GSPN  (PNR)
SET PEN NUMBER

GSTXN  (TXNR)
SET TEXT NUMBER

GSTXSP  (CUPX,CUPY,CWIX,CWIY,CSPX, CSPY)
SET TEXT SIZE AND SPACING

GSMK  (MUPX,MUPY,MWIX,MWIY)
SET MARKER SIZE

GSPCID  (PCID)
SET PICK IDENTIFIER

GSVIS  (SGNA,SW)
SET VISIBILITY

GSDTEC  (SGNA,SW)
SET DETECTABILITY

GSHLIT  (SGNA,SW)
SET HIGHLIGHTING

GSSGP  (SGNA,PRIOR)
SET SEGMENT PRIORITY

GSPRP  (WKID,PNR,LTYPE,LWDTH,COL)
SET PEN REPRESENTATION

GSTXRP  (WKID,TXNR,FONT,PREC)
SET TEXT REPRESENTATION

GSDEFS  (WKID,DEFSTA,REGMOD)
SET DEFERRAL STATE
```

OUTPUT FUNCTIONS

```
GPOLYL  (L,XWC,YWC)
POLYLINE
```

```
GPOLYM (L,XWC,YWC,MKTYP)
POLYMARKER

GGDRP (L,XWC,YWC,GDPRIM)
GENERALIZED DRAWING PRIMITIVE

GTX (XOWC,YOWC,LSTR,STR)
TEXT

GFILAR (L,XWC,YWC,COL)
FILL AREA

GPXA (PX,PY,QX,QY,ND,MD,PTAB)
PIXEL ARRAY
```

SEGMENT MANIPULATION FUNCTIONS

```
GCRSG (SGNA)
CREATE SEGMENT

GCLSG
CLOSE SEGMENT

GRENSG (OLD, NEW)
RENAME SEGMENT

GDLSG (SGNA)
DELETE SEGMENT

GTRSG (SGNA,M)
TRANSFORM SEGMENT

GINSG (SGNA,M)
INSERT SEGMENT
```

IPUT FUNCTIONS

```
GRQLC (WKID,LCDNR,LPX,LPY)
REQUEST LOCATOR

GRQVL (WKID,VLDNR,VAL)
REQUEST VALUATOR

GRQCH (WKID,CHDNR,CHNR)
REQUEST CHOICE

GRQPC (WKID,PCDNR,SGNA,PCID)
REQUEST PICK - DATA

GRQST (WKID,STDNR,MXLSTR,LSTR,STR)
```

REQUEST STRING

GSEC (WKID,DCL,DNR,ECHOSW)
SET ECHO

GSECP (WKID,DCL,DNR,EX,EY)
SET ECHO POSITION

GSLC (WKID,LCDNR,LPX,LPY)
SET LOCATOR

GSVL (WKID,VLDNR,IV,LV,HV)
SET VALUATOR

GSST (WKID,STDNR,BFSZ,CPOS,LSTR,STR)
SET STRING

GSCHPT (WKID,CHDNR,L,PRMOD)
SET CHOICE PROMPT

GSCHST (WKID,CHDNR,MXLSTR,NOSTR,LSTRA,STRA)
SET CHOICE STRINGS

GASTCH (WKID,CHDNR,MXLSTR,NOSTR,LSTRA,STRA)
ASSIGN STRING TO CHOICE

METAFILE FUNCTIONS

GWITM (WKID,ITYPE,L,ITM)
WRITE ITEM TO GKSM

GGTITM (WKID,ITYPE,L)
GET ITEM TYPE FROM GKSM

GRDITM (WKID,L,ITM)
READ ITEM FROM GKSM

GIITM (WKID,ITYPE,L,ITM)
INTERPRET ITEM

INQUIRY FUNCTIONS

GIOPSV (OPSTA)
INQUIRE OPERATING STATE VALUE

GIKSLV (LEVEL)
INQUIRE GKS LEVEL

```
GIWVWT (WXP,WYP,WXQ,WYQ,VWXP,VWYP,VWXQ,VWYQ,CLSW)
INQUIRE WINDOW/VIEWPORT TRANSFORMATION

GICSPA (PNR,TXNR,PCID,CUPX,CUPY,CWIX,CWIY,SPX,SPY,MUPX,MUPY,MWIX,MWIY)
INQUIRE CURRENT SETTING OF PRIMITIVE ATTRIBUTES

GIUDFV (UINT,UREA,USTR,UPX,UPY)
INQUIRE UNDEFINED VALUES

GIOPSG (SGNA)
INQUIRE NAME OF THE OPEN SEGMENT

GISG (MAXL,L,SGNAL)
INQUIRE LIST OF SEGMENT NAMES IN USE

GIOPWK (MAXL,L,WKIDL)

INQUIRE LIST OF OPEN WORKSTATIONS

GIACWK (MAXL,L,WKIDL)
INQUIRE LIST OF ACTIVE WORKSTATIONS

GIID (MAXL,L,DCLL,WKIDL,DNRL,MODEL)
INQUIRELIST OF INPUT DEVICES

GIWKID (WKID,CONID,WS)
INQUIRE WORKSTATION IDENTIFICATION

GIWKS (WKID,ACTIVE,DEFS,REGMOD,NFRAME)
INQUIRE WORKSTATION STATE

GIWKT (WKID,RWXP,RWYP,RWXQ,RWYQ,CWXP,CWYP,CWXQ,CWYQ,RQU,RQV,CU,CV)
INQUIRE WORKSTATION TRANSFORMATION

GITXN (WKID,MAXL,L,TXTNR)
INQUIRE LIST OF TEXT TYPE NUMBERS

GITXRP (WKID,TXTNR,FONT,PREC)
INQUIRE TEXT TYPE REPRESENTATION

GITXEX (WKID,LSTR,EOTPX,EOTPY)
INQUIRE TEXT EXTENT

GIPN (WKID,MAXL,L,PTNR)
INQUIRE LIST OF PEN TYPE NUMBERS

GIPRP (WKID,PTNR,LTYPE,LWDTH,COL)
INQUIRE PEN TYPE REPRESENTATION

GISGWK (WKID,MAXL,L,SGNAL)
INQUIRE LIST OF SEGMENT NAMES OF WORKSTATION

GILCDS (WKID,LCDNR,MODE,LPX,LPY,ESW,EX,EY)
INQUIRE LOCATOR DEVICE STATE
```

```
GIVLDS (WKID,VLDNR,MODE,IV,LV,HV,ESW,EX,EY)
INQUIRE VALUATOR DEVICE STATE

GIPCDS (WKID,PCDNR,MODE,ESW,EX,EY)
INQUIRE PICK DEVICE STATE

GISTDS (WKID,STDNR,MXLSTR,MODE,BFSZ,CPOS,LSTR,STR,ESW,EX,EY)
INQUIRE STRING DEVICE STATE

GICHDS (WKID,CHDNR,MXLSTR LEN,NOCHA,MODE,ESW,EX,EY,PSGNA,SGNA,STPAR,
        PRPAR,LSTRA,STRA,LPSTR,PRSTR,PRMOD)
INQUIRE CHOICE DEVICE STATE

GIMXDS (WS,SZLU,SZLV,SZRU,SZRV)
MAXIMUM DISPLAY SURFACE SIZE

GIPRPF (WS,MAXLT,MAXLW,NINT,SWCOL,NLT,LT,NLW,LW)
INQUIRE PEN REPRESENTATION FACILITIES

GINPP (WS,NPT)
INQUIRE NUMBER OF PREDEFINED PEN TYPES

GIPPA (WS,PPNR,LTYPE,LWDTH,COL)
INQUIRE PREDEFINED PEN ATTRIBUTES

GITXF (WS,MAXL,L,FONTL,PREC)
INQUIRE TEXT FACILITIES

GINPTX (WS,NTXTYP)
INQUIRE NUMBER OF PREDEFINED TEXT TYPES

GIPTXA (WS,PTXNR,FONT,PREC)
INQUIRE PREDEFINED TEXT ATTRIBUTES

GIACHS (WS,MAXL,L,CHSZXL,CHSZYL)
INQUIRE LIST OF AVAILABLE CHARACTER SIZES

GIAGDP (WS,MAXL,L,GDPRIM)
INQUIRE LIST OF AVAILABLE GENERALIZED PRIMITIVES

GIAMK (WS,MAXL,L,MKTYP)
INQUIRE LIST OF AVAILABLE MARKER TYPES

GIAMKS (WS,MAXL,L,MKSZX,MKSZY)
INQUIRE LIST OF AVAILABLE MARKER SIZES

GINSGP (WS,SGPR)
INQUIRE NUMBER OF SEGMENT PRIORITIES SUPPORTED

GIDYMD (WS,DYWKTR,DYDTEC,DYVIS,DYHIGH,DYDEL,DYPRP,DYTXRP,DYSGPR)
INQUIRE DYNAMIC MODIFICATION

GIAIP (WS,NRLC,NRVL,NRPC,NRCH,NRST)
INQUIRE AVAILABILITY OF INPUT PRIMITIVES
```

```
GIWK (WK,OUTIN,VR)
INQUIRE WORKSTATION TYPE

GIDECP (WS,DCL,DNR,EX,EY)
INQUIRE DEFAULT ECHO POSITION

GIDLCP (WS,LCDNR,LPX,LPY)
INQUIRE DEFAULT LOCATOR POSITION

GIDVLV (WS,VLDNR,VAL)
INQUIRE DEFAULT VALUATOR VALUE

GISTBF (WS,STDNR,BFSZ)
INQUIRE STRING BUFFER

GINCH(WS,CHDNR,NCHA)
INQUIRE NUMBER OF CHOICE ALTERNATIVES

GIDV (WS,REGMOD,DEFSTA)
INQUIRE DEFAULT ATTRIBUTES

GISGS (SGNA,SWVIS,SWDTEC,SWHIGH,SGPR)
INQUIRE SEGMENT STATE

GIASWK (SGNA,MAXL,L,ASWK)
INQUIRE LIST OF ASSOCIATED WORKSTATIONS

GISGT (SGNA,M)
INQUIRE SEGMENT TRANSFORMATION

GIPXAD (WKID,PX,PY,QX,QY,N,M)
INQUIRE PIXEL ARRAY DIMENSIONS

GIPXA (WKID,PX,PY,QX,QY,N,M,PTAB)
INQUIRE PIXEL ARRAY

GIPX (WKID,PX,PY,PNR)
INQUIRE PIXEL
```

ERROR HANDLING

```
GECLKS
EMERGENCY CLOSE GKS

GKSERR (ERRNR,ENAME)
GKS ERROR HANDLING ROUTINE
```

UTILITIES

    GATRIM (MIN,XO,YO,DX,DY,PHI,FX,FY,SW,MOUT)
    ACCUMULATE TRANSFORMATION IN MATRIX

    GSTRM (XO,YO,DX,DY,PHI,FX,FY,SW,MOUT)
    SET TRANSFORMATION MATRIX

LIST OF PARAMETERS

    DATA TYPES: I   INTEGER
                  R   REAL
                  L   LOGICAL
                  A(N)   ARRAY OF LENGTH N

PARAMETER	TYPE	MEANING
ASWK	I A(MAXL)	LIST OF ASSOCIATED WORKSTATIONS
ACTIVE	L	WORKSTATION STATE
ACTL	I	CURRENT LENGTH OF A LIST
BFSZ	I	BUFFER SIZE (NO. OF CHAR.)
CHDNR	I	CHOICE DEVICE NUMBER
CHNR	I	CHOICE NUMBER (BUTTON NUMBER)
CHSZXL,CHSZYL	R A(MAXL)	LIST OF CHARACTER SIZES
CLSW	L	CLIPPING INDICATOR (TRUE=ON, FALSE=OFF)
CONID	I	CONNECTION IDENTIFIER
COL	R A(3)	COLOUR (IN THE RANGE 0 TO 1)
CPOS	I	CURSOR POSITION
CSPX,CSPY	R	CHARACTER SPACING VECTOR
CU, CV	R	SIZE OF CURRENT WST VIEWPORT (DC)
CUP,CUPY	R	CHARACTER UP VECTOR
CWIX,CWIY	R	CHARACTER WIDTH VECTOR
CWXP,CWYP	R	POINT IN NDC, BOUNDARY OF CURRENT WST WINDOW
CWXQ,CWYQ	R	POINT IN NDC, BOUNDARY OF CURRENT WST WINDOW
DCL	I	DEVICE CLASS
DCLL	I A(MAXL)	LIST OF DEVICE CLASSES
DEFSTA	I	DEFERRAL STATE
DNR	I	DEVICE NUMBER
DNRL	I A(MAXL)	LIST OF DEVICE NUMBERS
DX,DY	R	SHIFT VECTOR
DYWKTR	L	WORKSTATION TRANSFORMATION CHHANGEABLE
DYTEC	L	DETECTABILITY CHANGEABLE
DYVIS	L	VISIBILITY CHANGEABLE
DYHIGH	L	HIGHLIGHTING CHANGEABLE
DYDEL	L	SEGMENT DELETION IMMEDIATELY VISIBLE
DYPRP	L	PEN-REPRESENTATION CHANGEABLE
DYTXRP	L	TEXT-REPRESENTATION CHANGEABLE
DYSGPR	L	SEGMENT PRIORITY CHANGEABLE
ECHOSW	L	ECHO SWITCH (ON=TRUE, OFF=FALSE)
ENAME	I	IDENTIFICATION OF SUBROUTINE
EOTPX,EOPTY	R	END OF TEXT POSITION
ERRFIL	I	ERROR FILE NUMBER

```
ERRNR          I              ERROR NUMBER
EX,EY          R              ECHO POSITION (WC)
FONT           I              TEXT FONT
FONTL          I A(MAXL)      LIST OF TEXT FONTS
FX,FY          R              ZOOM FACTORS
GDPRIM         I              GENERALIZED PRIMITIVE IDENTIFIER
HV             R              HIGH VALUE
ITM            I A(L)         ITEM
ITYPE          I              ITEM TYPE
IV             R              INITIAL VALUE
L              I              CURRENT LENGTH OF LIST
LCDNR          I              LOCATOR DEVICE NUMBER
LEVEL          I              GKS LEVEL
LPSTR          IA(NOCHA)      LIST OF LENGTHS OF PROMPT STRINGS
LPX,LPY        R              LOCATOR POSITION IN WC
LSTR           I              LENGTH OF STRING IN CHARACTERS
LSTRA          IA(NOSTR)      LIST OF LENGTHS OF CHOICE STRINGS
LT             IA(MAXLT)      LIST OF LINETYPES
LW             RA(MAXLW)      LIST OF LINEWIDTHS
LTYPE          I              LINETYPE
LV             R              LOW VALUE
LWDTH          R              LINEWIDTH
M              R A(6)         TRANSFORMATION MATRIX
MAXL           I              MAXIMUM LENGTH OF LIST
MAXLT          I              MAXIMAL LENGTH OF LIST OF LINETYPES
MAXLW          I              MAXIMAL LENGTH OF LIST OF LINEWIDTHS
MIN            R A(6)         OLD TRANSFORMATION MATRIX
MKSZX,MKSZY    R A(MAXL)      LIST OF MARKER SIZES
MKTYP          I              MARKER TYPE
MODE           I              MODE
MODEL          I A(MAXL)      LIST OF MODES
MPREC          I              MARKER PRECISION SUPPORTED
MOUT           R A(6)         NEW TRANSFORMATION MATRIX
MUPX,MUPY      R              MARKER UP VECTOR (WC)
MWIX,MWIY      R              MARKER WIDTH VECTOR (WC)
MXLSTR         I              MAXIMUM LENGTH OF STRING IN CHARACTERS
ND,MD          I              DIMENSIONS OF COLOUR TABLE INDEX ARRAY
NEW            I              NEW SEGMENT NAME
NOCHA          I              NUMBER OF CHOICE ALTERNATIVES
NOSTR          I              NUMBER OF CHOICE STRINGS
NRCH           I              NUMBER OF CHOICE DEVICES
NRLC           I              NUMBER OF LOCATOR DEVICES
NRPC           I              NUMBER OF PICK DEVICES
NRST           I              NUMBER OF STRING DEVICES
NRVL           I              NUMBER OF VALUATOR DEVICES
OLD            I              OLD SEGMENT NAME
OPSTA          I              OPERATING STATE VALUE
OUTIN          I              OUT/IN WORKSTATION TYPE
PSGNA          L              CHOICE SEGMENT PRESENT SWITCH
PCID           I              PICK IDENTIFFIER
PCDNR          I              PICK DEVICE NUMBER
PHI            R              ROTATION ANGLE (IN RADIAN)
PNR            I              PEN NUMBER
PPNR           I              PREDEFINED PEN NUMBER
```

```
PREC              I              TEXT PRECISION (0,1,2)
PRIOR             R              SEGMENT PRIORITY (IN THE RANGE 0 TO 1)
PRPAR             L A(LEN)       CHOICE PROMPT STRING PRESENT ARRAY
PRSTR             I A(MXLSTR,LEN) TUPLE OF CHOICE PROMPT STRINGS
PSGNA             L              CHOICE SEGMENT PRESENT SWITCH
PRMOD             L A(LEN)       PROMPT MODE ARRAY
PTAB              I              PEN TABLE
PTXNR             I              PREDEFINED TEXT NUMBER
PX, PY            R              POINT IN WC
QX, QY            R              POINT IN WC
REGMOD            I              IMPLICIT REGENERATION MODE
RQV,RQU           R              SIZE OF REQUESTED WST VIEWPORT (DC)
RWXP,RWYP         R              BOTTOM LEFT (NDC) OF REQUESTED WORKSTATION
                                 WINDOW BOUNDARY.
RWXQ,RWYQ         R              TOP RIGHT (NDC) OF REQUESTED WORKSTATION
                                 WINDOW BOUNDARY.
SGNA              I              SEGMENT NAME
SGNAL             I A(MAXL)      LIST OF SEGMENT NAMES
SGPR              I              NUMBER OF SEGMENT PRIORITIES
STDNR             I              STRING DEVICE NUMBER
STPAR             L A(LEN)       CHOICE STRING PRESENT ARRAY
STR               I A(LSTR)      CHARACTER STRING (DIN 66003)
STRA              I A(MXLSTR,NOSTR) TUPLE OF STRINGS
SW                L              LOGICAL SWITCH (TRUE=ON,FALSE=OFF)
SZRU,SZRV         I              MAXIMUM DISPLAY SURFACE SIZE IN RASTER UNITS
SZLU,SZLV         R              MAXIMUM DISPLAY SURFACE SIZE IN METER
TOUT              I              TIME OUT VALUE IN SECONDS
TXNR              I              TEXT NUMBER
U,V               R              WORKSTATION VIEWPORT SIZE (IN METER)
UINT              I              UNDEFINED INTEGER
UPX,UPY           R              UNDEFINED POINT
UREA              R              UNDEFINED REAL
USTR              I              UNDEFINED STRING
VAL               R              VALUEATOR VALUE
VLDNR             I              VALUATOR DEVICE NUMBER
VR                I              VECTOR/RASTER TYPE WORKSTATION
VWXP,VWYP         R              POINT IN NDC, VIEWPORT BOUNDARY
VWXQ,VWYQ         R              POINT IN NDC, VIEWPORT BOUNDARY
WKID              I              WORKSTATION IDENTIFIER
WKIDL             I A(L)         LIST OF WORKSTATION IDENTIFIERS
WKWXP,WKWYP       R              LOW LEFT (NDC) WORKSTATION WINDOW BOUNDARY
WKWXQ,WKWYQ       R              TOP RIGHT (NDC) WORKSTATION WINDOW BOUNDARY
WS                I              WORKSTATION SEQUENCE NUMBER
WXP,WYP           R              POINT IN WC, WINDOW BOUNDARY
WXQ,WYQ           R              POINT IN WC, WINDOW BOUNDARY
XO, YO            R              FIXPOINT
XOWC,YOWC         R              STARTING POINT IN WORLD COORDINATES
XWC               R A(L)         LIST OF POINTS IN WC (X-VALUES)
YWC               R A(L)         LIST OF POINTS IN WC (Y-VALUES)
```

Appendix B   NUMERIC CODES OF SUBROUTINES

umeric codes are output in error messages and are associated with subroutine names as in this list.

GKS FUNCTION IDENTIFICATIONS

Code	Name	Code	Name
0101	GOPKS	0102	GCLKS
0103	GOPWK	0104	GCLWK
0105	GACWK	0106	GDAWK
0107	GUPDTE	0108	GCLRWK
0109	GRSGWK	0110	GMESS
0201	GSW	0202	GSVW
0203	GSCLIN	0204	GSWKW
0205	GSWKVW	0301	GSPN
0302	GSTXN	0303	GSTXSP
0304	GSVIS	0305	GSPCID
0306	GSVIS	0307	GSDTEC
0308	GSHLIT	0309	GSSGP
0310	GSPRP	0311	GSTXRP
0312	GSDEFS	0401	GPOLYL
0402	GPOLYM	0403	GGDRP
0404	GTX	0405	GFILAR
0406	GPXA	0501	GCRSG
0502	GCLSG	0503	GRENSG
0504	GDLSG	0505	GTRSG
0506	GINSG	0601	GRQLC
0602	GRQVL	0603	GRQCH
0604	GRQPC	0605	GRQST
0633	GSEC	0634	GSECP
0635	GSLC	0636	GSVL
0637	GSST	0638	GSCHPR
0639	GSCHST	0640	GASTCH
0701	GWITM	0702	GGTITM
0703	GRDITM	0704	GIITM
0801	GIOPSV	0802	GIKSLV
0803	GIWVWT	0804	GICSPA
0805	GIUDFV	0806	GIOPSG
0807	GISG	0808	GIOPWK
0809	GIACWK	0810	GIIND
0811	GIWKID	0812	GIWKS
0813	GIWKT	0814	GITXN
0815	GITXRP	0816	GITXEX
0817	GIPN	0818	GIPRP
0819	GISGWK	0820	GILCDS
0821	GIVLDS	0822	GIPCDS
0823	GISTDS	0824	GICHDS
0825	GIMXDS	0826	GIPRPF
0827	GINPP	0828	GIPPA
0829	GITXF	0830	GIPTX
0831	GIPTXA	0832	GIACHS
0833	GIAGDP	0834	GIAMK

0835	GIAMKS	0836	GINSGP
0837	GIDYMD	0838	GIAIP
0839	GIWK	0840	GIDECP
0841	GIDLCP	0842	GIDVLV
0843	GISTBF	0844	GINCHA
0845	GIDV	0846	GISGS
0847	GIASWK	0848	GISGT
0849	GIPXAD	0850	GIPXAR
0851	GIPX	0901	GATRIM
0902	GKSERR	1001	GECLKS
1002	GSTRM		

Appendix C   ADDITIONAL ERROR MESSAGES

The ISO document [1 pp84-86] lists error messages corresponding to numbers between 1 and 99. This implementation of GKS has additional error messages with numbers >100. These are listed below.

    110.   LINEWIDTH TABLE OVERFLOW
    111.   TABLE OF PREDEF. TEXTS OVERFLOW
    112.   TABLE OF PREDEF. PENS OVERFLOW
    113.   TOO MUCH WORKSTATION DESCRIPTION TABLES
    114.   TABLE OFF MARKER TYPES OVERFLOW
    115.   TABLE OF TEXT FONTS OVERFLOW
    116.   INVALID WORKSTATION SEQUENCE NUMBER
    117.   TABLE OF LINETYPES OVERFLOW
    118.   TABLE OF CHHARACTER SIZES OVERFLOW
    119.   TABLE OF MARKER SIZES OVERFLOW
    120.   WORKSTATION TYPE IS ALREADY DEFINED
    121.   TABLE OF GEN. DRAW. PRIM. OVERFLOW
    122.   TABLE OF INPUT DEVICES OVERFLOW
    123.   AT LEAST ONE PEN REPRESENTATION HAS TO BE PREDEF.
    150.   ERROR IN WORKSTATION DESCRIPTION TABLE DATA FILE
            (FOR EXAMPLE: NOT ASSIGNED CORRECTLY).

Appendix D   REFERENCES

[1] Draft International Standard ISO: Graphical Kernel System (GKS)
    Functional Description (version 6.2) 4 July 1980. This is obtainable
    from Julian Gallop (RLVAD::JRG).

[2] GKS Primer for Starlink -- SUN/12

REFERENCES