

MANUAL CHANGES REQUIRED  
FOR NEW 220/330 MULTI-DEVICE IPL  
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GA-16 110/220 System

Reference Manual

(88A00508A-E)

Table 3-4. IPL Selector Switch on SCI Module (GA-16/220)

Applicable to IPL ROMs 70100933A01/70A00934A01/70A00935A01/70A00936A01

See Appendix \_\_\_\_\_ for earlier versions.

Position	Device
0	Teletype (Load and Go)
1	High-speed Paper Tape Reader (Load and Go)
2	Card Reader (Load and Go)
3	3241/3442 Mini and Standard Soft-sectored Diskette
4	3343/3346(Removable)/3347 Disk
5	3349 Hard-sectored Diskette
6	<del>Remote Communications Bootstrap</del> <i>Remote/Local Bootstrap</i>
7	3346(Fixed) Disk
8	3342 Head Per Track Disk
9	Card Read (Load and Stop)
A	Teletype (Load and Stop)
B	High-Speed Paper Tape Reader (Load and Stop)
C	3345 Data Storage Module
D	Jump to Console Switch Register Address
E	Clear Memory and Jump to Console Switch Register Address
F	Reserved for Special Applications (Goes to WAIT)

NOTE: Refer to description of IPL SEL switch (14) in Table 3-3.

### 3.4 START-UP AND PROGRAM LOAD

This section provides start-up and program load procedures for basic configurations of the GA-16/110 and the GA-16/220 systems. These configurations are:

1. A general-purpose GA-16/220 system configured to use with one of the GA-16 series operating systems. This configuration will include the system console interface module equipped with IPL ROM for loading a program from various devices. It may include a 2K piggyback RAM (on the CPU-1 module) however, the IPL ROM on the piggyback will not be used.
2. A dedicated application GA-16/220 or 220 system configured to use a special-purpose program. This configuration will use the 2K piggyback RAM on the CPU-1 module with a single device IPL. When a GA-16/220 is configured as a dedicated system, the SCI module is not used.

Figure 3-8 provides a general flow diagram for GA-16/110 and GA-16/220 System Start-Up.

In either case:

- RUN indicator illuminates.
- or
- RUN indicator illuminates and paper tape loads, as described in Section 3.5.2.

### 3.5 IPL ROMS

As standard options, GA offers the following Initial Program Load (IPL) ROMs:

1. Single-device IPL - This IPL runs on a GA-16/110 or a dedicated GA-16/220 and mounts on a 2K piggyback memory. It is a complete 64-word mini PGS loader requiring no preamble on the media being loaded. It is an absolute load-and-go binary loader with check sum.

Version 1 - TTY

Version 2 - High-speed paper tape reader

2. Multi-device IPL - This IPL ROM is mounted on the GA-16/220 System Console Interface Module. It consists of two 256-word programs which provide bootstrap loaders for the TTY, high-speed paper tape reader, card reader, floppy disk moving arm disk (both fixed and removable platter) and head-per-track disk. Each of these bootstrap loaders accesses its designated peripheral to bring a small program into the RAM. (The program must be in sector zero of a disk or in the preamble of tapes and card decks.) The bootstrap loader is normally used to load a larger device-specific loader into RAM which in turn loads an operating system or stand-alone program.

The following sections describe PGS and mini-PGS formats, use of single-device ROM on a GA-16/110 or dedicated GA-16/220, and use of the multiple-device ROM on a general-purpose GA-16/220.

#### 3.5.1 PGS AND MINI-PGS FORMAT

The PGS (Program Generation System) format is the standard for all GA program generation systems. All language translators (Macro Assembler, FORTRAN, BASIC, COBOL) output object code in PGS format; the Core Load Overlay Builder (CLOB) links PGS elements into a loadable PGS module; all utilities, subroutines, T&Vs, etc., are in PGS format. All GA device loaders require the PGS format. They perform check summing, permit specification of load address and automatically relocate program elements. PGS format is described in Appendix D.

- b. Cold Start Line and (momentarily) Power Fail Detect Line. (Grounding PFD is equivalent to the power-up or restart signal.) This auto-loads with a complete system reset.
- 4. With power, on, the PTR automatically starts reading when the IPL is initiated. However, TTY start is different. When IPL is initiated, the ROM goes out to the TTY and attempts to start reading. The TTY reader must then be manually switched to "START". (This manual switching at the TTY need not be done immediately, since the IPL ROM continues indefinitely to apply "start" sequence to TTY until it detects the first character from the reader.)
- 5. Without interruption, either TTY or PTR read their tapes to the end and stop. The IPL ROMs then automatically transfer control to the start address of the program just loaded and begin execution. Both TTY and PTR IPLs are load-and-go.

### 3.5.3 GA-16/220 MULTI-DEVICE INITIAL PROGRAM LOAD ROM ON SCI

This section describes the characteristics of various devices when loading programs under the control of the IPL ROM installed on the SCI module. Loading of a program via the IPL ROM takes place under the following conditions:

1. Upon initial power turn-on or automatic power restart; provided option 2. (Section 3.4.1.1.) has been implemented.
2. When an operator presses the RESET button (16) on the microconsole; provided option 2 (Section 3.4.1.1) has been implemented; (alternatively, an external RESET button may be connected via hardware interface, RSET line).
3. When an operator presses the IPL button (13); (alternatively an external IPL button may be connected via hardware interface, IPLSW).

The IPL ROM looks for the highest X'nA00' address available; for a 32K memory this would be X'7A00'; for a 64K memory this would be X'FA00'. All bootstraps load starting at this address except the Remote Communications IPL which loads at X'n400'. Note that the possible presence of the Console ROM at X'FC00' limits the length of the module loaded by a bootstrap.

The IPL ROM will zero all memory before executing any bootstrap except the Jump to Switches, IPL D, or the Remote Communications Bootstrap, IPL 6. This is necessary to prevent parity errors immediately after powering up on systems which use memories with parity checking.

### 3.5.3 GA-16/220 MULTI-DEVICE INITIAL PROGRAM LOAD ROM ON SCI (continued)

An IPL without clearing memory can be effected by using the software entry point. (See Sections 3.5.3.8 and 3.5.3.9).

The IPL's are executed using the background registers. Therefore, the foreground indicator (Indicator 20, Table 3-3.) will be off while the IPL is executing and will be on when control has transferred to the loaded program.

#### 3.5.3.1 Teletype (TTY)

Blank leader is ignored. Loading continues until either feeding stops (tape runs out or reader is turned off), or 150 blank frames have been encountered. If 150 blank frames have gone by, it is assumed that either the module just loaded is itself a loader and what it is to load follows on the same piece of tape, or that the program is stand-alone. When in the load-and-go mode, execution will transfer to the starting load location; load-and-stop will print the starting address in hex and transfer to the Console ROM.

If feeding stops, control goes immediately to the Console ROM when in load-and-stop mode, or the IPL routine will wait for the reader to be started up again if in load-and-go mode. Refer to the GA-16/220/330 Stand-Alone Utilities document number 94A001531A for detailed operating procedures.

### 3.5.3.2 High-Speed Paper Tape Reader (PTR)

This device is functionally identical to the TTY. The only real difference is that there is no way for the operator to restart the PTR in load-and-go mode, so that the IPL routine will periodically try to restart it. Since this method is not particularly reliable, it is recommended that for the PTR, both loader and program be on the same tape (separated by at least 150 blank frames), or that load-and-stop be used.

### 3.5.3.3 Card Reader (CDR)

The CDR loader continues loading until a 9 punch in column 72 is encountered in any card. At this point, load-and-go mode will wait for CDR-ready and go to the loaded module, while load-and-stop will transfer control the Console ROM. Refer to GA-16/220/330 Stand-Alone Utilities document for detailed operating procedures.

### 3.5.3.4 Disk (DKx)

The devices are functionally identical. Sector 0, track 0, head 0, is loaded and control is immediately transferred to the sector just loaded. Normally, sector 0 contains a sector loader written by a GA operating system.

3241	Mini Soft-sectored Diskette	(CK1)
3342	Fixed-Head Disk	(DK2)
3343	20-Surface Disk	(DK3)
3345	Data Storage Module	(DK5)
3346	Dual-Platter Disk, Removable Cartridge	(DK6)
3346	Dual-Platter Disk, Fixed Surface	(DK6F)
3347	Removable Cartridge Disk	(DK7)
3349	Hard-sectored Diskette	(DK9)
3442	Standard Soft-sectored Diskette	(DK1)

The length of the module loaded will depend on the characteristics of disk involved. The 3241/3442 IPL will load 256 words regardless of the diskettes sector-size and, therefore, may load from 1 to 4 sectors.

### 3.5.3.5 ~~Remote Communications IPL~~ *Remote/Local Bootstrap*

This IPL transfers the contents of a 2K ROM located on the 31D02337A Remote/Local IPL board into RAM and transfers control to that program. The contents of the Console Switch Register (5) and (6, Table 3-3) are passed in register Z. If bit 15 of the Switch Register is 0, memory will be cleared; if bit 15 = 1, no memory clear will occur.

### 3.5.3.6 Jump to Console Switches

These IPL's transfer control to the address in the Console Switch Register (5) and (6, Table 3-3). They perform initialization as follows:

## 3.5.3.6 Jump to Console Switches (continued)

- . Register D points to X'nA00'-1 where n indicates the highest RAM location available.
- . Register Y contains X'20' as a base for loading SCR's and CAR's.
- . Register Z contains 0 for byte addressing.
- . If the address is in the upper 32K, switch 15=1, the CPU is placed into 64K mode if possible.
- . If IPL E is selected memory is zeroed.

These IPL's can be used to initiate execution of any program in memory. In particular, IPL D to location X'FC00' can be used to enter Console BUS in 64K mode.

## 3.5.3.7 Multi-device IPL memory Structure

The multi-device IPL, beginning with 70A00933A01/70A00934A01/70A00935A01/70A00936A01, is a 512 word ROM. The ROM is divided into two 256 word portions. Only one 256 word portion is accessible for any given IPL selector setting. The IPL's selected by settings 0-3 and 8-B are in the first 256 word segment. IPL's 4-7 and C-F are in the second segment.

## 3.5.3.8 Software Entry to IPL's

An IPL may be initiated under program control by placing the IPL selector number in the X register and doing a JSR to location X'FFFF'. If the IPL is not accessible because of the selector switch setting a return from the subroutine results. An IPL initiated via software does not zero memory. (IPL 6 and IPL D clear memory in the bootstrap itself and the use of software entry will not prevent clearing of memory by these routines.)

## 3.5.3.9 IPL Without Zeroing Memory

The software entry provides a means of IPL'ing without zeroing memory.

- . Set the device selector for the desired device.
- . Using Console BUS, load the IPL number into the X register.
- . Using Console BUS, begin execution at X'FFFF'.

Example: load from 3346 removable disk

```
1R CR
X=xxxx 4 CR
FFFFG CR
```



## 3.5.3.9 IPL Without Zeroing Memory (continued)

The use of this procedure will properly initialize Console BUS to allow the use of the BREAK function for stopping the loaded program. In such situations, the contents of location X'46' must not be changed by the program being loaded. (In CONTROL systems, rev. 5 and later, place a NOP at location RST\$46.)

## 3.5.3.10 Closed Subroutine to Set 64K Mode

The IPL ROM provides a subroutine that will set 64K mode. It is entered at location X'FFFD' and destroys register B. The following sequence can be used to set 64K mode from Console BUS:

```
7R (CR)
E=XXXX FC00 (CR)
FFFDG (CR)
```

3.6 SCI CONSOLE ROM(GA-16/220)

The SCI Console ROM provides an interactive program which permits program diagnostic and development activities to be carried out via the teletype or CRT. The SCI Console ROM is entered by several methods:

1. Upon power-up, auto-restart, or when an operator pressed RESET button (10), provided CNS1 switch (13) is in the CNSL position (option 1, Section 3.4.1.1).
  - Carriage return (CR) and line feed (LF) occur on TTY.
  - The break interrupt vector X'46' is loaded so that subsequent entry may be made with TTY BREAK key.
2. When teletype operator pressed BREAK key, provided the following hardware conditions are met:
  - a. BKDS switch (11) is not set in the BKDS position.
  - b. BKINT switch (12) is not set in the BKINT position.
  - c. - Address of next instruction to be executed is printed.

### 3.6.3.11 I/O Reset

nemonic: !

format: ! (CR)

operation: A system-level I/O reset is performed (i.e., a CTRL 2 to device X'3' is performed). This will initialize (reset) all peripheral controllers (except the teletype) and will not affect the CPU.

## 3.7 CONSOLE ROM SYSTEM INTERFACES (GA-16/220)

This section describes the methods by which the console ROM may interact with a user's program.

### 3.7.1 USE OF INTERRUPT VECTORS

The Console ROM makes use of interrupt vectors at locations X'44' and X'46'.

Location X'44' and its associated cells X'7C' and X'7D' are used to service traps. When a G (3.6.3.2) command is given, the Console ROM checks to see if the user has specified any traps to be set. If any traps are to be set, the Console ROM, at this time, sets the appropriate traps after first saving the user's original object code. The contents of location X'44' is then saved and the vector is changed to the Console ROM TRAP entry point.

When a trap interrupt through location X'44' occurs, the Console ROM examines the instruction causing the trap. If it is not a trap that the Console ROM set, control will go to the location pointed to by the saved trap vector; if a trap that the Console ROM set caused the interrupt, the address where the trap occurred will be printed on the teletype, those user locations containing the traps will be re-established with user code, and the location X'44' vector will be reset to the user's original contents.

Location X'46' is set by the Console ROM to point to its single step or break interrupt entry point whenever the RESET button is pressed or a G (3.6.3.2) or S (3.6.3.7) command is given. The user's contents are neither preserved or restored.

### 3.7.2 USE OF THE BREAK INTERRUPT FEATURES

The CPU has a BKDS switch and a BKINT switch. When the BKDS is set to enable the BREAK key and the BKINT switch is set to allow an interrupt upon the detection of a break signal, the user may interrupt his program at any point in time by pressing the teletype BREAK key. When this is done, an interrupt through location X'46' will occur, the Console ROM will save all registers and the status at the time of the interrupt, and then print at the teletype the address of the next instruction to be executed in the user program. When BREAK will be used following an IPL, the procedures of Section 3.5.3.9 must be used.

APPENDIX

Early versions of Multi-Device Initial Program Load ROM's.

Four versions of the Multi-device IPL ROM's were released prior to the version described in Section 3.5.

Version 1 - 70A00339A01  
70A00339A02  
70A00339A03  
70A00339A04

Version 2 - 70A00339A11  
70A00339A12  
70A00339A13  
70A00339A14

Version 3 - 70A00649A01  
70A00650A01  
70A00651A01  
70A00652A01

Version 4 - 70A00938A01  
70A00939A01  
70A00651A01  
70A00652A01

The applicable selector switch settings for the above versions are as follows:

Position	Device
0	Teletype (Load and Go)
1	High-speed Paper Tape Reader (Load and Go)
2	Card Reader (Load and Go)
3	3347 Disk
4	3346 Removable Disk
5	3349 Floppy Disk
6	3343 Disk
7	3346 Fixed Disk
8	3342 Disk (functional only in Version 4)
9	3341 Disk
A	Teletype (Load and Stop)
B	High-speed Paper Tape Reader (Load and Stop)
C	Card Reader (Load and Stop)
D	Version 3: Jump to Console Switches, Version 1 & 2: Option
E	Version 3: Clear Memory, Jump to Switches, Version 1 & 2: Option
F	Option

Note: Refer to description of IPL SEL switch (14) in Table 3-3.

The following variations exist in the earlier versions of the IPL ROM from the description given in Section 3.5:

- The earlier ROM's are 256 word programs in a 256 word memory.
- Earlier IPL's for disk load into the Console RAM area, X'FE00'.
- The software entry point will clear memory in earlier versions.
- No indication of IPL activity appears in the foreground indicator (Indicator (20), Table 3-3).
- Versions 2, 3, and 4 were modified to permit loading from the card reader in 64K mode.
- The IPL for the 3342 Head per Track Disk is incorrect in Versions 1, 2, and 3.
- In Version 4 the 3342 will load into main memory as described in section 3.5.3.
- Jump to Console Switches and Clear Memory-Jump to Switches exist only in Version 3. In Version 3, no initialization is performed and it is not possible to execute in 64K mode directly from IPL (the loaded program can set 64K mode once executed).
- The software entry will clear memory and, therefore, the procedures of 3.5.3.9 are not applicable to earlier versions.
- The closed subroutine to set 64K mode is not available in the earlier versions.

REFERENCE MANUAL BOOK 1

The operation of the multi-device IPL for the 330 is identical to that for the 220. I would suggest that the material from the 220 manual be incorporated in the 330 manual in the following way.

On Page 3-5

Delete the table of IPL selector positions and the lead in sentence.

On Page 3-6

Add Table 3-4 from the 220 manual with these changes:

- . Change "Table 3-4" to "Table 3-2".
- . Delete "on SCI Module (GA-16/220)"
- . Change " (14) Table 3-3 "to" (17) in Table 3-1".

Delete the present sections 3.3.1 through 3.3.4. Insert in place the material in the 220 manual starting at insert B of 3.5.3 and continuing through section 3.5.3.10. The appropriate section number is found by deleting the .5 from the 220 section number.

These changes are needed:

<u>Section</u>	<u>Is</u>	<u>Should Be</u>
3.5.3, Insert B, last paragraph	"20, Table 3-3"	"5, Table 3-1"
3.5.3.6, first paragraph	"5 and 6, Table 3-3"	"6 and 8, Table 3-1"

Make the addition from 220 Section 3.7.2 to 330 Section 3.5.2.

Add the Appendix. Change "section 3.5" to "section 3.3". At the bottom of the table change "14 in Table 3-3" to "17 in Table 3.1". In the next paragraph change "Section 3.5" to "Section 3.3". In the fourth item in the list of variations change "20, Table 3-3" to "5, Table 3-1". In the next to last paragraph, change "3.5.3.9" to "3.3.9".

FOR 88A00480A-B, STAND-ALONE UTILITIES

This manual includes a number of explicit examples of 220/330 loading procedures that may be affected by the changes to the IPL. I have not reviewed this document exhaustively but I have noted the following areas that should be reviewed:

Page 1-5, last paragraph

An alternative loading procedure now exists that allow an IPL load without clearing memory.

Page C-1, first caution

Same as page 1-5

Page 3-2, second caution

All programs load at m A00 except remote communications IPL.

Page C-12

Same as 1-5

Page C-20 and C-21

The IPL switch selections are changed.

FOR 88A00525A-A, HOW TO USE YOUR GA-16/220

Page 2-17, last paragraph

This paragraph is obsoleted. Table 3-4, device select list, was never included but is obsolete anyway. I don't think any meaningful discussion of the IPL's belong in this document. I have no idea of what should be said.