List of Software Versions

BOOT	1.2
FDOS	1.3
CONMON	1.1
BASIC	1.2
FUP	1.1
SET	2.0
TIME	1.0

NOTICE

This manual documents this set of software versions only. Software modules will function properly only in compatible versions. Refer to the software compatibility check procedure at the end of the installation section for additional information.

1720A

Instrument Controller

User Manual

P/N 518654
April 1980
Rev 1 11/80
Rev 2 11/81

FLUKE®

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO., INC., warrants each instrument controller it manufactures to be free from defects in material and workmanship under normal use and service for the period of 90 days from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, floppy disks or contents thereof, or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc. will repair an instrument controller returned to an authorized Service Facility within 90 days of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument controller returned within 90 days of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC., SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify the JOHN FLUKE MFG. CO., INC., or the nearest Service Facility, giving full details of the difficulty, and include the model number, type number, and the serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument controller transportation prepaid. Repairs will be made at the Service Facility and the instrument controller returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of JOHN FLUKE MFG. CO., INC., instrument controllers should be made via United Parcel Service or "Best Way" prepaid. The instrument controller should be shipped in the original packing carton. If this original carton is not available a suitable container that is rigid and of adequate size may be used. However, the JOHN FLUKE MFG. CO., INC., does not recommend shipment of instrument controllers in substitute containers. In the event a substitute container must be used, the instrument controller should be wrapped in paper and surrounded with at least four inches of excelsior or other similar shock absorbing material. JOHN FLUKE MFG. CO., INC., shall assume NO risk for intransit shipment damage.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument controller should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument controller is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO. INC., will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO. INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands. *

*For European customers, Air Freight prepaid.

CHANGE/ERRATA INFORMATION

ISSUE NO: 2 7/82

This change/errata contains information necessary to ensure the accuracy of the following manual.

MANUAL

Title: 1720A Instrument Controller User Manual
Print Date: April 1980
Rev. and Date: 2 11/81

C/E PAGE EFFECTIVITY

Page No.	Print Date
1	7/82
2	7/82
3	7/82

ERRATA #1

On page 2-3, para. 2-18, first sentence:
CHANGE: 10°C to 40°C (50°F to 104°F)
TO: 10°C to 35°C (50°F to 95°F)

On page 2-4, para. 2-19:
CHANGE: -10°C to 60°C (14°F to 140°F)
TO: -10°C to 50°C (14°F to 122°F)

CHANGE #1 - 15675

On page 4D-1:
Para. 4D-5, change the first sentence:
FROM: ... a sequence of 350 (512-byte) blocks.
TO: ... a sequence of 400 (512-byte) blocks.

Para. 4D-6, change the first sentence:
FROM: A track is one of 35 ...
TO: A track is one of 40 ...

Para. 4D-9, change the second sentence:
FROM: That works out to (348 blocks) X (512 bytes/block) or 178,176 bytes maximum file size.
TO: That works out to (398 blocks) X (512 bytes/block) or 203,776 bytes maximum file size.

CHANGE #2 - 16668

On the front of the manual:
REPLACE: The 'List of Software Versions' and the 'NOTICE'
WITH: Consult the current issue of Change/Errata for updates to this manual. For the list of compatible software module versions please consult the packing list of the software package that this manual accompanied.

On page 2-2, add the following options and accessories:

15. Bit parallel interface with two independent 16-bit data ports and eight control lines, Option 1720A-002. A maximum of two boards can be used with each unit. Bit parallel interface cable (Y1717) for use with the bit parallel interface.

16. Multiple Controller Interface, Option 1720A-006, which allows one 1720A to pass control to another 1720A.

17. A 5 1/4", 5M byte Winchester Disk, model 1765A/AA which interfaces to the 1720A via the IEEE-488 interface.

18. InfoTouch Display Operator Terminal (1780A).

19. General purpose 32-bit digital input/output card, model A17-4, plugs into the Fluke 1120A IEEE-488 bus translator. Up to three cards can be inserted for up to 96 digital bits. Binary or hexadecimal modes can be initiated.

20. BASIC startup disk for tutorial programming information (Option 1720A-902).

21. Plotter Applications Package (S1716) with extensive software for driving the HP7225A or HP9872B plotters.

22. Assembly Language (Option 1720A-200U).

23. FORTRAN, an enhanced version of FORTRAN IV which complies with ANSIX3.9-1966 (Option 1720A-202), with one E-Disk (Option 1720A-212) and with two E-Disks (Option 1720A-222).

24. Compiled BASIC (Option 1720A-203), with one E-Disk (Option 1720A-213), and with two E-Disks (Option 1720A-223).

25. BASIC update pack for updating older versions of Fluke Interpretive BASIC to current version, (1720A-201U).

26. Assembly Language update pack for updating older versions of Fluke Assembly Language to current version (Option 1729A-201U).

27. FORTRAN update pack for updating older versions of Fluke FORTRAN (Option 1720A-202U).

28. Customizing Keyboard Cable (Accessory Y1718).

29. Handheld Keypad with 28 user-definable push-button keys (Accessory Y1722).

30. Remote Control unit with three LEDs and three push button switches for remote operation (Accessory Y1721).

31. Circuit board extender (Accessory Y1704).

32. Programmer's Worksheets (pad of 50) (P/N 533547).

33. Printer cable, 2 meters, (Accessory Y1709).

On page 2-10, steps 6 & 8:
REPLACE: "BOOT V1.2"
WITH: BOOT Vx.x
ADD:

NOTE

x.x refers to the version of a particular software module. Consult the packing list of the software package that this manual accompanied for the current software versions.

On page 2-11, step 15:
REPLACE: "Basic Version 1.3"
WITH: Basic Version x.x

On page 2-12, Table 2-6:
REPLACE: "SEE TITLE PAGE"
WITH: SEE SOFTWARE PACKING LIST

On page 2-13/2-14, delete steps 2, 4, 5, 6, and 7 and replace with:

2. Check that the initial display includes BOOT Vx.x .

4. Check that the final display includes FDOS Version x.x and Console Monitor Version x.x .

5. After the prompt#, type TIME RETURN . Check that the resulting display includes Time Version x.x . Then enter <CTRL/P>.

6. After the prompt#, type SET RETURN . Check that the resulting display includes Set Version x.x . Then enter <CTRL/P>.

7. After the prompt#, type FUP RETURN . Check that the resulting display includes File Utility Program Version x.x .

Table of Contents

(continued on page ii)

TABLE OF CONTENTS, *continued*

List of Tables

List of Illustrations

Note

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with this User Manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Section 1
Introduction

1-1. DESCRIPTION OF 1720A DOCUMENTATION

1-2. Several documents are available to serve the needs of a variety of users. Figure 1-1 illustrates the manual set. To obtain additional copies of these, or other manuals when developed, check with a local Fluke Sales Office, listed at the end of this manual. A summary description of each manual is given below:

1720A User Manual	An introductory manual for the programmer or system designer who is using the 1720A to set up an instrumentation system. It presents both the purpose of and the interaction between the various software and hardware resources in the 1720A. In addition, it serves as a reference guide for FDOS, the Console Monitor, and the utility programs. Fluke Part Number 518654.
1720A Fluke BASIC Programming Manual	A description of the Fluke-enhanced ANSI-standard BASIC language developed for the 1720A Instrument Controller. It is arranged by subject, and combines syntax diagrams with examples. Emphasis is on instrumentation system control. This manual presumes familiarity with the 1720A User Manual. Fluke Part Number 518670.
1720A BASIC Reference Guide	A pocket-size quick reference guide that summarizes the most often used contents of the User and BASIC Programming manuals. Fluke Part Number 526210.
HPL to Fluke BASIC Handbook	A specialized manual for the programmer who is familiar with the Hewlett-Packard 9825 Calculator using the HPL language. Building upon this familiarity, the handbook describes functional similarities and differences and leads the programmer through the task of converting existing HPL programs for use with the 1720A Instrument Controller. Fluke Part Number 546341.

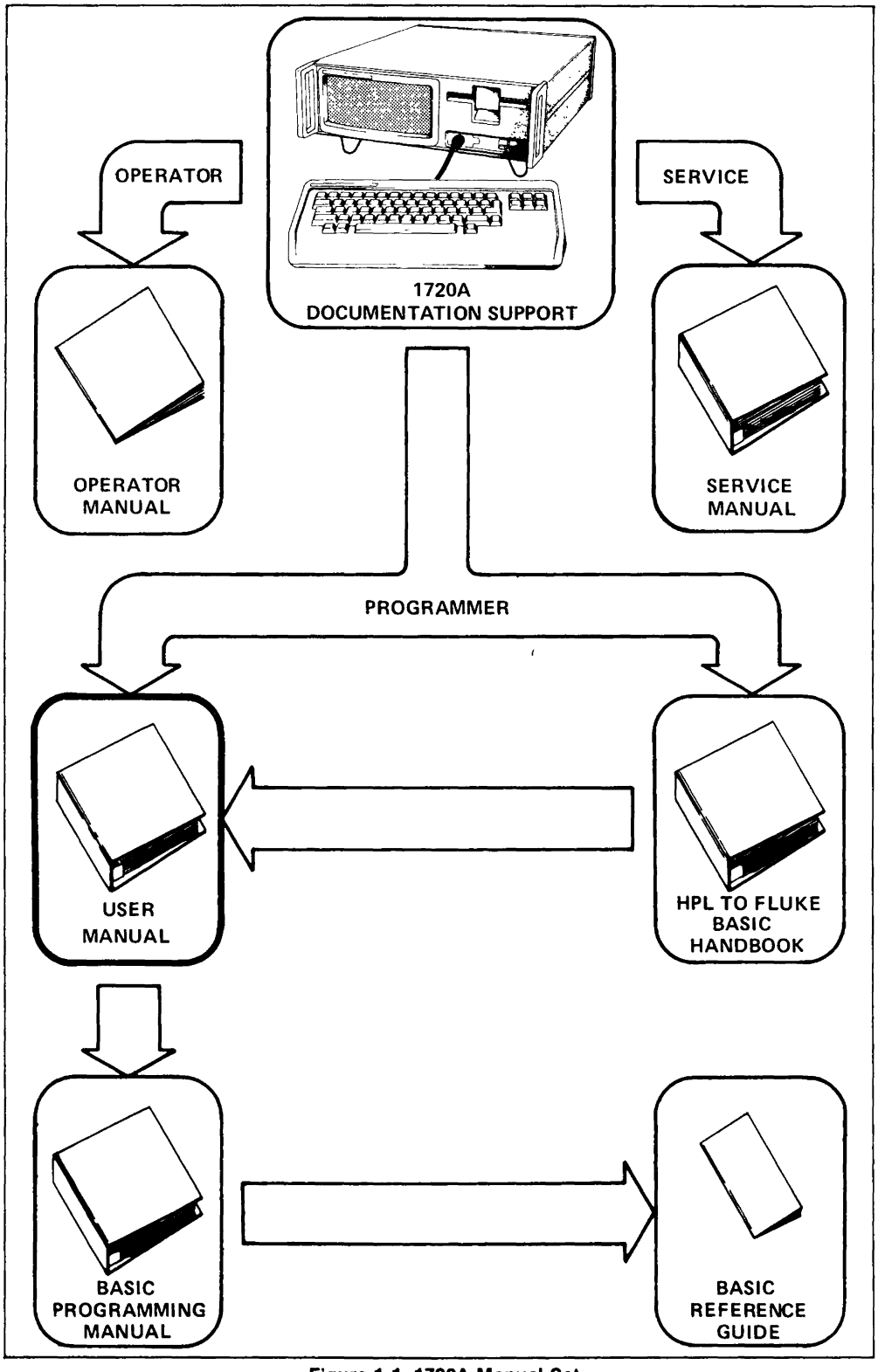


Figure 1-1. 1720A Manual Set

1720A Display Worksheet Pads	A grid-pattern worksheet that shows both the normal and double size character positions and the touch sensitive areas. This aids the programmer in the design of effective display layouts. Available in pads of 50. Fluke Part Number 533547.
1720A Operator Manual	A brief manual for the operator of a programmed 1720A-controlled instrument system. It discusses proper disk handling and error interpretation and includes an error and trouble-incident log. Fluke Part Number 518647.
1720A Service Manual	A component level theory of operation for each hardware module, with diagnostic procedures to resolve failures to the modular level. Schematics and parts lists are included. Fluke Part Number 518662.

1-3. INTRODUCTION TO THIS MANUAL

1-4. This manual introduces the 1720A and is a reference for FDOS, the Console Monitor, and the other utility programs provided. It establishes familiarity with both software and hardware capabilities. The Fluke BASIC Programming Manual and other language manuals then build upon this system familiarity describing the use of a programming language and its associated software tools. The subject matter is divided into sections as follows:

Section 1	Introduction. Describes the documentation set, the User Manual, syntax diagrams, and the 1720A Instrument Controller.
Section 2	Installation. Covers unpacking and set-up. Identifies controls, indicators and connectors. Includes start-up procedures and a software module compatibility check.
Section 3	Software. Describes use of FDOS, the Console Monitor, and each system-level utility program. Divided into modular subsections.
Section 4	Hardware. Describes use of each of the hardware modules as a system resource. Divided into modular subsections.

1-5. Programming languages are covered in separate manuals that presume familiarity with this user manual. Where programming examples are required, Fluke Enhanced BASIC is used unless otherwise specified.

1-6. Command Definitions

1-7. The length of any command line cannot exceed 80 characters. Commands are introduced with a syntax diagram that defines legitimate command constructs. A complete definition of the command follows the syntax diagram. The short indented paragraphs (with a "bullet" in place of a paragraph number) following the syntax diagram are part of the definition.

1-8. Syntax Diagrams

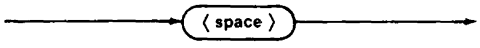
1-9. Syntax diagrams are used throughout this manual to define correct spelling, punctuation, sequences of words, symbols, and expressions for system and utility commands. The following guidelines define proper use of these diagrams:

- Any path through a diagram starting from the left that does not run contrary to an arrowhead forms a legitimate command construct. The text accompanying the diagram explains legal usage.

- Boldface words in a circular enclosure are to be entered exactly as shown. Example:

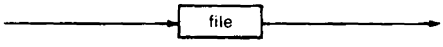
- Key entries with names, such as ESC or RETURN, are shown in a box with rounded corners. Example:

- A required space character entry is always shown as:

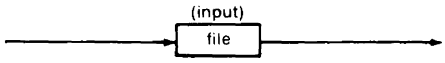


- Control character entries are shown in circular enclosures within angle brackets. The representation CTRL/ means to hold the CTRL key depressed while typing the letter that follows. Example:

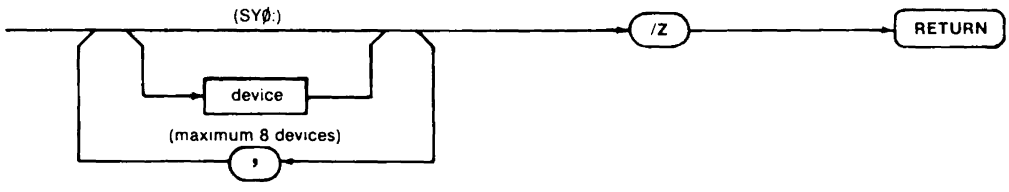
- Lower case words enclosed in a box represent other information to be supplied. Example:



- Words outside the path of the diagram, usually in parentheses, provide supplementary information. These words are normally not part of the definition of the statement. Example:



1-10. The following syntax diagram of the zero directory command of the File Utility Program illustrates these points. The diagram shows that the basic construction of the command is /Z. The supplementary note shows that the default system device (SY0:) is assumed when one is not specified. The diagram also shows that one or more devices may be specified, separated by commas.



1-11. THE 1720A INSTRUMENT CONTROLLER

1-12. The Fluke 1720A Instrument Controller was designed for the task of building and controlling instrument systems. Because it has a removable Programmer Keyboard, a Touch-Sensitive Display for operator interaction, and a rack-mountable package, it can be used on the programmer's desk or rack mounted in an industrial instrumentation system.

1-13. The 1720A includes a 16-bit microcomputer and is supplied with a System Disk containing Fluke-designed system software, utility programs, and one or more programming languages. Dual IEEE-488-1978 standard ports allow the 1720A to control up to 28 compatible instruments or peripheral devices. In addition, two RS-232-C ports permit the 1720A to interface with a wide variety of general purpose peripherals and data communications equipment.

1-14. The 1720A is not a business computer or calculator that has been adapted to the job of an industrial controller. Instead, the 1720A is a special purpose machine that has a variety of standard features specifically designed for controlling industrial instruments. These standard features include:

- A rack-mount package that occupies a minimum of valuable rack space.
- A full-width touch-sensitive display that allows the design of operator control interfaces that are flexible, simple to use, and specifically adapted to the process.
- A detachable, ASCII keyboard that allows separation of programming functions from daily operation.
- A two-port IEEE-488-1978 interface that allows the 1720A to function as two controllers with up to 14 instruments in each system.
- A software development system that includes an operating system, a monitor, utility programs, and one or more programming languages with an editor and other supporting software tools.
- A double-density floppy disk drive that allows storage of programs and files on a permanent media. The floppy disks provided with the 1720A contain the standard software development programs as well as a complete set of diagnostic software for isolation of failures to the module level.
- A soft-loaded software architecture that allows field upgrading of software as new capabilities and languages are developed.
- A 60K byte memory module that provides the main memory area for program execution, file transfer, and the execution area for all system software.
- An optional electronic disk memory module, E-Disk™, that provides an additional 128K or 256K bytes of storage. It is intended for use as a fast access operation media. Internal battery backup can sustain the contents of the electronic disk for a short time when AC power is removed. This backup time may be extended indefinitely by using an external battery. (E-Disk is a trademark of the John Fluke Mfg. Co., Inc.)

Section 2
Installation and Start-Up

2-1. INTRODUCTION

2-2. This section covers unpacking and installation. In addition, it provides a description of the controls, indicators, and connectors. Following this, it presents start-up procedures for putting the 1720A into operation.

2-3. UNPACKING

2-4. The 1720A Instrument Controller is carefully packed for shipping to ensure that the unit arrives in good condition. Unpack all containers carefully and check all packing materials for accessories, cables, and manuals. Do not dispose of the packing materials before inspecting for shipping damage. If this inspection reveals damage or indicates that damage might have occured, notify the shipper immediately. Then call a Fluke Sales Office or Customer Service Office. A checklist of the standard and optional items included with the 1720A Instrument Controller is presented in paragraph 2-6.

2-5. If the 1720A Instrument Controller needs to be shipped again at a later date, the original packing carton should be used with all fillers properly in place. Fluke does not recommend shipping the 1720A in a substitute container. To obtain an approved shipping container, call any Fluke Sales Office.

2-6. Unpacking Checklist

1. Controller Mainframe
2. Programmer Keyboard
3. Power Cord
4. System Disk
5. Diagnostics Disk
6. Data Disk
7. This User Manual
8. 1720A Fluke-Enhanced BASIC Programming Manual
9. 1720A Fluke BASIC Reference Guide (pocket-size)
10. 1720A Operator Manual
11. 1720A Service Manual
12. 1720A Controller Programming Work Sheet (Pad of 50)

2-7. Options and Accessories

2-8. These items are not included in the shipment unless ordered separately. They may or may not be separately packaged.

1. 128K Byte Electronic Disk Module, Option 1720A-001, maximum two per unit. These will be installed in the mainframe if ordered with the Instrument Controller.

2. Extra Programmer Keyboard (accessory Y1720).

3. Ten-pack of blank floppy disks, unformatted (accessory Y1706).

4. IEEE-488-1978 Cables, one-meter length (accessory Y8001), two-meter length (accessory Y8002), four-meter length (accessory Y8003).

5. RS-232-C Standard Interface Cable, allows connection to standard telephone data sets and modem-type devices. Two-meter length (accessory Y1707). Ten-meter length (accessory Y1708).

6. RS-232-C Null Modem Cable, 0.3 meter length. This cable allows connection to standard data terminal devices (accessory Y1705).

7. RS-232-C Printer Cable, two-meter length. This cable is designed for connecting the 1720A to a Fluke 1776A Serial Printer (accessory Y1709).

8. Rack Mounting Kit, includes 61 cm (24 inch) slides (accessory number Y1790).

9. Shipping Case (accessory Y1711).

10. Customer Maintenance Kit, includes the tools and accessories that are required by the diagnostic and troubleshooting procedures in the 1720A Service Manual. This kit is included in the Module Service Kits below. Order through Fluke Service Centers as part number 577791.

11. Module Service Kit, includes one of each of the functional modules, the Maintenance Kit of required tools, and a selection of additional parts and tools. This is the basic spares kit for modular servicing. Order through Fluke Service Centers as part number 539379.

12. Module Service Kit with E-Disk™, includes one of each of the functional modules, the Maintenance Kit of required tools and a selection of additional parts and tools. This kit is identical to the 539379 kit except for the addition of an E-Disk™ module and associated spares. Order through Fluke Service Centers as part number 537506.

13. CRT Display Service Kit, includes the CRT display tube with factory aligned yoke, the high voltage transformer, and the horizontal and vertical drive electronics. Order through Fluke Service Centers as part number 537472.

14. 70% Level Service Kit, includes a minimum number of functional modules that have been calculated or shown by experience to have the lowest mean time between failure (MTBF). This kit must be supplemented by a Maintenance Kit. Order through Fluke Service Centers as part number 539361.

2-9. INSTALLATION

2-10. Installation of the 1720A requires locating the 1720A on a suitable table, attaching the keyboard and line cord, and turning on the power. The Power Switch is located on the rear panel. The line voltage has been factory set as ordered. This voltage setting is indicated on the rear panel decal.

2-11. Line Voltage Range Selection

2-12. The 1720A Instrument Controller uses a high-efficiency switching power supply that will operate from any of the inputs shown in Table 2-1.

Table 2-1. Power Supply Inputs

VOTAGE RANGE	LINE FREQUENCY	SWITCH SETTING	FUSE
90V to 132V	47 Hz to 63 Hz	115	3A SB
192V to 250V	47 Hz to 63 Hz	230	1.5A SB
104V to 126V	380 Hz to 420 Hz	115	3A SB

2-13. If line voltage requirements change, it will be necessary to set the power supply line voltage switches. It may also be necessary to change the fuse to match the power source and install an appropriate power plug.

CAUTION

Do not operate the 1720A from a 230V-range source with the 3 amp fuse installed. This size fuse may be unable to protect the unit from internal damage if a failure-caused overload occurs.

WARNING

TO AVOID ELECTRICAL SHOCK HAZARD, REMOVE THE POWER CORD FROM THE 1720A AT LEAST FIVE (5) MINUTES PRIOR TO PERFORMING THE FOLLOWING PROCEDURE. THIS WILL ALLOW TIME FOR THE INTERNAL CAPACITORS TO DISCHARGE TO A SAFE LEVEL.

2-14. To gain access to the voltage range setting, use a #1 Phillips screwdriver to remove the three screws holding the Power Supply Module to the chassis and slide the power supply straight out the rear. Facing the rear of the unit, the power supply is the right half-panel. The two slide switches are located under the right side of the top circuit board as illustrated in Figure 2-1, and are labeled with the numbers 115 and 230.

2-15. The fuse is accessible without removing the power supply, and is on the right side of the rear panel. Be sure that the fuse value corresponds to the setting of the voltage range switches as given in Table 2-1.

2-16. Environment

2-17. The 1720A requires adequate ventilation to maintain the correct operating temperature. Keep the rear panel at least 10 cm. (4 inches) from the wall so that the fan can be effective. There is no minimum distance for top or bottom placement, as the controller is designed to be mounted in a rack with other instruments.

2-18. The 1720A operates reliably within the temperature range of 10°C to 40°C (50°F to 104°F). The controller may be turned on at lower temperatures, down to -10°C (14°F), to help warm it up to room temperature. The relative humidity should be within the range of 8% to 80%, non-condensing.

CAUTION

Low humidity environments can induce electrostatic discharges within the rotating floppy disk, and between the touch-sensitive display and the operator. Such discharges can permanently damage high-density MOS microcircuitry within the 1720A.

2-19. The 1720A must be stored (non-operating) within the temperature range of -10°C to 60°C (14°F to 140°F), and within a humidity range of 5% to 95%, non-condensing.

2-20. Floppy disks are more sensitive to storage environments than the instrument controller. They must not be allowed to become colder than 10°C (50°F), or warmer than 52°C (126°F). Relative humidity must be kept within the range 8% to 90%, non-condensing. If a disk has been stored outside these limits, the best way to attempt recovery of data is to allow it to slowly reach room temperature and humidity at least 3 to 4 hours before placing it in the controller. The Start-up Procedures include other disk handling precautions.

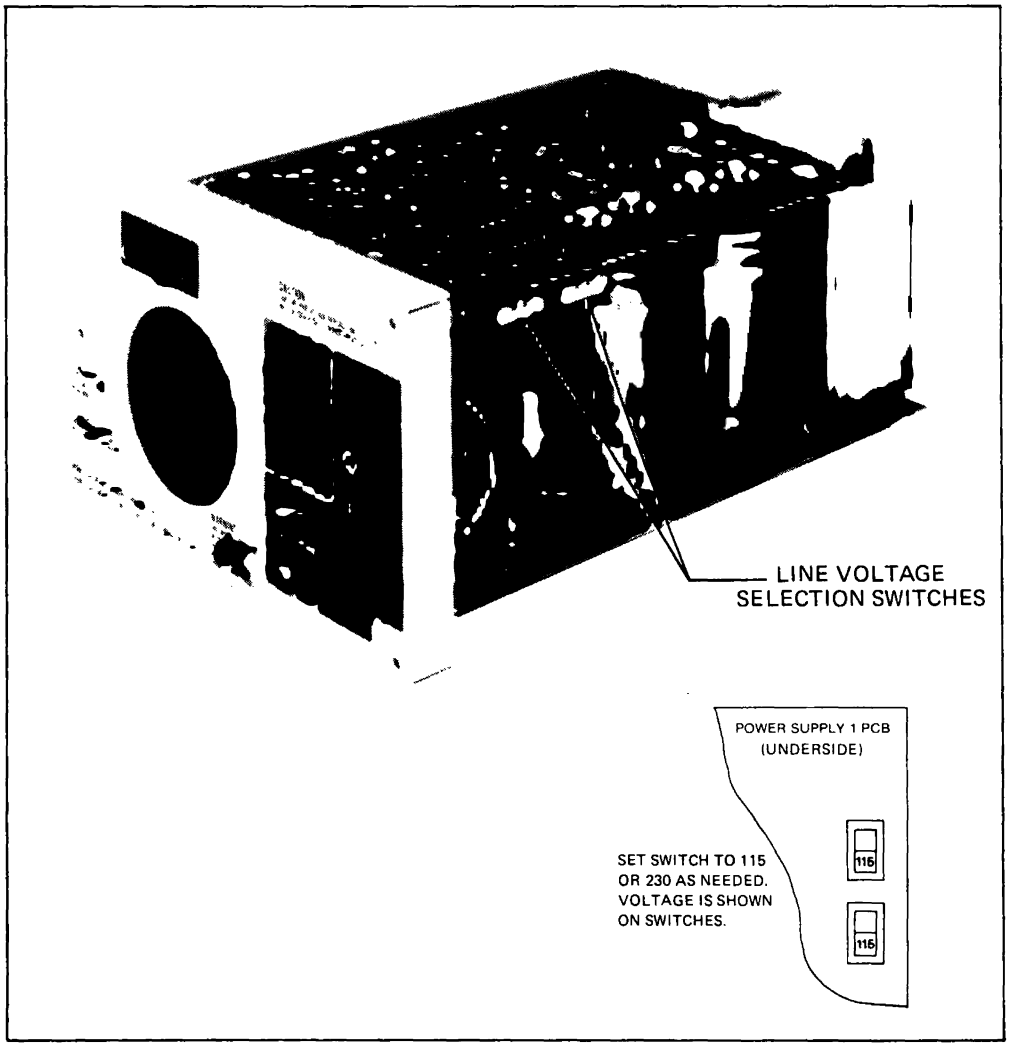


Figure 2-1. Power Voltage Range Selection

2-21. CONTROLS, INDICATORS, AND CONNECTORS

2-22. Figure 2-2 and Table 2-2, illustrate and describe the front and rear panels, and Figure 2-3 and Table 2-3, illustrate and describe the programmer keyboard.

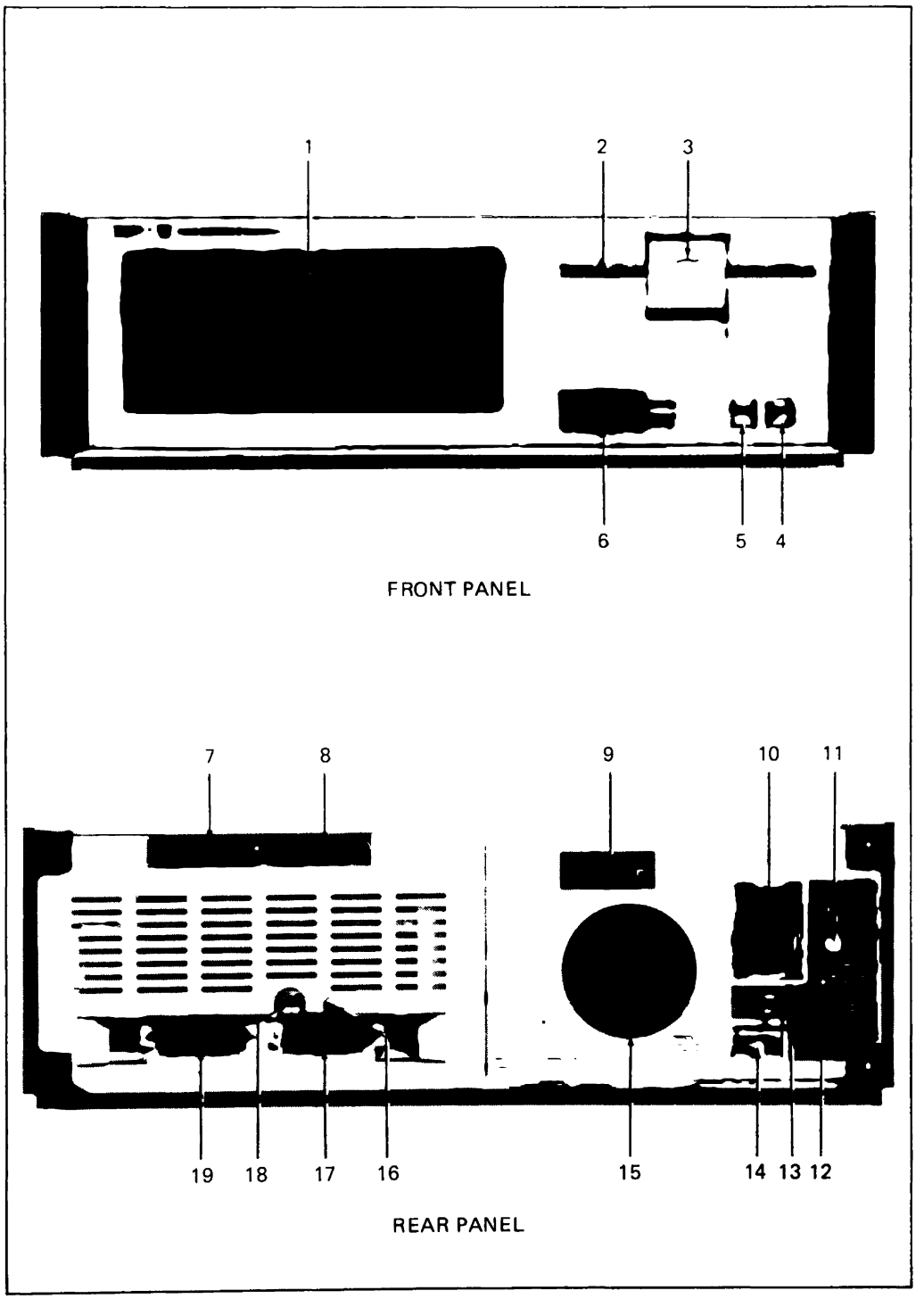


Figure 2-2. Front and Rear Panel Controls, Indicators, and Connectors

Table 2-2. Front and Rear Panel Controls, Indicators, and Connectors

REF. NO.	NAME	FUNCTION
1	Touch-Sensitive Display	A display with touch sensitive areas which allows operation of a program by touch according to commands shown on the screen. The commands are program controlled and generated.
2	Disk Loading Slot	The floppy disk is loaded into the disk loading slot for program execution and data storage.
3	Disk Entry Latch	Seats disk for operation.
4	ABORT Push Button Switch	Clears devices on the IEEE-488 buses and either stops the program or allows automatic program continuation, depending on the application program.
5	RESTART Push Button Switch	Initiates self test, clears main memory, and reloads program.
6	Keyboard Connector	For connecting the detachable keyboard.
7	RS-232-C Connector #1	Standard I/O port for peripheral devices. (KB1:)
8	RS-232-C Connector #2	Standard I/O port for peripheral devices. (KB2:)
9	Remote Interface Connector	Provides for external E-Disk battery back-up, external control of ABORT and RESTART switches, and two software controlled output lines.
10	Main Power Switch	Applies and removes line power to the instrument controller.
11	Fuse	Power supply line fuse.
12	Power Connector	Input line power connector.
13	System Ground	A common ground for system components.
14	E-Disk Enable Switch	Enables battery backup for E-Disk.
15	Air Filter	Filters air used to cool power supply. See maintenance procedures.
16	Display Intensity Control	A screwdriver adjustment which controls the intensity of the display.
17	IEEE-488 Port 1 Connector	Standard IEEE-488-1978 connector for instrumentation.
18	Composite Video Connector	Drives standard data display monitor.
19	IEEE-488 Port 0 Connector	Standard IEEE-488-1978 connector for instrumentation.

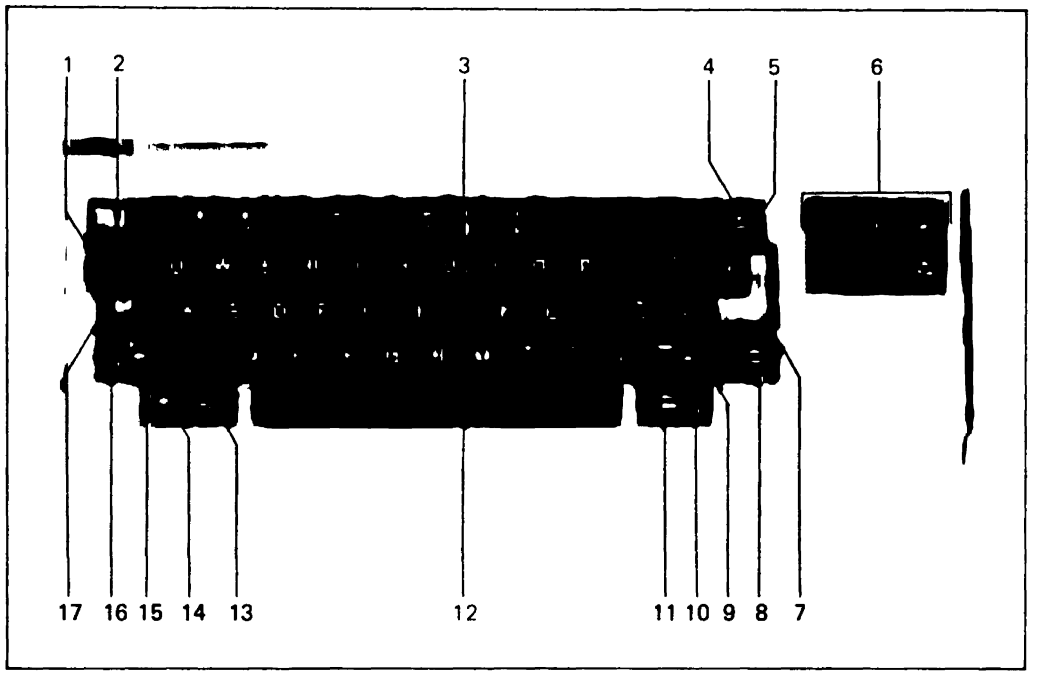


Figure 2-3. Programmer Keyboard

Table 2-3. Programmer Keyboard

REF. NO.	NAME	FUNCTION
1	TAB Key	Not used at this time (Horizontal Tab code).
2	ESCape Key	Escape code.
3	Character Entry Keys	In standard typewriter layout, for entry of characters and numbers into the 1720A.
4	BACK SPACE Key	Functional only in Edit Mode.
5	DELETE Key	Delete the character just entered and backspace to the previous position.
6	Editing Keypad	Functional only in EDIT Mode. Arrows indicate direction of cursor movement. DELete LINE and DELete CHARacter act upon the current cursor position.
7	RETURN Key	General-purpose entry key. Command or statement entries in all modes are stored in temporary buffer unit RETURN is pressed. The display then moves the cursor to the start of the next line.
8	LINE FEED Key	Functional only in Edit Mode.
9	SHIFT Key	A key modifier that must be held down while another key is pressed to select the upper character of any key that has two characters on it, or the CAPITAL of any alpha character.

Table 2-3. Programmer Keyboard (cont)

REF. NO.	NAME	FUNCTION
10	Page Mode Indicator	ON when Page Mode has been selected. See Reference Number 11.
11	PAGE MODE	Alternate action switch that selects or cancels Page Mode. In Page Mode, the indicator is lighted, and display output stops at the bottom without scrolling. See Reference Number 13.
12	Space Bar	Generates space characters.
13	NEXT PAGE Key	Functional in Page Mode only. Clears the screen and allows an additional 16 display lines.
14	CTRL (Control) Key	A key modifier that must be held down while another key is pressed.
15	SHIFT Key	A key modifier that must be held down while another key is pressed to select the upper character of any key that has two characters on it, or the CAPITAL of any alpha character.
16	Caps Lock Indicator	ON when Caps Lock Mode has been selected. See Reference Number 17.
17	CAPS LOCK	Alternate action switch that places the controller into and out of Caps Lock Mode. In Caps Lock Mode the indicator is lighted, and all alpha characters are automatically capitalized. Other characters remain unchanged.

2-23. START-UP PROCEDURE

2-24. Following is a step by step procedure for starting up the 1720A Instrument Controller. This procedure is for the standard 1720A, supplied with Fluke-enhanced BASIC.

1. Check for proper line voltage selection as discussed under Installation earlier in this section. Plug the power cord into a properly grounded outlet.

WARNING

SAFE OPERATION OF THE 1720A, AS WELL AS RELIABLE SYSTEM OPERATION REQUIRES A GROUNDED POWER CONNECTION.

2. Apply power to the system by depressing the top of the power switch located on the rear panel.

3. Release the door latch on the floppy disk drive by pressing in on the top of the door, as shown in Figure 2-4.

4. Read the disk handling precautions in Table 2-4. Gently insert the System Disk into the disk drive with the label upward, as shown in Figure 2-4, until the disk is fully seated. Then latch the drive closed by pressing the bottom of the door.

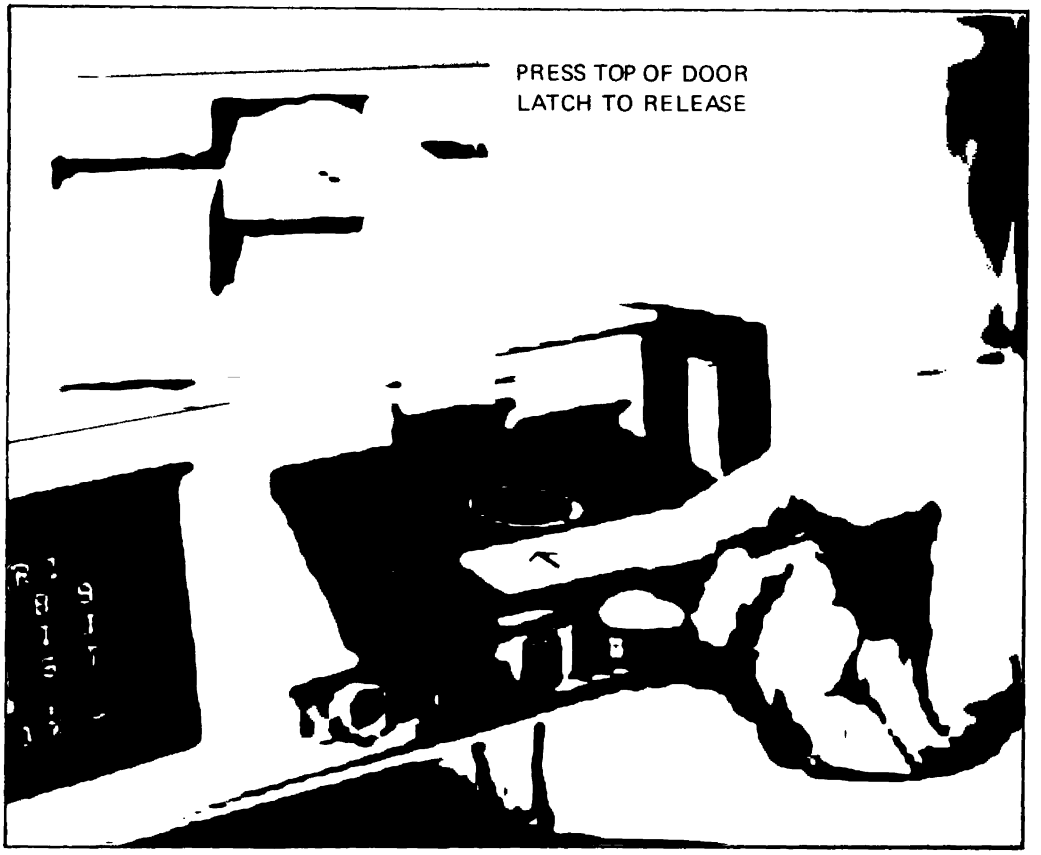


Figure 2-4. Inserting the Disk

Table 2-4. Disk Handling Precautions

1	Keep the disk in its protective folder when not in use.
2	The disk surface can be easily damaged. Do not touch the exposed disk surface with hands or any material which may damage it.
3	Careless handling may damage the disk. Avoid dropping, throwing, or twisting the disk.
4.	Store disks vertically and support them so they will not bend. Stacking may distort them and affect their contents. Avoid placing heavy objects on the disks.
5.	Exposure to heat and sunlight may warp the disks.
6.	Magnetic sources may erase data on the disks. Keep the disks away from electric motors, generators, and transformers.
7.	Mark disk labels before placing them on the disk envelope or use a felt tip pen. Pressure from a ball point pen or pencil may destroy data on the disk.
8.	Temperature affects the performance of the disk. Do not use a disk that is overheated or overcooled until it has reached room temperature.

5. Press RESTART. This step may be avoided by inserting the disk before turning power ON; however, some of the following messages would not appear as the display system warms up to normal intensity.

6. Observe the display. It should read:

```
FLUKE 1720A CONTROLLER
HELLO
BOOT V1.2
```

7. Verify that the version number is 1.2. If it is not, check the front of this manual for supplemental information, or call a Fluke Customer Service Center for advice.

8. Following this display, the 1720A then performs a self-test procedure from permanent (ROM) memory located on the CPU module. The display changes the `BOOT V1.2` to `SELF TEST`. The Self Test functionally tests the following modules:

a. CPU Module

b. Floppy Disk Interface

c. Memory Module

d. Electronic Disk (if present)

e. Keyboard/Video Interface

f. IEEE-488 Interface

9. Refer to Table 2-5 if any error messages occur. This table presents the error messages that the self-test program can generate.

10. After the self-test, the 1720A loads the Floppy Disk Operating System software (FDOS) into main memory from the floppy disk. During the loading process, the display reads:

```
FLUKE 1720A CONTROLLER
LOADING
```

11. When loading is complete, FDOS takes control and attempts to load a System Command File from the disk by looking for a file named COMMND.SYS. A command file contains stored keyboard commands that would otherwise have to be typed in. Section 3 explains these concepts.

a. If the file COMMND.SYS is not found, FDOS loads the Console Monitor (CONMON) directly and transfers control to it. This may be the case if the disk being loaded is not the system disk supplied with the 1720A, or the COMMND.SYS file has been renamed or deleted. The Console Monitor displays a # prompt character. Section 3 explains the use of CONMON.

b. If the file COMMND.SYS is found, it is loaded and command file status is designated active. The display then reads:

```
Command File Active
```

12. The next action depends on the contents of the command file. The System Disk supplied with the 1720A contains a short system command file that first checks the TIME utility to see if the time has been set. It then loads the BASIC interpreter and transfers control to it.

Table 2-5. Self Test Errors

MESSAGE	ACTION
!Memory Error	Indicates a problem with the memory board. Service may be required.
!Video Error	Indicates a problem with the video board. Service may be required.
!IEEE Missing or Faulty	Indicates a problem with the IEEE Bus Interface board. Check that all bus instruments connected to the controller are ON and that all cables are securely in place. If everything seems correct and the message still appears when RESTART is again pressed, service may be required. *NOTE* *Disconnect the IEEE Bus cables from the controller to confirm that the instruments are the source of trouble.*
!Floppy Error	Indicates a problem with the floppy disk drive or its control board. Service may be required.
?No System on Device	Check that the disk in the drive is a system disk. Try another system disk. The wrong disk may be inserted or it may be inserted incorrectly.
?Disk not Mounted	Insert or reinsert a system disk. Either there is no disk inserted or it is improperly inserted. Check to see if the disk is upside down or the entry latch has not been closed.
?Floppy Error	The inserted disk is faulty. Try another system disk.
?Bad Directory on Device	The directory on the disk is incorrect. Use another disk.

13. If you are using the System Disk, and the time clock has not previously been set, the display will next read:

```
Enter Date:  DD-MM-YY
```

14. Type in today's date in numeric form, starting with the day, then the month, and then the year. The entries must be separated by any non-numeric character. Use DELETE to correct any mistakes. Press RETURN and the display reads:

```
Enter Time:  HH-MM
```

15. Type in the time, in 24-hour form, starting with the hour, followed by the minutes. The entries must be separated by any non-numeric character. Press RETURN and the display reads:

```
BASIC  (time)  (date)

Basic Version 1.3

Ready
```

NOTE

The 24-hour day starts at 00:00 (midnight) and ends at 23:59 (just before midnight). If the time is at or beyond midnight and before 1:00 A.M., subtract 12 hours. If the time is at or beyond 1:00 P.M., and before midnight, add 12 hours. Otherwise, use the time unchanged.

Three examples:

TIME	24-HOUR TIME
12:30 A.M.	00:30
9:45 A.M.	09:45
4:20 P.M.	16:20

16. The 1720A is now in Immediate Mode BASIC. Check that the version number agrees with the title page. If it is not, check the front of this manual or the Fluke BASIC Programming Manual for supplemental information, or call a Fluke Customer Service Center for advice. Refer to the 1720A Fluke BASIC Programming Manual for details on the use of BASIC in the 1720A Controller. Information on loading and the use of other languages is presented in separate manuals.

2-25. SOFTWARE COMPATIBILITY CHECK

2-26. Software modules are supplied with the 1720A Instrument Controller as files on the System Disk. These machine-language program files are interdependent and are compatible only in the combinations of versions supplied by Fluke and documented in published Fluke manuals, including addendum inserts. The portability and copying ease of Fluke system software allows the user to take advantage of the continuing program of software development at Fluke. The user should make sure however in copying new or updated Fluke system software that all of the software modules are compatible. This can be verified by obtaining the appropriate Fluke manuals and then following the procedure below.

2-27. Because software modules are easily erased and copied, do not assume that the label on a Fluke System Disk is valid unless the disk is new. The use of incompatible system software modules will produce unpredictable results for which Fluke cannot provide analytical, diagnostic, or other software support, except for identification of compatible combinations.

2-28. Compatible Versions of System Software

2-29. The versions of Fluke system software modules that are compatible and supported in this manual are listed in table 2-6. If subsequent software releases are also supported by this manual, an addendum insert is available that identifies the compatible versions and any functional changes and additions.

Table 2-6. Compatible Versions of System Software

NAME	VERSION	NAME	VERSION
BOOT	SEE	TIME.CIL	SEE
FDOS.SYS	TITLE	SET.CIL	TITLE
CONMON.SYS	PAGE	FUP.CIL	PAGE

NOTE

BOOT is contained in PROM memory on the CPU module. All other system software modules are supplied as disk files.

2-30. Procedure

1. With power ON, insert the System Disk and press RESTART.

2. Check that the initial display includes `BOOT V1.2` .

3. If the final display includes `Command File Active` the version of FDOS will not be displayed unless the system command file is temporarily renamed as follows:

   a. Enter ⟨CTRL/P⟩ (Hold [CTRL] down while typing P.)

   b. After the prompt #, type FUP [RETURN].

   c. After the prompt *, type `MFϕ:/A` [RETURN].

   d. After the prompt *, type `COMMND.CMD=COMMND.SYS/R` [RETURN].

   e. Press RESTART

4. Check that the final display includes `FDOS Version 1.5` and `Console Monitor Version 1.2` .

5. After the prompt #, type TIME [RETURN]. Check that the resulting display includes `Time Version 1.0`. Then enter ⟨CTRL/P⟩.

6. After the prompt #, type SET [RETURN]. Check that the resulting display includes `Set Version 2.0` . Then enter ⟨CTRL/P⟩.

7. After the prompt #, type FUP [RETURN]. Check that the resulting display includes `File Utility Program Version 1.1`.

8. If the system command file was temporarily renamed in step 3, restore it as follows:
   After the prompt *, type `COMMND.SYS=COMMND.CMD/R` [RETURN]

9. Press RESTART.

2-31. If any of the displays do not agree with these software versions, check the front of this manual for supplemental information, or call a Fluke Technical Service Center for advice.

CAUTION

Do not continue to use the 1720A with system software modules that are not known to be compatible and supported by a published Fluke manual or manual addendum. To do so will produce unpredictable results for which Fluke cannot provide analytical, diagnostic, or other support, except for identification of compatible combinations.

Section 3
System Software

3-1. INTRODUCTION

3-2. System Software developed for the 1720A Instrument Controller consists of distinct modules that serve specific purposes. This section provides a brief description of each software module.

3-3. Detailed functional descriptions of each software module, Fluke-Enhanced BASIC, and other programming languages are covered in separate manuals. The software modules are summarized below.

3-4. FDOS

3-5. The Floppy Disk Operating System (FDOS) performs file management for all programs and responds to interrupts from input and output (I/O) devices, such as the keyboard and the floppy disk. Whenever the 1720A is operating under normal conditions, FDOS is present in Main Memory. FDOS also includes a processor that allows command files of stored user defined keyboard inputs to be processed.

3-6. CONMON

3-7. The Console Monitor (CONMON) is a system program that works through FDOS to simplify the process of loading and transferring control to the other software tools available to the programmer. This software, including CONMON, remains on the system disk, or when configured, in the optional electronic disk until needed. This arrangement allows the 1720A to make efficient use of the Main Memory.

3-8. TIME

3-9. The Time and Date Set utility (TIME) enables the user to set the time and date into the system clock where it is accurately maintained for use by other programs.

3-10. SET

3-11. The Set Serial Port utility (SET) enables the user to independently set the baud rate, number of data bits, stop bits, parity, and line and file terminator characters for each RS-232-C Serial Port.

3-12. FUP

3-13. The File Utility Program (FUP) is a file transfer and management program that gives the programmer flexible control over the files on floppy disks and on the optional electronic disk. FUP has many other capabilities which are explained fully.

Section 4
Hardware

4-1. INTRODUCTION

4-2. This section describes each of the hardware modules individually from a user point of view. Beginning with an overview of the hardware architecture, a separate subsection is then devoted to each module. The reader who needs additional technical detail should consult the 1720A Instrument Controller Service Manual.

4-3. SYSTEM ARCHITECTURE

4-4. Refer to Figure 4-1 for a functional view of the 1720A Instrument Controller. Using system software, the CPU Module processes information to and from the other modules while directing their functions. The actions of the CPU are direct responses to a variety of conditions in the sequence that they occur. Among these are the statements in a user program, inputs from the programmer keyboard or the touch sensitive display, and interrupts from the disk drive or an external device.

4-5. The modular design of the 1720A Instrument Controller results in a segregation of tasks among the modules. These modules are internally connected by a high speed parallel bus similar to that found in computer systems. In addition to ease of servicing, this design approach enhances functional and processing throughput. The subsections that follow discuss the functions of each module independent of the programming language or utility program in use. Fluke Enhanced BASIC is used wherever programming examples are provided unless specified otherwise.

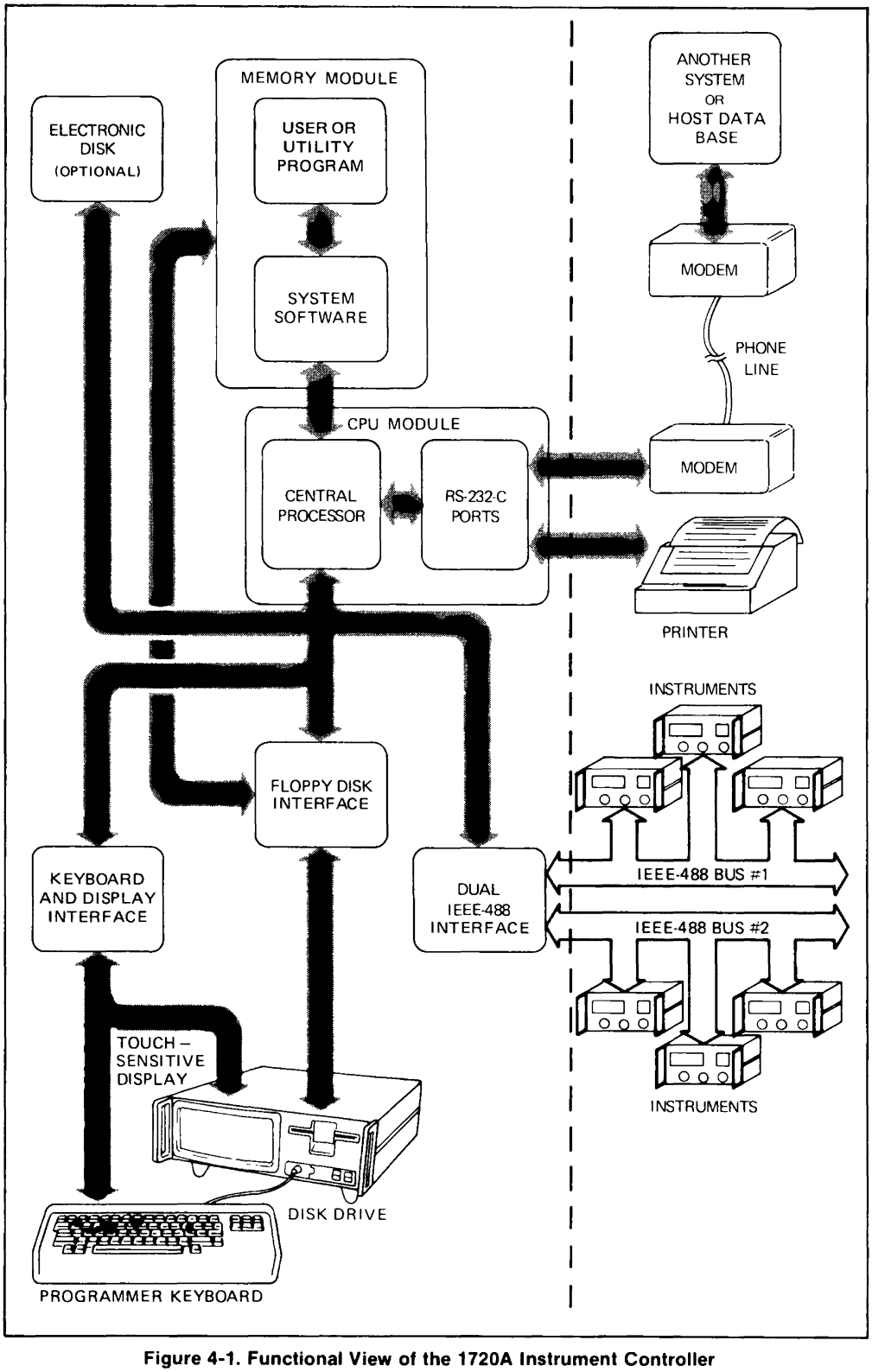


Figure 4-1. Functional View of the 1720A Instrument Controller

Section 4A
CPU MODULE

4A-1. INTRODUCTION

4A-2. The CPU Module gives the 1720A Instrument Controller the ability to accept and carry out user programs and control an instrument system precisely as the user intended. Through system software residing in the Main Memory Module, the user's program is processed into control actions, data collection and processing, and event-driven decisions. The system software may include processing tools such as a language interpreter as well as programming tools such as a compiler, assembler, linker, or editor. These software tools, covered in separate manuals, are placed in Main Memory by FDOS only when they are in use.

4A-3. The instructions that the CPU Module receives from memory are in 16-bit binary coded machine language corresponding to the microprocessor instruction set. Since these codes are not easily recognizable to the user,one of the functions of system software modules, themselves in binary form, is to provide the CPU with the necessary instructions to change the user recognizable utility commands and program statements into binary machine codes.

4A-4. LOCAL MEMORY

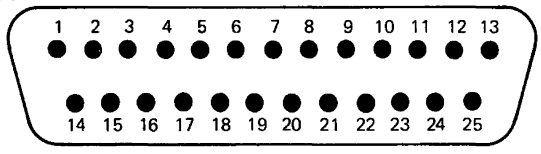
4A-5. The CPU Module intercepts memory addresses generated by its microprocessor within the upper 2048 words of address space for use on the module. Half of this is assigned to permanent read-only memory (ROM) located on the CPU module. The standard program factory recorded in this memory performs a functional test of each hardware module at start-up and then loads FDOS from the System Device into Main Memory. Since this ROM memory is in sockets, special purpose ROM components can be substituted to augment troubleshooting procedures. Refer to the 1720A Instrument Controller Service Manual for further detail.

4A-6. Of the remaining 1024 words, 256 are assigned to a local scratchpad memory, and 768 are set aside for directly addressing other modules in the system. This technique of addressing a hardware module through a memory location is called memory-mapped I/O.

4A-7. THE SERIAL PORTS

4A-8. The CPU Module includes two serial interfaces that conform to EIA Standard RS-232-C for Data Terminal Equipment. These ports are assigned the names KB1: and KB2: respectively by FDOS. Table 4A-1 lists the pin connections for these ports with a summary description of each pin function.

Table 4A-1. RS-232-C Serial Data Ports (KB1: and KB2:)



(MALE PINS)

PIN	NAME	DIRECTION	MEANING
1	GND	---	Ground. See below.
2	$\overline{\text{XMT}}$	OUT	Transmitted Data. (Low = 1)
3	$\overline{\text{REC}}$	IN	Received Data. (Low = 1)
4	RTS	OUT	Request To Send. Asserted (high) during data transmission.
5	CTS	IN	Clear To Send. Must be high or open for data to be transmitted. May be used to stop transmission on character boundaries by switching to low (nominal -12V).
6	DSR	IN	Data Set Ready. Not required by current driver software.
7	RET	---	Signal Return. Zero-voltage reference point for all other signals.
11	---	OUT	Unassigned. Always high. (+12V through 4700 ohms)
12	SCD	IN	Secondary Carrier Detect. Must be high or open for data to be transmitted. May be used to stop transmission on character boundaries by switching to low (nominal -12V).
19	SRTS	OUT	Secondary Request To Send. Always high (+12V through 4700 ohms)
20	DTR	OUT	Data Terminal Ready. Always high. (+12V through 4700 ohms)

4A-9. Grounding

4A-10. Pin 1 of an RS-232-C cable supplied by Fluke is connected to the cable shield. This pin is not a reference point for signals. Its purpose is to connect the cable shield to a system ground. Make sure that use of this connection does not result in circular grounding paths (loops) through the system. Such ground loops can conduct current of enough magnitude to interfere with data transmission.

4A-11. In the 1720A, Pin 1 of Serial Port 1 is connected to Pin 1 of Serial Port 2, and then to a jumper point on the board just to the right of Serial Port 2. This jumper connects Pin 1 of both ports to the system chassis ground. Cutting the jumper disconnects both cable shields from the 1720A chassis, but they remain interconnected. In general it is good practice to ground only one end of each cable shield to avoid circular ground paths.

4A-12. Signal Characteristics

4A-13. RS-232-C uses larger voltages than standard logic levels, and they swing both positive and negative. Data 0 and logic true are represented by a range from +3V to +25V, nominally +12V. Data 1 and logic false are represented by a range from -3V to -25V, nominally -12V. The rate of change of these voltages is limited to 30 volts per microsecond,maximum.

4A-14. The 1720A serial port output lines are nominally ±12V. The can withstand shorting to ground or being connected to an opposing output without damage. They are designed for a DC load between 3000 ohms and 7000 ohms, with a capacitive load of less than 2500 picofarads. They are not designed for inductive loads, and cannot drive a relay coil. The capacitive loading restriction generally limits cable lengths to about fifteen meters. Special low capacitance cables, however, can extend this limit to 50 meters or more.

4A-15. The 1720A serial port input lines can withstand ±30V inputs and are set for an input threshold level of 0.75V. An open input line is interpreted as high.

4A-16. Parameters

4A-17. The start-up condition of the serial ports, when not modified by SET commands in a system command file, is as follows:

Baud Rate	S1 setting
Data Bits per Character	8
Parity	None
Stop Bits per Character	1
End-of-Line Code	10 (line feed)
End-of-File Code	26 ((CTRL Z))

4A-18. Rotary switch S1 is located on the CPU module near the connector for Serial Port 2. This switch is factory set for 300 baud. It is relatively simple to prepare a system command file containing SET commands that change any of the port parameters, independently of each other, automatically at start-up time. For this reason, the setting of S1 is normally of no concern to the user.

4A-19. External Terminal

4A-20. When the Video Interface Module is removed, the console device (KBØ:) defaults to Serial Port 2. This feature allows an external terminal to be used as console if the Video Interface Module, the programmer keyboard, or the display fails. This procedure should be considered a temporary remedy only while the failure is being repaired. In this case, the setting of switch S1 becomes important.

CAUTION

The internal modules contain MOS circuitry that is easily damaged by static electricity. The following procedure should be performed only by qualified service personnel familiar with the handling of MOS circuits. Specifically, the case and the technician must be grounded and interconnected. The modules must be handled only by the edges and wrapped in a conductive protective wrap when not installed. This procedure must not be performed in a low humidity environment. Failure to observe these precautions will, at the discretion of John Fluke Mfg. Co., Inc., violate the terms of the warranty as well as any service contract. Refer to the 1720A Instrument Controller Service Manual for additional information.

4A-21. The procedure for using an external terminal as the 1720A console device (KBØ:) is:

1. Turn power OFF.

2. Remove the rear card cage cover (3 screws) using a #1 Phillips screwdriver. Facing the rear, this is the left half-panel.

3. Remove the Video Interface Module and place it in a conductive protective wrap.

4. Slide the CPU Module out approximately 3 cm.

5. Set rotary switch S1 to a baud rate that is compatible with the terminal. See Table 4A-2.

6. Press the CPU Module fully back into place.

7. Install the rear card cage cover.

8. Connect the terminal to serial port 2.

9. Turn Power ON.

10. The terminal will now be addressed by FDOS as KBØ.

Table 4A-2. CPU S1 Settings

POSITION	BAUD RATE	POSITION	BAUD RATE
0	110	4	1200
1	150	5	2400
2	300	6	4800
3	600	7	9600

Section 4B
Main Memory Module

4B-1. INTRODUCTION

4B-2. The Main Memory Module provides a high speed direct access storage medium for system software, user programs, and data. It is constructed of 36 dynamic RAM IC's that each store 16,384 bits, for a total capacity of 65,536 bytes or 32,768 words. Each byte includes an additional parity bit for error detection. Refreshing of the volatile dynamic storage cells is performed by on-board refresh timing circuitry that is transparent to the rest of the system. The module can transfer data in either a byte (8-bit) or word (16-bit) mode. Processor instruction fetches are in word mode, while some types of data are transferred in byte mode.

4B-3. MEMORY ALLOCATION

4B-4. The allocation of memory space is application dependent. The following discussion using the Fluke Enhanced BASIC Interpreter provides a useful perspective.

4B-5. Figure 4B-1 illustrates the general allocation of memory space during a running BASIC program. After studying the memory map, the trade-offs in optimizing use of this resource become apparent. Memory overflow occurs when either the data being collected by the program or an editing step attempts to use memory area in use by the interpreter stack. This stack stores return location and status information needed by the BASIC interpreter. It grows downward as required and retreats upward as tasks are completed. Variables and their data contents being used and collected by the program grow upward from the program area as needed. Should an overflow condition occur during a program run, the following may offer a solution. This discussion covers two possible causes of overflow: program size, and data overflow.

4B-6. Program Size

4B-7. Without allowing for variable data storage, there is room for about 24,000 characters (bytes) in a program. For an average statement length of between 10 and 15 characters, this works out to be somewhere between 1500 and 2400 program statements. If the program is that large, try restructuring it to make greater use of subroutines, or breaking it into separable tasks that can be chained together with RUN statements. Refer to the 1720A Fluke-Enhanced BASIC Programming Manual for techniques.

4B-8. Data Overflow

4B-9. Several options exist for the handling of data. Even if the program is going to modify the data after collection, try opening a channel to a virtual array on the floppy disk, or the optional high speed electronic disk. This will keep the data from accumulating in memory. Movements of large strings (e.g. A$=B$) will temporarily occupy the interpreter stack, an occasional cause of overflow condition during a program run. Also, see that programs do not dimension data arrays larger than the application really requires, and that space consuming string variables are de-allocated when no longer needed.

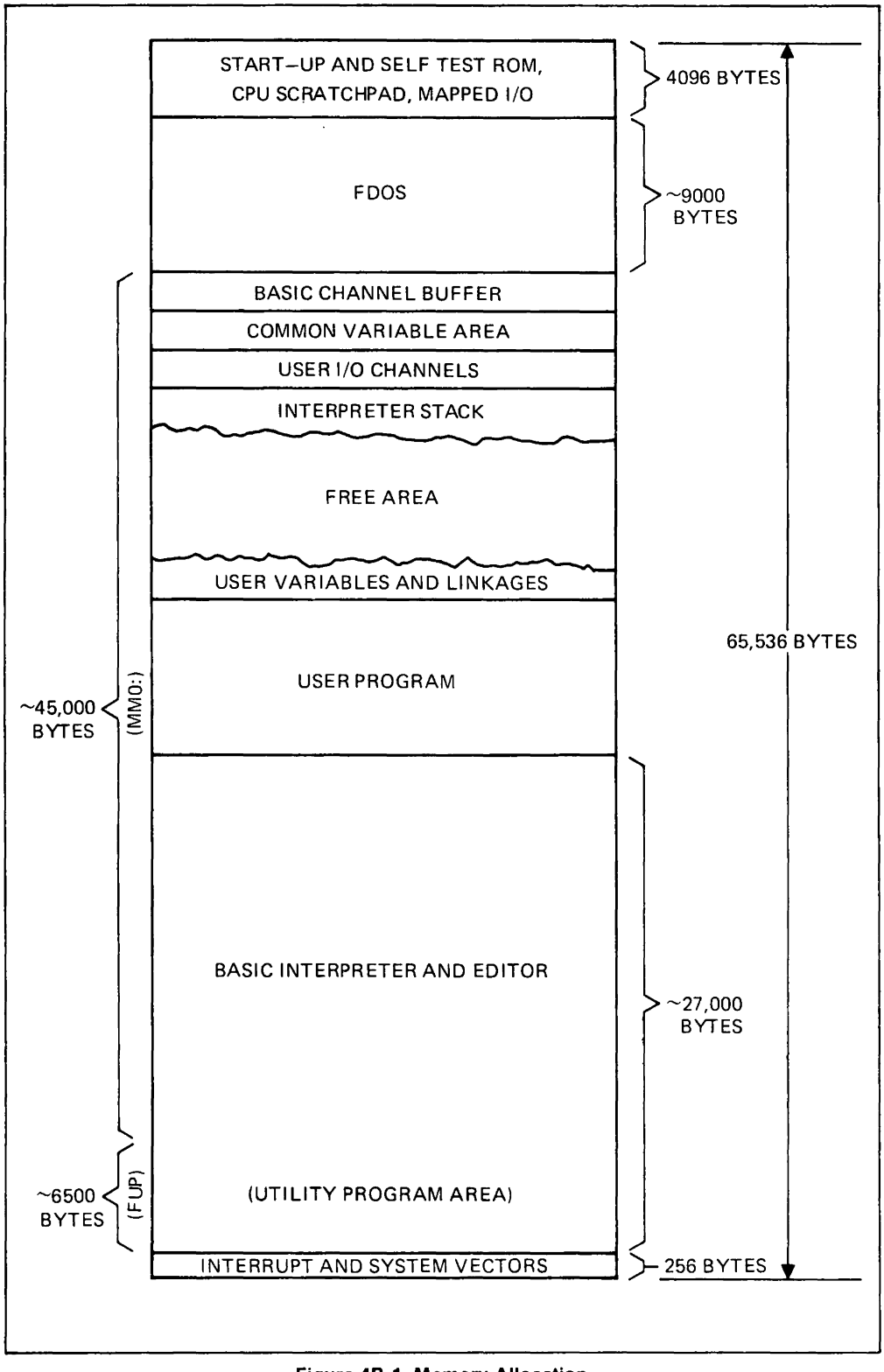


Figure 4B-1. Memory Allocation

Section 4C
Video Interface and Keyboard Module

4C-1. INTRODUCTION

4C-2. The Video Interface Module performs two main functions within the 1720A Instrument Controller:

1. Generates and controls all display functions in response to instructions from the CPU Module.

2. Receives inputs from the programmer keyboard and the touch sensitive panel overlaying the display, and interrupts the CPU module to pass them on.

4C-3. This module runs independent of the CPU Module, except for the passing of data and instructions. The design includes a separate microprocessor with local program and data memory, an LSI display controller, and a high speed on-board display refresh memory. The microprocessor performs a parallel scan of the programmer keyboard and the touch-sensitive display while handling screen formatting and all communications with the CPU module. The LSI display controller scans an on-board display memory, generates dot-patterns from a character ROM, and keeps the screen continually refreshed with information stored in an on-board memory. In graphics mode, character pattern information is supplied to the LSI display controller from alternate circuitry.

4C-4. On-board ROM programming for the microprocessor defines the characteristics and responses of the display to inputs from the user program. In general, these conform to subsets of recognized industrial standards. The discussion that follows covers these standards.

4C-5. ASCII 3.4-1968

4C-6. Table 4C-1 is a chart of ASCII codes as used by the 1720A Instrument Controller display. The left column depicts the actual display response for each ASCII code. Codes numbered decimal 0 through 31 that come from the programmer keyboard (by use of the CTRL key) are passed on to the CPU module unchanged, but are not displayed. In their place is displayed a block character (number 127) unless the code caused the CPU Module to return instructions to clear the screen. Exceptions are control codes C, P, and Z, which are displayed as ^C, ^P, and ^Z respectively.

4C-7. To send the display a code in the range of 0 through 31, it must come from the CPU Module. For example, using BASIC, the statement PRINT CHR$(27) will send the display an ESCape code. Note that the symbols available are different from the graphics mode characters presented in this section. These symbols can be enhanced with such things as high intensity or blinking just as any other character. Graphics mode characters cannot be enhanced.

4C-8. Figure 4C-1 is a short program that will display all of the displayable characters in double-size format. Type the program while in BASIC, and then type RUN followed by RETURN . The block, character number 127, is displayed in place of all control characters that are not displayable. The space character is just left of the !. Touch the screen to clear the display.

```
10   E$=CHR$(27)+"["\BL$=CHR$(127)
20   PRINT E$+"1p";CPOS(2,5);BL$:
30   FOR I=1 TO 6\PRINT CHR$(I);\NEXT I
40   FOR I=7 TO 13\PRINT BL$;\NEXT I
50   FOR I=14 TO 26\PRINT CHR$(I);\NEXT I\PRINT BL$;
60   FOR I=28 TO 31\PRINT CHR$(I);\NEXT I
70   PRINT CPOS(4,5);\FOR I=32 TO 63\PRINT CHR$(I);\NEXT I
80   PRINT CPOS(6,5);\FOR I=64 TO 95\PRINT CHR$(I);\NEXT I
90   PRINT CPOS(8,5);\FOR I=96 TO 127\PRINT CHR$(I);\NEXT I
110  END
```

Figure 4C-1. Character Display Program

4C-9. ANSI X3.64-1977

4C-10. This document of the American National Standards Institute defines some control actions to be associated with certain sequences of ASCII codes. These control sequences are always introduced by an ESCape code, usually followed by a "[" character. When sent to the Video Interface Module from the CPU Module, a control action is initiated by the Video Interface. Table 4C-2 summarizes these control actions by type, and shows the associated code sequence.

Table 4C-2. ANSI Control Sequences

TYPE	ACTION	CODE SEQUENCE
CURSOR CONTROLS	Up n lines	⟨ESC⟩ [n A
	Down n lines	⟨ESC⟩ [n B
	Right n columns	⟨ESC⟩ [n C
	Left n columns	⟨ESC⟩ [n D
	Direct to line, column	⟨ESC⟩ [l ; c H
	Scroll down 1 line	⟨ESC⟩ D
	Scroll up 1 line	⟨ESC⟩ M
	Scroll to start next line	⟨ESC⟩ E
ENHANCEMENTS	Off	⟨ESC⟩ [m
	High intensity	⟨ESC⟩ [1 m
	Underline	⟨ESC⟩ [4 m
	Blinking	⟨ESC⟩ [5 m
	Reverse image	⟨ESC⟩ [7 m
MODES	Normal size	⟨ESC⟩ [p
	Double size	⟨ESC⟩ [1 p
	Graphics off	⟨ESC⟩ [2 p
	Graphics on	⟨ESC⟩ [3 p
	Enable keyboard	⟨ESC⟩ [4 p
	Disable keyboard	⟨ESC⟩ [5 p

Table 4C-2. ANSI Control Sequence (cont)

TYPE	ACTION	CODE SEQUENCE
ERASING	To end of line	⟨ESC⟩ [K
	To start of line	⟨ESC⟩ [1 K
	All of line	⟨ESC⟩ [2 K
	To end of display	⟨ESC⟩ [J
	To start of display	⟨ESC⟩ [1 J
	All of display	⟨ESC⟩ [2 J
CURSOR STATUS	Request cursor position	⟨ESC⟩ [6 n
	Cursor position report	⟨ESC⟩ [l ; c R
EXTERNAL LINE CONTROL	All lines off	⟨ESC⟩ [q
	Line 1 on	⟨ESC⟩ [1 q
	Line 2 on	⟨ESC⟩ [2 q
	Line 3 on	⟨ESC⟩ [3 q
	Line 4 on	⟨ESC⟩ [4 q
	Line 5 on	⟨ESC⟩ [5 q
	Line 6 on	⟨ESC⟩ [6 q
	Line 7 on	⟨ESC⟩ [7 q

4C-11. Cursor Controls

4C-12. Cursor control sequences allow the user to move the display cursor to any position on the screen, either relative to its current position, or absolutely, by designating line and column. Scrolling commands allow movement of the entire display up or down one line at a time when movement goes beyond an edge. A cursor control sequence produces immediate results, and does not occupy a display location. Cursor controls will not move the cursor beyond the display boundaries, except that scrolling commands will cause a one-line scroll when the cursor is already at a top or bottom boundary.

4C-13. The following Fluke BASIC statement will move the cursor right 3 columns. Note the final semicolon to inhibit the usual Carriage Return and Line Feed codes following a BASIC PRINT statement.

```
PRINT CHR$(27)+"[3C";
```

4C-14. Enhancements

4C-15. Display enhancements are used to draw attention to a word or portion of the displayed message. Four different enhancements are available: high intensity, underlining, blinking, and reverse image. Enhancement commands occupy one character position on the display screen and define a display mode for all characters that follow until another enhancement command is encountered. Overwriting a display location containing an enhancement command will delete the enhancement. Each enhancement command cancels all previous enhancements.

4C-16. Multiple enhancements can be used simultaneously by separating the enhancement numbers with semicolons. A multiple enhancement command occupies one display location. For example:

```
PRINT CHR$(27)+'[1;4;5m";
```

4C-17. Since the refresh scanning rate of the display exceeds the 4800 baud rate at which characters are written into the display memory, underlining and reverse image commands

will momentarily cause the entire remaining display to have underlines or light background until the enhancements-off command is written. This problem can be avoided by positioning the cursor to place the enhancements-off command, then backing up to place the desired enhancement command before the start of the words to be enhanced. The use of the Display Worksheet (Part Number 533547, pad of 50) will make positioning the cursor easier. When planning an enhanced display that uses this technique, remember that the cursor spaces forward one place after each enhancement command, just as it does for any other character.

4C-18. Modes

4C-19. Mode selections cover three different areas: character size, the alternate graphics characters, and disabling of keyboard inputs. They may be intermixed with other display control commands, but, as explained below, the sequence can sometimes make a difference. They do not occupy a character position on the display.

4C-20. Character size is changed by controlling the display raster scan timing. For this reason it is available only as an attribute of the entire display. Character size commands clear the screen, set the entire screen to the selected character size, and move the cursor to the upper left (home) position. Normal size is 16 lines of 80 characters each. Double size is 8 lines of 40 characters each.

4C-21. If it is planned to both position the cursor and change the character display size, the program should first change the display size, and then position the cursor. This sequence is necessary because these commands return the cursor to the home position, and because cursor positioning relates to the current size mode.

4C-22. Graphics mode substitutes block graphics characters generated from alternate circuitry for the numbers 0 through 9, and the : character. Table 4C-3 shows the graphics mode characters in normal and double size. When graphics mode is enabled, these characters are displayed from alternate pattern generation circuitry whenever the numbers 0 through 9, or the : are sent to the screen. Because they are not part of the character set in the ROM, they cannot be enhanced.

4C-23. Note the names assigned to each character. Although it is not immediately obvious from looking at the character shapes, there is a correlation between single and double size characters that allow a graphics display to be set up that will change only in size and not in shape as the display mode is changed between normal and double size. This means, for example, that a display subroutine should use a 2 instead of a 6 for a normal size lower right corner. That way if the display is later changed to double size it will still be a lower right corner. Some attention to this detail will produce graphics code subroutines that are useful later for other projects.

4C-24. The program presented in Figure 4C-2 will display all of the graphics characters, first in normal size, and then, when the screen is touched, in double size. Touching the screen again will clear the display. Type it while in BASIC and then type RUN followed by RETURN.

```
10   E$=CHR$(27)+"["\CL$=E$+"2J"
20   PRINT CL$;E$+",3p";CPOS(8,24);\GOSUB 50
30   PRINT CL$;E$+"1;3p";CPOS(4,5);\GOSUB 50
40   PRINT E$+";2p";CL$\GOTO 70
50   PRINT "0 1 2 3 4 5 6 7 8 9 :"
60   WAIT FOR KEY\K$=KEY\RETURN
70   END
```

Figure 4C-2. Graphics Character Display Program

Table 4C-3. Graphics Mode Characters

CHARACTER	NORMAL SIZE	DOUBLE SIZE	CHARACTER NAME
0			Top Right Corner
1			Top Left Corner
2			Bottom Right Corner
3			Bottom Left Corner
4			Top Intersect
5			Right Intersect
6			Left Intersect
7			Bottom Intersect
8			Horizontal Line
9			Vertical Line
:			Crossed Line

NOTES:
1. To enable Graphics Mode, send the display ESC [3p
2. To disable Graphics Mode, send the display ESC [2p
3. In Graphics Mode, characters in the left column are displayed as shown.
4. Use the character names as defined to construct illustrations that do not change form between normal and double size.

4C-25. Erasing

4C-26. Commands are provided to allow a program to erase part or all of any line or of the entire display. Partial erase commands are relative to the current cursor position. An erase control sequence produces immediate results, and does not occupy a display location. For example, the BASIC statement `PRINT CHR$(27)+"[2J"` will clear the display.

4C-27. Cursor Status

4C-28. Two control sequences are implemented. The sequence ⟨ESC⟩[6n sent from the CPU Module to the Video Interface requests a report of the current cursor position. The Video Interface returns that report to the CPU Module in the form ⟨ESC⟩[l;cR where l = line number and c = column number.

4C-29. External Line Control

4C-30. Seven external lines are available for software control through control sequences from the CPU Module to the Video Interface. Two of these are located on the

Remote Interface connector on the rear of the Power Supply Module. Five are located in the connector for the programmer keyboard. The drivers of these lines are industry standard TTL, capable of sinking 24 milliamperes, or sourcing 3 milliamperes. The two lines available at the rear Remote Interface connector have an additional 390 ohm series resistor, limiting sink current to approximately 10 milliamperes when used with a red light-emitting diode that is sourced from +5 volts. Table 4C-4 shows the location of each external line by connector and pin number.

Table 4C-4. External LED Lines

LINE #	CONNECTOR	PIN	LINE #	CONNECTOR	PIN
1	Keyboard	7	5	Keyboard	13
2	Keyboard	2	6	Remote Interface	11
3	Keyboard	21	7	Remote Interface	13
4	Keyboard	8			

4C-31. THE TOUCH SENSITIVE DISPLAY

4C-32. The touch-sensitive panel overlaying the face of the display is constructed of two layers of transparent flexible material. The two surfaces of this material that face together are slightly metalized for conductivity, and etched into horizontal and vertical bands. The result is a resistive switch contact matrix that responds to touch pressure. Decoding circuitry in the Video Keyboard Interface can separately identify any of 60 different areas on the display. The size of each touch sensing area or block is three double-size characters. These blocks are arranged in 6 rows of 10 each, numbered from upper left 1 through 60. The lines that the user sees on the overlay are the etch lines that form the boundaries of each touch sensitive block. A proper touch target is the center of a block.

4C-33. Operating System Software (FDOS) is notified by the Video Interface whenever a touch key has been pressed. The system variable KEY is maintained for use by other software modules, such as BASIC. This variable contains the number of the last touch key pressed, and remains set until it is read. For example, in BASIC, `K$=KEY` reads the system variable KEY.

4C-34. When a touch key is held down, it will repeat the same as a key on the programmer keyboard. The repeat rate is 15 per second. Unlike the programmer keyboard, touch sense keys have no provision for key rollover. This is the feature of a keyboard that allows a second (or more) key to be pressed before lifting the current one. Because touch keys do not have defined edges like a keyboard, multiple key rollover can cause erroneous multiple entries. Consequently, the Video Interface recognizes only one key when multiple keys are pressed.

4C-35. Figure 4C-3 illustrates the display worksheet, available in pads of 50 as Fluke part number 533547. Note that the touch sense blocks are shown overlaying both single and double-size display locations with the corresponding KEY number in the lower right corner of each block.

4C-36. THE PROGRAMMER KEYBOARD

4C-37. The keyboard provided with the 1720A Instrument Controller is designed primarily as a programming tool. The controller can be rack mounted easily because the keyboard is removable and there is an alternate method of operator response input through the touch-sensitive display.

4C-38. The keyboard generates the full 128-character ASCII code set. Not all of the keys are used at this time by the 1720A. This has been done to provide flexibility in future

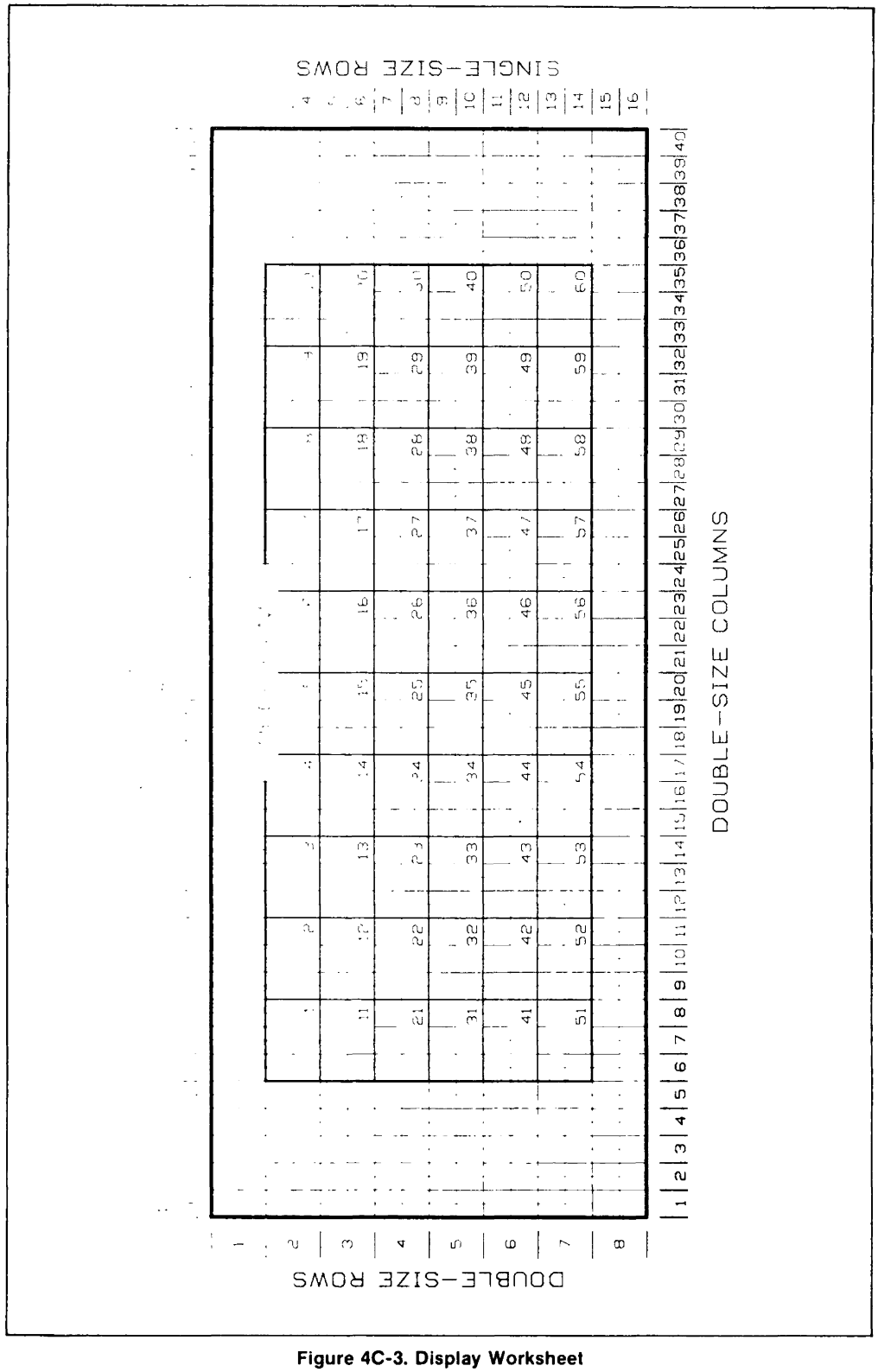


Figure 4C-3. Display Worksheet

applications. Two-key rollover and multiple key lockout is provided for unambiguous key response. All keys (except SHIFT and CTRL) will repeat at 15 per second when held down. An audible clicker identifies acceptance of each keystroke. The back of the keyboard case has provisions for holding its connecting cable. A cutout under the front edge provides a convenient carrying handle. Protective ridges moulded into the case allow the keyboard to be turned face down without damage to the keys.

4C-39. CTRL/SHIFT Keys

4C-40. The Video Interface Module interprets many keys that are modified by both CTRL and SHIFT simultaneously as additional system variable KEY inputs. These inputs are handled by EDOS in the same manner as a touch-sense key input, using the same system variable KEY. This variable contains the number of the last key input received by EDOS, and remains set until read. Table 4C-5 lists the CTRL SHIFT key inputs and their associated KEY values. Note that touch-sense KEY values are numbered 1 through 60, and CTRL SHIFT key inputs are numbered 61 and up. For example, in BASIC the statement `IF KEY > 60 THEN GOSUB 5000` will branch only if the last KEY entry was from a CTRL/SHIFT keyboard operation.

Table 4C-5. CTRL/SHIFT Keys

CTRL/SHIFT KEY	KEY NUMBER	CTRL/SHIFT KEY	KEY NUMBER
NEXT PAGE	61	6	91
Z	62	7	92
CAPS LOCK	64	(	93
TAB	65	)	94
Q	66	J	95
ESC	67	K	96
1	68	I	97
X	69	O	98
C	70	8	99
A	71	9	100
S	72	?	101
W	73	PAGE MODE	102
E	74	L	103
2	75	:	104
3	76	P	105
V	77	{	106
B	78	Ø	107
D	79	SPACE	109
F	80	"	111
R	81	\	112
T	82	}	113
4	83	DELETE	114
5	84	+	115
N	85	~	116
M	86	LINE FEED	118
G	87	RETURN	119
H	88	←	122
Y	89	BACK SPACE	123
U	90	↑	124

Section 4D
Floppy Disk and Interface

4D-1. INTRODUCTION

4D-2. The Floppy Disk Interface Module, together with the Floppy Disk Drive, provide the user with a file structured bulk storage medium that can be removed for a permanent record. Since system software is initially loaded from disk, updating a system to take advantage of newer software is simply a matter of inserting a different System Disk. The portability afforded to user programs allows the development ofstandardized test procedures that work identically for every instrument controller. The non-volatility of a disk allows the creation of permanent records for such applications as a calibration laboratory.

4D-3. In addition, the Floppy Disk Interface Module includes the Real-Time Clock used in numerous ways where time-of-day is required. The clock is discussed later in this subsection.

4D-4. DATA ORGANIZATION

4D-5. Programs and data on a floppy disk are organized as a sequence of 350 (512-byte) blocks. A directory is maintained in the first two blocks that enables FDOS to locate each file by its assigned name. The disk interface converts the sequential block number to a track and sector address.

4D-6. A track is one of 35 distinct radial distances from the center of the disk and is accessed by step movements of the read/write head. Data on the disk is therefore organized into concentric circles. Each track contains ten blocks or 5120 bytes of data.

4D-7. There are 10 pie-shaped radial subdivisions on a disk that divide each track into 10 sectors. An index hole punched in the disk identifies the start point for numbering the sectors. The 10 sectors on each track each contain one block or 512 bytes or data.

4D-8. Any block of data on a floppy disk can be located by positioning the head to the required track and reading sector numbers until the required one is found. Formatting a disk, one of the FUP functions presented earlier, is the process of preparing a disk for data by writing track and sector identification numbers, followed by a standard data pattern, throughout the disk surface. When reading or writing data on the disk, the DMA Floppy Interface always positions the head in or out the necessary number of steps. It then compares both track and sector identification from the disk with the desired track and sector address. When a match is found, it proceeds with the read or write operation.

4D-9. The largest file that can be put on a disk is the full capacity less two blocks for the directory. That works out to (348 blocks) X (512 bytes/block) or 178,176 bytes maximum file size. The smallest file that can be put on a disk is one block, or 512 bytes. However, the maximum number of files is limited by the size of the directory to 72.

4D-10. FILE ACCESS TIME

4D-11. The Floppy Disk Interface Module uses a direct memory access (DMA) technique to transfer programs and data to and from the Main Memory Module. Processor control of the internal bus is intermittently suspended in favor of the disk interface for a direct memory byte transfer. The result is a block transfer rate of 15,625 bytes per second, and an average transfer rate over a file of 25 blocks per second. This is the full transfer rate of the disk drive itself, as the DMA process easily outpaces the drive.

4D-12. If 16 seconds elapse during which no disk access has been made, the drive motor is turned off to extend its life as well as that of the head and the disk. The first access after a turn-off is delayed approximately one second while the disk comes up to speed.

4D-13. In addition, there is an average file seek time before data transfer starts, as the head moves to the proper track and locates the desired data block. Based upon an average head movement of 17.5 tracks, and an average rotation of 180 degrees, this time is about 0.55 second.

4D-14. FLOPPY DISKS

4D-15. Fluke makes available ten-packs of unformatted blank floppy disks which have been manufactured and certified to Fluke standards.

NOTE

Performance of the 1720A Controller to published specifications can be ensured only by using Fluke Accessory Number Y1706 floppy disks, or a Fluke-approved equivalent. Contact any Fluke Sales or Service Office for information.

4D-16. Refer to Figure 4D-1. The disk drive has a sense switch along each side of the disk slot. When fully inserted, one of them falls into the write enable notch, unless it has

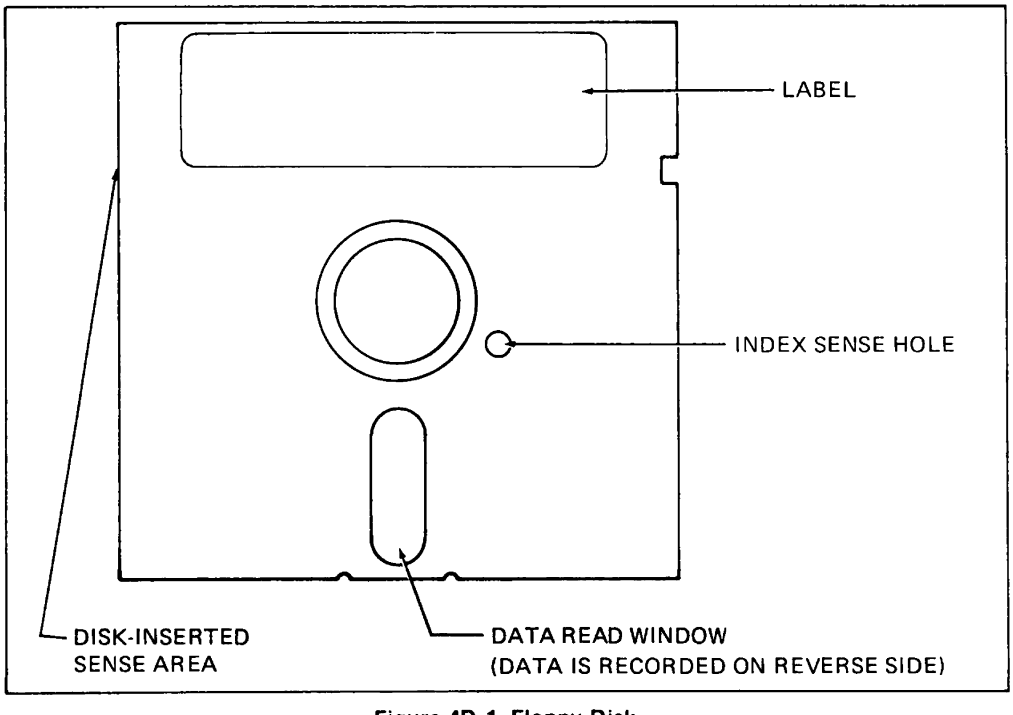


Figure 4D-1. Floppy Disk

been covered over with a write protect tab. The other switch along the opposite side is used to sense the presence of the disk.

4D-17. Three floppy disks are supplied with the 1720A Instrument Controller. The System Disk contains FDOS, a programming language, and the standard set of utility programs. The Diagnostic Disk contains the programs that are used by the diagnostic procedures in the 1720A Service Manual. The Data Disk is a formatted blank disk.

4D-18. THE REAL-TIME CLOCK

4D-19. The Floppy Disk Interface Module includes a Real-Time Clock that allows a program to label data files with date and time-of-day, to measure elapsed time, and to display or use this information in other ways. In addition, FDOS labels each directory entry with the date the file was created.

4D-20. Refer to the discussion in Section 3 on the TIME utility program for setting this function with the proper date and time. Once set, it is correct until February 29 of the next leap year, when it will have to be manually set. The internal battery will keep the clock running at least two months before requiring recharge, if the power is turned off for that long.

4D-21. Note that if an external battery is used the internal battery should be disconnected from the system. Whenever the external battery is disconnected, the clock will turn off and require resetting.

4D-22. The system can operate with the internal battery disconnected and without an external battery. In this case, it is necessary to reset the time and date, using the TIME utility, whenever the system is tuned on.

4D-23. An added feature of the Real Time Clock is a status flag that is set whenever power is first applied, and reset whenever the time and date are set. The flag is checked whenever the TIME utility is entered from within an active system command file. If it is reset, control is returned directly to CONMON, and to the next system command file line, without requiring any input. This allows a system command file to be set up with a T command that will not require a keyboard response unless power to the clock had been interrupted.

Section 4E
Optional Electronic Disk Modules

4E-1. INTRODUCTION

4E-2. The optional electronic disk is a one or two module memory system designed to provide fast access file storage. It functions just like the floppy disk, differing only in capacity and speed. Electronic disk files must be transferred to the floppy disk for permanent storage. Like a disk, it contains a file directory and must be formatted (using FUP) before it can be used. Program files must be transferred to the Memory Module before they can be executed. Data files can be directly accessed through virtual array channels.

4E-3. DATA ORGANIZATION

4E-4. Programs and data on the electronic disk are organized as a sequence of 256 512-byte blocks. Adding the second module, the maximum allowable, expands this to 512 blocks. This second module results in a larger electronic disk, rather than two of them. This relieves concern over which electronic disk contains a given file, and allows the storage of files larger than one electronic disk. A two-module system can handle a file larger than the capacity of the floppy disk. A single directory in the first two blocks of the first module functions as the directory for both modules.

4E-5. The largest file that can be put on the electronic disk is the full capacity less two blocks for the directory. For one module, that works out to (254 blocks) X (512 bytes/block) or 130,048 bytes. A two-module system has a maximum file capacity of (510 blocks) X (512 bytes/block) or 261,120 bytes.

4E-6. The smallest file that can be put on the electronic disk is one block, or 512 bytes. However, the number of files is limited by the size of the directory to a maximum of 72.

4E-7. Although a single module is 73% of the capacity of the floppy disk, it can be used to create back-up copies of floppy disks as long as no single file exceeds 254 blocks (130,048 bytes) in size. See the discussion of the FUP /W command in Section 3.

4E-8. An electronic disk is needed to create back-up floppy disks whenever any single-file size exceeds the memory capacity available for this function (approximately 85 blocks). A two-module electronic disk is needed to create back-up floppy disks whenever any single-file size exceeds 254 blocks (130,048 bytes).

4E-9. FILE ACCESS TIME

4E-10. Access time to an electronic disk file before data transfer can proceed is 18 microseconds. Thereafter data transfer proceeds at the rate of 260 blocks (133,120 bytes) per second, or at the rate the other device can accept the transfer. For a program load, which proceeds at full speed, that is equivalent to filling the entire contents of the Main Memory Module in less than 0.5 second.

4E-11. BATTERY BACK-UP

4E-12. The electronic disk will hold its contents intact when the 1720A Controller is powered down, provided the E-DISK BATTERY switch on the power supply is set to ENABLE and there is an internal or external source of battery power. A fully charged internal battery will support a single electronic disk module for approximately 1 hour or two electronic disk modules for about 30 minutes. Voltage sensing circuitry in the power supply determines when the battery has significantly discharged, and disconnects it from electronic disk back-up so that the internal time clock may continue to run.

4E-13. If battery back-up of the electronic disk will not be used, battery life can be extended by leaving the feature disabled. This prevents the battery from having to discharge and recharge regularly.

4E-14. SWITCH SETTINGS

4E-15. Electronic disk modules are identical except for a switch that identifies the module as first or second. They may be installed in either or both of the spare circuit board slots. The only requirement is that a single module must be designated as first, and that two modules must not be designated the same. Refer to Figure 4E-1, E-Disk Switch Settings.

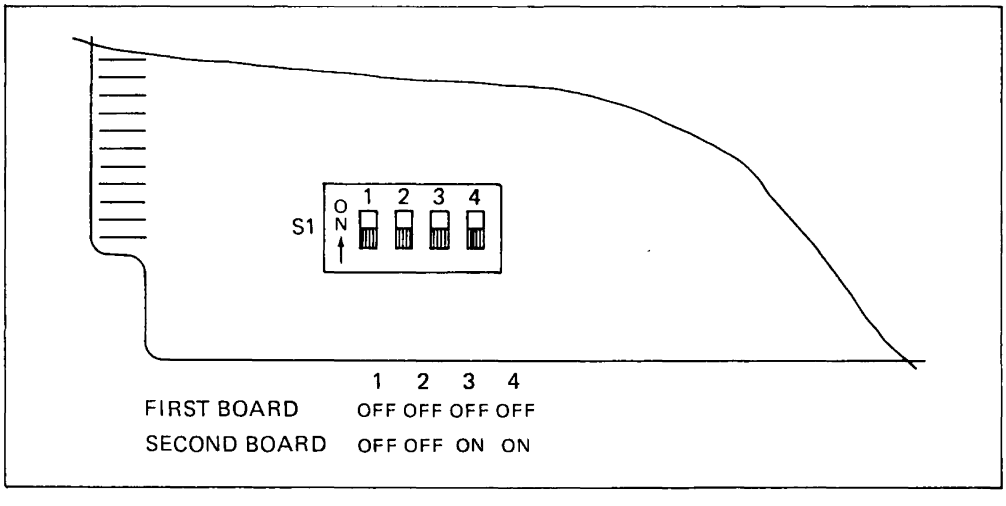


Figure 4E-1. E-Disk Select Switch Position

Section 4F
Dual IEEE-488 Interface Module

4F-1. INTRODUCTION

4F-2. Industrial instrumentation control is the primary design focus of the 1720A Instrument Controller. The dual IEEE-488-1978 (GPIB) interface supplied standard with each controller enables the 1720A to effectively function as two independent controllers for as many as 28 instruments on different IEEE-488 busses.

4F-3. FEATURES

4F-4. The availability of two separate IEEE-488 buses allows instruments to be isolated from each other. This can be a significant advantage in a number of ways. The major advantage is when the bus must connect to a device being tested. Separate buses allow the suspect device to be functionally separated from other instrumentation participating in the test. In addition, there is often a noticable speed advantage in separating devices that respond slowly to bus protocols from higher speed instruments.

4F-5. All standard controller functions defined in subsets C1 through C4 and C6 of the IEEE-488-1978 standard are implemented. Data transfer can be in any code acceptable to system software. Each port is switch set to System Controller, able to assert Interface Clear. Each port also includes readback circuitry for diagnostic self-testing.

4F-6. With current system software, this interface is designed to function as System Controller. The 1720A will not function as a listener or talker without also being System Controller. The 1720A also will not pass control to another controller on the same bus.

4F-7. Table 4F-1 lists ASCII codes and their corresponding Bus messages. Refer also to the appropriate programming language manual for Bus message sequences that have been standardized for instrument control.

Table 4F-1. ASCII/IEEE-488-1978 Bus Codes

ASCII	DECIMAL	OCTAL	HEX	BINARY 7654 3210	MESSAGE (ATN = TRUE)		DEV. NO.	ASCII	DECIMAL	OCTAL	HEX	BINARY 7654 3210	MESSAGE (ATN = TRUE)		DEV. NO.
NUL	0	000	00	0000 0000	ADDRESSED COMMANDS	——		@	64	100	40	0100 0000	TALK ADDRESSES	MTA	0
SOH	1	001	01	0000 0001		GTL		A	65	101	41	0100 0001		MTA	1
STX	2	002	02	0000 0010		——		B	66	102	42	0100 0010		MTA	2
ETX	3	003	03	0000 0011		——		C	67	103	43	0100 0011		MTA	3
EOT	4	004	04	0000 0100		SDC		D	68	104	44	0100 0100		MTA	4
ENQ	5	005	05	0000 0101		PPC		E	69	105	45	0100 0101		MTA	5
ACK	6	006	06	0000 0110		——		F	70	106	46	0100 0110		MTA	6
BEL	7	007	07	0000 0111		——		G	71	107	47	0100 0111		MTA	7
BS	8	010	08	0000 1000		GET		H	72	110	48	0100 1000		MTA	8
HT	9	011	09	0000 1001		TCT		I	73	111	49	0100 1001		MTA	9
LF	10	012	0A	0000 1010		——		J	74	112	4A	0100 1010		MTA	10
VT	11	013	0B	0000 1011		——		K	75	113	4B	0100 1011		MTA	11
FF	12	014	0C	0000 1100		——		L	76	114	4C	0100 1100		MTA	12
CR	13	015	0D	0000 1101		——		M	77	115	4D	0100 1101		MTA	13
SO	14	016	0E	0000 1110		——		N	78	116	4E	0100 1110		MTA	14
SI	15	017	0F	0000 1111		——		O	79	117	4F	0100 1111		MTA	15
DLE	16	020	10	0001 0000	UNIVERSAL COMMANDS	——		P	80	120	50	0101 0000		MTA	16
DC1	17	021	11	0001 0001		LLO		Q	81	121	51	0101 0001		MTA	17
DC2	18	022	12	0001 0010		——		R	82	122	52	0101 0010		MTA	18
DC3	19	023	13	0001 0011		——		S	83	123	53	0101 0011		MTA	19
DC4	20	024	14	0001 0100		DCL		T	84	124	54	0101 0100		MTA	20
NAK	21	025	15	0001 0101		PPU		U	85	125	55	0101 0101		MTA	21
SYN	22	026	16	0001 0110		——		V	86	126	56	0101 0110		MTA	22
ETB	23	027	17	0001 0111		——		W	87	127	57	0101 0111		MTA	23
CAN	24	030	18	0001 1000		SPE		X	88	130	58	0101 1000		MTA	24
EM	25	031	19	0001 1001		SPD		Y	89	131	59	0101 1001		MTA	25
SUB	26	032	1A	0001 1010		——		Z	90	132	5A	0101 1010		MTA	26
ESC	27	033	1B	0001 1011		——		[	91	133	5B	0101 1011		MTA	27
FS	28	034	1C	0001 1100		——		\	92	134	5C	0101 1100		MTA	28
GS	29	035	1D	0001 1101		——		]	93	135	5D	0101 1101		MTA	29
RS	30	036	1E	0001 1110		——		^	94	136	5E	0101 1110		MTA	30
US	31	037	1F	0001 1111		——		—	95	137	5F	0101 1111		UNT	
SP	32	040	20	0010 0000	LISTEN ADDRESSES	MLA	0	`	96	140	60	0110 0000	SECONDARY ADDRESSES	MSA	0
!	33	041	21	0010 0001		MLA	1	a	97	141	61	0110 0001		MSA	1
"	34	042	22	0010 0010		MLA	2	b	98	142	62	0110 0010		MSA	2
#	35	043	23	0010 0011		MLA	3	c	99	143	63	0110 0011		MSA	3
$	36	044	24	0010 0100		MLA	4	d	100	144	64	0110 0100		MSA	4
%	37	045	25	0010 0101		MLA	5	e	101	145	65	0110 0101		MSA	5
&	38	046	26	0010 0110		MLA	6	f	102	146	66	0110 0110		MSA	6
'	39	047	27	0010 0111		MLA	7	g	103	147	67	0110 0111		MSA	7
(	40	048	28	0010 1000		MLA	8	h	104	150	68			MSA	8
)	41	049	29	0010 1001		MLA	9	i	105	151	69	0110 1001		MSA	9
*	42	050	2A	0010 1010		MLA	10	j	106	152	6A	0110 1010		MSA	10
+	43	051	2B	0010 1011		MLA	11	k	107	153	6B	0110 1011		MSA	11
,	44	054	2C	0010 1100		MLA	12	l	108	154	6C	0110 1100		MSA	12
-	45	055	2D	0010 1101		MLA	13	m	109	155	6D	0110 1101		MSA	13
.	46	056	2E	0010 1110		MLA	14	n	110	156	6E	0110 1110		MSA	14
/	47	057	2F	0010 1111		MLA	15	o	111	157	6F	0110 1111		MSA	5
0	48	060	30	0011 0000		MLA	16	p	112	160	70	0111 0000		MSA	16
1	49	061	31	0011 0001		MLA	17	q	113	161	71	0111 0001		MSA	17
2	50	062	32	0011 0010		MLA	18	r	114	162	72	0111 0010		MSA	18
3	51	063	33	0011 0011		MLA	19	s	115	163	73	0111 0011		MSA	19
4	52	064	34	0011 0100		MLA	20	t	116	164	74	0111 0100		MSA	20
5	53	065	35	0011 0101		MLA	21	u	117	165	75	0111 0101		MSA	21
6	54	066	36	0011 0110		MLA	22	v	118	166	76	0111 0110		MSA	22
7	55	067	37	0011 0111		MLA	23	w	119	167	77	0111 0111		MSA	23
8	56	070	38	0011 1000		MLA	24	x	120	170	78	0111 1000		MSA	24
9	57	071	39	0011 1001		MLA	25	y	121	171	79	0111 1001		MSA	25
:	58	072	3A	0011 1010		MLA	26	z	122	172	7A	0111 1010		MSA	26
;	59	073	3B	0011 1011		MLA	27	{	123	173	7B	0111 1011		MSA	27
<	60	074	3C	0011 1100		MLA	28	|	124	174	7C	0111 1100		MSA	28
=	61	075	3D	0011 1101		MLA	29	}	125	175	7D	0111 1101		MSA	29
>	62	076	3E	0011 1110		MLA	30	~	126	176	7E	0111 1110		MSA	30
?	63	077	3F	0011 1111		UNL		DEL	127	177	7F	0111 1111			

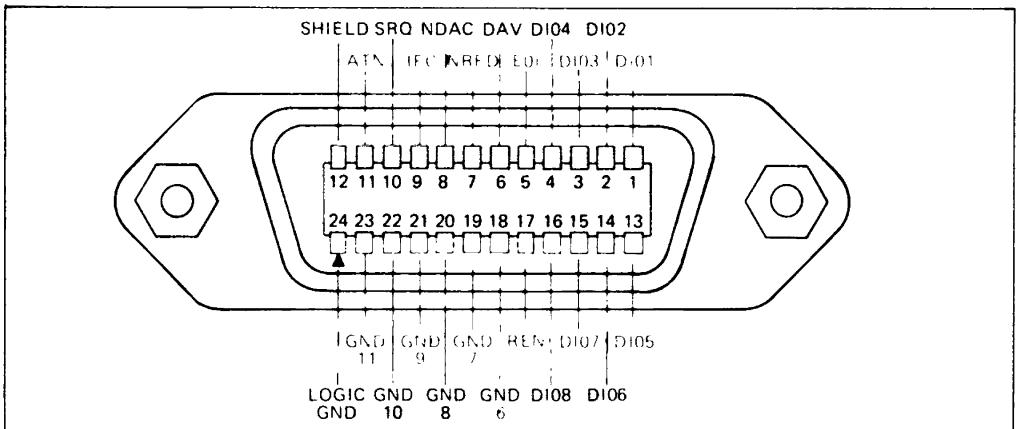
4F-8. Table 4F-2 lists the pin connections for the IEEE-488 instrument ports. These connections can be functionally divided into three groups: the Data Bus, the Management Bus, and the Transfer Bus.

4F-9. The Data Bus contains eight bidirectional active-low signal lines, DIO1 through DIO8. One byte of information (eight bits) is transferred over the bus at a time. DIO1 is least significant; DIO8 is most significant. Each byte represents a peripheral address (either primary or secondary), a control word, or a data byte.

4F-10. The Management Bus is a group of five signal lines which are used to control data transfers over the Data Bus. The Transfer Bus performs a handshake sequence executed by the talker and the listeners each time a byte is transferred over the Data Bus.

4F-11. Table 4F-3 lists the memonic abbreviations that are used in this subsection.

Table 4F-2. IEEE-488-1978 Instrument Ports (Port 0 and Port 1)



BUS	PIN	SIGNAL	DEFINITION
DATA BUS	1 2 3 4 13 14 15 16	DIO1 DIO2 DIO3 DIO4 DIO5 DIO6 DIO7 DIO8	Data input and output lines, bidirectional and active-low, DIO8 is most significant. Data transfers are 8-bit parallel and byte serial.
MANAGEMENT BUS	11 23	ATN ATN Return	Attention. Activiated by the 1720A when peripheral devices are being assigned as listeners and talkers. The 1720A assumes it is the only source of this signal.
	10 22	SRQ SRQ Return	Service request. Any peripheral device on the Instrument Bus can request the attention of the 1720A Controller by setting SRQ active low.
	9 21	IFC IFC Return	Interface clear. Set by the 1720A to place all instruments on the bus in a predetermined reset state. The 1720A assumes that it is the only source of this signal.
	17	REN	Remote enable. Causes all responding instruments on the Bus to ignore their front panel controls and operate under remote control via signals and control messages received over the Bus.

Table 4F-2. IEEE-488-1978 Instrument Ports (Port 0 and Port 1) (cont)

BUS	PIN	SIGNAL	DEFINITION
MANAGEMENT BUS (cont)	5	EOI	End or identify. Can be used by a talker to identify the end of a data transfer sequence, or with ATN by a Controller, to execute a polling sequence.
TRANSFER BUS	7 19	NRFD NRFD Return	Not ready for data. An active low signal line to indicate that one or more assinged listeners are not ready to receive the next data byte. When all of the assigned listeners for a particular data transfer have released NRFD, the NRFD line goes inactive high. The talker can then place the next data byte on the Data Bus.
	6 18	DAV DAV Return	Data valid. Activated by the talker shortly after the placing a valid data byte on the Data Bus. An active low DAV signal tells each listener to capture the data byte presently on the Data Bus. The talker should be inhibited from activating DAV when NRFD is active low.
	8 20	NDAC NDAC Return	Not data accepted. Held active low by each listener until the listener captures the data byte currently being transmitted over the Data Bus. When all listeners have captured the data byte, NDAC goes inactive high. This tells the talker the transfer is complete.

Table 4F-3. ASCII and IEEE-488 Mnemonic Abbreviations

ACK	Acknowledge	DLE	Data Link Escape
ASCII	American Standard Code for Information Interchange	ENQ	Enquiry
		EOF	End of File
ATN	Attention	EOI	End or Indentify
BEL	Bell	EOT	End of Transmission
BS	Backspace	ESC	Escape
CAN	Cancel	ETB	End of Transmission Block
CR	Carriage Return	ETX	End of Text
DCL	Device Clear	FF	Form Feed
DCn	Device Control 1, 2, 3, or 4	GET	Group Execute Trigger
DEL	Delete	GND	Ground
DIOn	Data Input/Output 1 through 8	GTL	Go To Local

Section 4G
Remote Interface

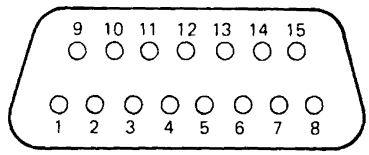
4G-1. INTRODUCTION

4G-2. The Remote Interface Connector provided on the rear power supply panel allows the user to do any of the following:

- Disable the front panel controls.
- Remotely perform front panel switch functions.
- Connect a larger capacity external battery.
- Halt the processor at the completion of the current machine instruction.
- Gain access to two software controlled external lines.
- Separate the battery back-up function so that it responds only to power failures and not to power turn-off by an exernal system power switch.

4G-3. Table 4G-1 lists these functions and their associated connector pin numbers.

Table 4G-1. Remote Interface Connector (Rear Power Supply)



PIN	NAME	MEANING
1	ABORT SW	The front panel ABORT switch applies a ground to this pin when pressed. If the internal jumper connecting pins 1 and 2 is cut, the front panel ABORT switch is enabled by connecting this pin to pin 2.
2	ABORT ENABLE	The ABORT function is available on this pin. If the internal jumper connecting pins 1 and 2 is cut, the front panel ABORT switch is enabled by connecting this pin to pin 1. Applying ground (pin 7, 8, or 15) to this pin will cause an ABORT.

Table 4G-1. Remote Interface Connector (Rear Power Supply) (cont)

PIN	NAME	MEANING
3	RESTART SW	The front panel RESTART switch applies a ground to this pin when pressed. If the internal jumper connecting pins 3 and 4 is cut, the front panel RESTART switch is enabled by connecting this pin to pin 4.
4	RESTART ENABLE	The RESTART function is available on this pin. If the internal jumper connecting pins 3 and 4 is cut, the front panel RESTART switch is enabled by connecting this pin to pin 3. Applying ground (pin 7, 8, or 15) to this pin will cause a RESTART.
5	EXT. BATT.	Connect the positive terminal of an external battery here, if you need to extend the E-Disk back-up time provided by the internal battery. Any DC voltage between 6 and 12 may be used. Before using this function: remove the power cord, wait 5 minutes, remove the power supply, and unplug the internal battery.
6	HALT	CPU Halt. Applying ground (pin 7, 8, or 15) to this pin will halt the processor at the completion of the current machine instruction, and execute a LOAD sequence. Unless HDT software is available (see the 1720A Service Manual), an error message will result.
7	GROUND	One of three available ground pins.
8	GROUND	One of three available ground pins.
9	RESERVED	
10	N/C	
11	LED #6	A software-controlled output line designed to drive a Light-Emitting Diode. See section 4C.
12	+5V	Five volts from the power supply. Use this to supply positive voltage for LEDs on pins 11 and 13.
13	LED #7	A software-controlled output line designed to drive a Light-Emitting Diode. See section 4C.
14	BATTERY DISABLE	A ground applied to this line will disable the battery back-up function. Use this to prevent regular discharage of the battery when the power is applied and remove externally by a common power switch.
15	GROUND	One of three available ground lines.