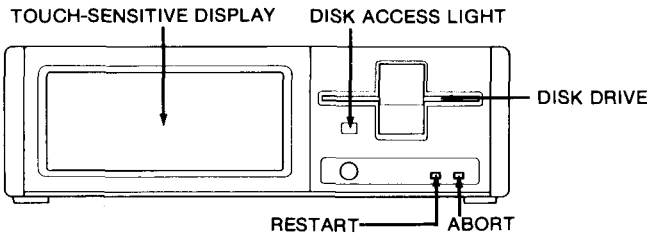


1722A
INSTRUMENT CONTROLLER

System Guide



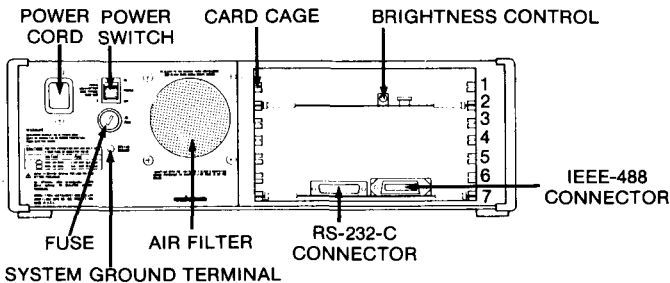
1722A Operator's Quick Reference Card



RESTART and **ABORT** pressed at the same time is the same as turning the power off and then on again (a cold start).

RESTART begins the program again. It reloads system software and performs the start-up sequence.

ABORT is a programmable function. Consult with the programmer to learn its meaning and use for each program.



Slots

Single Board Computer	7
Video/Graphics/Keyboard Interface Options	2
Memory Expansion Options	1, 3, 4, 5, 6
Input/Output Options	1, 3, 5
Non-Input/Output Options	4, 6

SYSTEM MESSAGES

Failures in system performance usually result in a message being displayed. Many errors are recoverable, although some of them indicate a hardware failure has occurred, and others indicate a problem with the software. Consult the information below to see how to proceed if a system error is reported.

Self-Test Messages

Every time the system performs a cold start (power up or RESTART and ABORT pressed simultaneously), it performs a Self Test. If any portion of the Self-Test fails, a message displays indicating which hardware component has failed. These are non-recoverable errors. Report the failure to the System Manager.

General Messages

These messages can occur any time during operation. They are all preceded by a question mark, indicating that they are recoverable. Use this guide to determine the cause of the error, and how to proceed if they are displayed.

? Device Error

The system is having difficulty reading the floppy disk. Check to be sure it is a System disk and that it is inserted properly. If it is, press RESTART and try again. If the failure continues, try another System disk.

? Disk Not Ready

Insert or reinsert the System disk. Either there is no disk in the drive, or it has been inserted incorrectly. Make sure the disk drive door is latched.

? No System On Device

The Controller does not recognize the disk in the drive as a System disk. Try another System disk. The wrong disk may be inserted, or it may be inserted incorrectly.

Other Messages

If any message occurs other than those described here, seek the assistance of the programmer. These messages are either non-recoverable, or indicate a problem with the software.

1722A
Operator's
Quick Reference Card

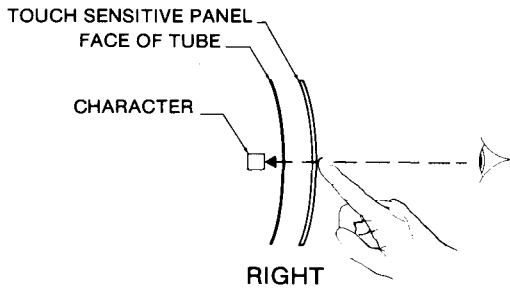
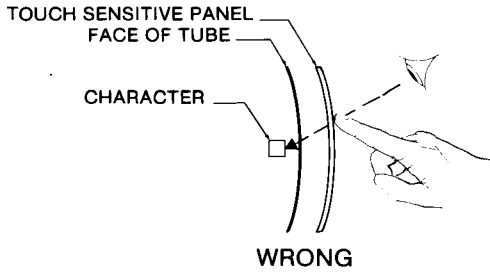
FLUKE

P/N 718163
OCTOBER 1983

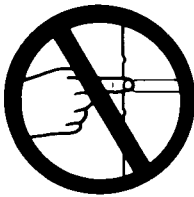
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all rights reserved. Litho in U.S.A.

PARALLAX ERROR

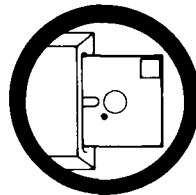
Face the screen directly to avoid parallax errors when you touch the Touch-Sensitive Display.



FLOPPY DISK CARE



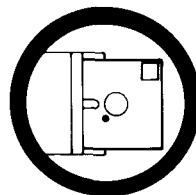
Never



Insert Carefully.



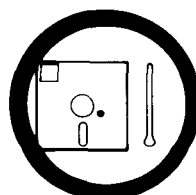
Never



Protect



No

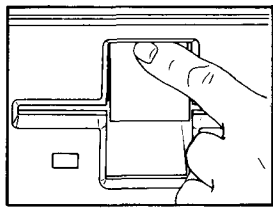


10°C - 50°C
50°F - 122°F

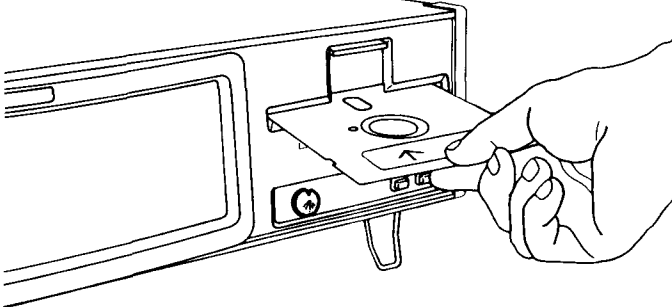


LOADING A DISK

- Gently insert the System disk (label up) into the disk drive.
- When the disk is fully seated, latch the drive closed by pressing in on the bottom of the latch.
- Floppy disks supplied by Fluke use reinforced center rings to help seat the disk on the spindle. If floppy disks without such rings are used, first insert the disk, and gently close the door without latching it. Reopen the door slightly, then close and latch it. That insures that the disk seats on the spindle, and improves the reliability of reading and recording data.



PRESS TOP OF DOOR LATCH
TO RELEASE



1722A USER INFORMATION
SYSTEM DIAGNOSTIC SOFTWARE

INTRODUCTION

This section covers the operation of the System Diagnostic software and assists the user in diagnosing problems with the 1722A Instrument Controller.

The System Diagnostic software is provided on a floppy disk and is designed to be a customer, manufacturing, and field service tool. Successful completion of testing the 1722A using the System Diagnostic software gives the user confidence that the 1722A Instrument Controller is operating properly.

System Diagnostics Software

MAINTENANCE PHILOSOPHY

The maintenance philosophy for field-service repair is at the module level, including the SBC, V GK, video electronics, power supply, floppy disk drive, and the options. Faulty modules are identified by using the System Diagnostic software.

Replacement modules are available through your local Fluke Service Center. Contact your local Fluke Service Center for details on in-warranty repair, and contact the Module Exchange Center for out-of-warranty repair.

DIAGNOSTIC DESIGN

The System Diagnostic software uses a menu system and presents the 1722A as a set of modules. A module is either a circuit board, an externally connected peripheral, or a major subsystem. There is a set of subtests for each module. Each subtest covers one specific function of a module. The test selections are presented on the 1722A display and use touch-sensitive command blocks for making choices.

The menu system allows individual modules to be selected and tested. A particular combination of tests is called a test configuration. The Standard Test Configuration can be used to test a standard 1722A with no options installed. Other test configurations can be created, edited, stored, and recalled as Configurations A, B, and C.

Some module tests can cover up to five units (modules of the same type). For example, the test for the 512K byte Memory Expansion module (Option -007) can test from one to five modules.

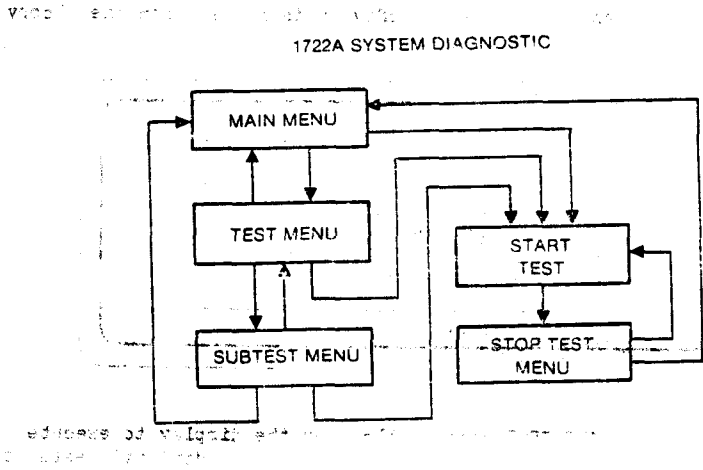
System Diagnostics Software

MENU LEVELS

The diagnostic software has three menu levels:

- 0 The Main Menu presents the test configurations, test modes, and a destination for the test results.
- 0 The Test Menu presents the modules and options that can be selected for testing.
- 0 The Subtest Menu presents the subtests that can be selected for each module and option.

Here is the menu level diagram:



System Diagnostics Software

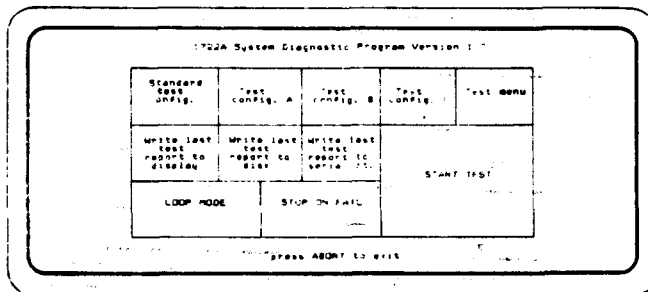
OPERATION

NOTE

Copy any programs stored in the 1722A E-Disk onto a floppy disk before loading the System Diagnostic software. When the System Diagnostic software is loaded into the 1722A memory, portions of the E-Disk and program memory in the 1722A are erased.

Use the following procedure to run the System Diagnostic software.

1. Insert the System Diagnostic disk into the disk drive. Power up the 1722A, or press the RESTART and ABORT switches on the front panel simultaneously if the 1722A is already running.
2. After the System Diagnostic software is loaded from the floppy disk, the 1722A display reads:



3. Touch the START TEST command block on the display to execute the Standard Test Configuration, or select individual tests as described in the paragraphs below.
4. The test will stop and display a prompt at any point where a user response is required. At the end of the test, the results will be displayed on the screen.

NOTE

If any problems are encountered while loading the System Diagnostic software or during the execution of a test, refer to "Troubleshooting" at the end of this section.

System Diagnostics Software

Main Menu

The Main Menu has 11 command blocks, described below.

1. Standard Test Config.

The Standard Test Configuration is a set of tests that has been preselected to test the proper functioning of standard 1722A system modules. The tests allow untrained personnel to perform diagnostic testing. Additional hardware or test cables are not used with this test configuration. If the 1722A passes the Standard Test Configuration, the 1722A is fully functional up to the I/O drivers. The I/O drivers are tested with additional subtests and external hardware.

2. Test Config. A, or B, or C

The purpose of Test Configurations A, or B, or C is to allow the creation of special test configurations. To create a configuration, select any combination of module tests and subtests, and store the special configuration if it will be needed again. Instructions on storing special configurations are given in the descriptions of the Test Menu selections.

3. Test Menu

By pressing the Test Menu command block, the Test Menu is displayed. From this menu, alternate test configurations can be defined and stored by the user.

4. Write Last Test Report to Display, or Disk, or Serial Pt. (Port).

After a test has stopped running, these command blocks allow the user to redisplay the test results or send them to a floppy disk or printer for future use.

If Write Last Report to Disk is selected, the test results are stored in the file MFO:REPORT.DAT. If Write Last Report to Serial Pt. is selected, the test results are sent to serial port KB1: and can be output to a printer for a hard copy. The default baud rate set by the start-up command file when the System Diagnostic software is loaded is 1200 baud. Set your printer to this baud rate. See Section 5 of the 1722A System Guide for more information about RS-232 communications and using the SET Utility Program.

System Diagnostics Software

5. Loop Mode

The LOOP MODE command block performs like a toggle switch. When it is off (the power-up default), the test configuration executes one time and then stops. When LOOP MODE is on, the test configuration continues until the ABORT switch on the 1722A front panel is pressed.

6. Stop On Fail

The STOP ON FAIL command block performs like a toggle switch. When the System Diagnostic software is first loaded, STOP ON FAIL is selected. When STOP ON FAIL is off, the System Diagnostic software tests do not stop if a failure occurs.

When STOP ON FAIL is selected, the System Diagnostic software will halt the test and give a Stop Test Menu whenever a failure is encountered. Here is an example of a Stop Test Menu:

```
SBC ROM checksum
Checksum is 0A00. Should be 7E00

Command -> CONTINUE REPEAT REPEAT NEXT LOOP ON ABORT
            TESTSTEP SUBTEST SUBTEST TESTSTEP end test

SBC ROM checksum
```

System Diagnostics Software

7. Start Test

The START TEST command block begins execution of the currently selected test configuration. The tests are executed and any failures are logged.

To begin any of the test configurations, press START TEST on the 1722A display. As the test runs, the 1722A display is updated at the completion of each subtest. To return to the Main Menu, or to halt any test, press the ABORT switch on the 1722A front panel. If all the tests in the chosen configuration are successful, the display reads 'No failures'. If any of the tests in the selected configuration are unsuccessful, three things happen:

- a. The 1722A display indicates the name of the test in progress at the time of the failure.
- b. The errors are stored on the E-Disk.
- c. A Stop Test Menu is displayed with an error log and more operator choices.

CAUTION

Portions of the System Diagnostic software can write over areas of RAM used by FDOS. Always reload the operating system by executing a cold start (press the RESTART and ABORT buttons on the front panel simultaneously) if <CTRL>/P is used to stop the System Diagnostic software.

System Diagnostics Software

TEST MENU

The Test Menu lets the user specify which modules are to be included in a particular test configuration. An example of a test configuration is the Standard Test Configuration which includes tests for the SBC, VGK, and floppy disk drive. If optional modules are installed in the 1722A, they can also be selected for testing from this menu.

The Test Menu is displayed on two screens. The first screen has 15 possible module selection blocks and six additional command blocks. The module selection blocks act as toggle switches to select and deselect the module.

The Test Menu includes module selection blocks for the SBC, Floppy Disk Drive, VGK, Option -006 256K RAM, Option -007 512K RAM, and Option -008 RS-232/IEEE-488. Here is an example of the first screen of the Test Menu:

Test Menu					
SBC	Floppy disk drive	VGK	256k ram option -006	512k ram option -007	
RS232/IEEE option -008					
All off	Store config. A	Store config. B	Store config. C	Main menu	START TEST

When a module is selected from the Test Menu the second screen is displayed. The lower six command blocks in the Test Menu are replaced with another set of command blocks. If the desired module is already selected, it must be toggled off and on again to display the second screen.

From the second screen of the Test Menu, the user can choose how many of the selected modules are to be tested, return to the first screen of the Test Menu, or go to the Subtest Menu for the selected module. Here is an example of the second screen of the Test Menu:

Test Menu					
SBC	Floppy disk drive	VGK	256k ram option -006	512k ram option -007	
RS232/IEEE option -008					
UNIT 1				Normal Buttons	Subtest menu

SBC

System Diagnostics Software

The command blocks for both screens of the Test Menu are described in the following paragraphs.

1. All Off

The All Off command block deselects all the modules in the Test Menu that were previously selected for testing.

2. Store Configuration A, or B, or C

After a test configuration has been selected by lighting the appropriate display blocks in the Test Menu and subtest Menus, the test configuration may be stored as Test Configuration A, B, or C by touching one of these command blocks. The special configuration is stored on the floppy disk and can be used again by selecting it from the Main Menu.

3. Unit # 1, 2, 3, 4, 5

From the second screen of the Test Menu the user can select the number of units (modules of the same type) to be included in the testing.

4. Normal Buttons

When the Normal Buttons command block is selected, the System Diagnostic software returns to the first screen of the Test Menu.

5. Main Menu

When the Main Menu command block is selected, the System Diagnostic software returns to the Main Menu.

6. Start Test

When the Start Test command block is touched, the currently selected test configuration begins to execute.

7. Subtest Menu

When the Subtest Menu command block is selected, the Subtest Menu for the chosen module is displayed.

System Diagnostics Software

SUBTEST MENUS

There is a Subtest Menu for each module listed in the Test Menu. From the Subtest Menu the user can select specific tests to be executed for the chosen module. This is useful for obtaining more specific information about a module that has failed. For example, a failure at an RS-232 port may be due to a problem on either side of the I/O buffers. To isolate the problem, there is an Internal Loopback Test, an External Loopback Test, and a Port-to-Port Loopback Test, any of which can be selected to exercise a particular portion of the module circuitry.

For each module subtest, there are 15 toggle type subtest selection blocks and five command blocks. An example of the SBC Subtest Menu is shown below.

SBC				
Clear	ROM checksum	Non destructive memorystore	Destructive memorystore	Non destructive RAM
Destructive ram	RS232 internal loop	RS232 external loop	RS232 Port to port loop	IEEE internal loop
IEEE port to port loop				
ALL off	Select standard subtest	Main menu	Test menu	START TEST

Subtest Menu

The command blocks in the Subtest Menu operate identically to the command blocks described above for the Test Menu. The subtest selection blocks for each of the modules are described in the following paragraphs.

System Diagnostics Software

Subtest Descriptions

SBC (Single Board Computer)

The SBC Subtest Menu includes the following tests:

1. Clock

Checks time rollover and storage of all stages of the real-time clock registers.

2. ROM Checksum

Generates a checksum for the contents of the BOOT ROM. The test fails if the checksum is not equal to zero.

NOTE

The ROM checksum test will not work properly with Version 1.0 of the BOOT ROM. The correct checksum for Version 1.0 is hex 8AA0.

3. Non-Destructive Macrostore

Perform a simple read/write test of the Macrostore memory. The contents of the Macrostore are left intact at the end of the test.

4. Destructive Macrostore

This is a comprehensive memory test including pattern sensitivity. The System Diagnostic software loads another program from the disk to do this test, deleting the Operating System and the System Diagnostic software from the 1722A memory in the process. This test takes several minutes to complete. At the conclusion of the test, the Operating System and the System Diagnostic software must be reloaded.

5. Non-Destructive RAM

This tests portions of the 1722A memory not presently being used by the System Diagnostic software.

System Diagnostics Software

6. Destructive RAM

This is an intensive memory test requiring approximately 30 minutes to execute. When the test is over, the System Diagnostic software must be reloaded because the test deletes the software from memory.

7. RS-232 Internal Loop

This test sets an internal loopback mode on the UART (Universal Asynchronous Receiver Transmitter) to allow the 1722A to send and receive data internally. The I/O buffers to off-board devices are not tested.

8. RS-232 External Loop

This test uses a special test connector (Fluke P/N 731216) to allow any port to talk to itself. This tests the buffers and registers of the RS-232 port.

9. RS-232 Port-to-Port Loop

A Null Modem cable (Fluke Model Number Y1705) is required to permit two RS-232 ports to communicate with each other and test the entire communications interface including the buffers. The Option 17XXA-008 IEEE/RS-232 Interface module must be installed to run this test. The Null Modem cable connects the RS-232 ports on the SBC and the Option -008 module.

10. IEEE Internal Loop

The IEEE-488 Internal Loop tests the operation of the IEEE-488 interface. The buffers to the IEEE-488 bus are not tested.

System Diagnostics Software

11. IEEE Port to Port Loop

The IEEE-488 Port-to-Port Loop Test verifies the port's ability to transmit or receive data and drive the IEEE-488 bus. Use any standard Fluke IEEE-488 cable, Y8021, Y8022, or Y8023. The Option 17XXA-008 IEEE/RS-232 module must be installed to run this test. The IEEE cable connects the IEEE-488 ports on the SBC and the Option -008 module. Switch positions 5 and 6 on the SBC must be in the "OFF" position and switch positions 5 and 6 on the Option -008 module must be in the "ON" position for the test to complete successfully.

NOTE

This test requires the user to remove the SBC or Option -008 module from the 1722A chassis in order to verify proper switch settings. It is not necessary to run this test unless there are IEEE-488 bus problems that cannot be identified using the Standard Test Configuration supplied with the System Diagnostic software. If it becomes necessary to run this test, refer to the discussion on "Installing Hardware Options" in the section entitled "Options" in the 1722A System Guide. This discussion explains how to remove the rear panel to gain access to the SBC and Option -008 module. Also, be sure to return the SBC and -008 option to their initial switch configuration after running the test.

System Diagnostics Software

Floppy Disk Drive

The Floppy Disk Drive menu includes the following tests:

1. Write Protect Switch

This test displays the status of the Write Protect Switch. Removing or inserting a disk causes the switch to toggle. The System Diagnostic software tests to insure that the switch does toggle. When testing is complete, touch the screen, and the System Diagnostic software reports its findings.

2. Track 0 Sw & Stepper Motor

A disk is not needed for this test. The read/write head is moved from track 00 to track 39 and back again to test the operation of the track 00 indicator and the stepper motor.

3. Disk RPM Check/Adjust

A disk must be loaded to perform this subtest. Any disk will do, because nothing is written or read from the disk.

In this subtest the disk speed is measured and tested to insure it is within tolerance. The disk speed is displayed continuously if the System Diagnostic software is not in the LOOP MODE. When the System Diagnostic software is in the LOOP MODE, the disk speed is sampled and displayed for about 15 seconds, then the test continues to the next subtest. If the test results indicate that the disk speed needs to be adjusted, please refer to the 1722A Service Manual or return the unit to your local Fluke Service Center for servicing.

4. Bad Block Scan

Each block on the disk is read and checked for errors. A total of 1600 blocks is read (two passes over the disk). The disk is never written on. Use this subtest to check a disk for bad blocks. If this subtest is used to check the disk drive itself, a disk with flawless format is required.

System Diagnostics Software

5. Soft Error Rate

This subtest does an extensive test of the disk drive's ability to read a worst case data pattern over many passes of the disk. A scratch disk with error free format is required. After writing the worst case data pattern (hex 6DB6DB...) over the entire disk surface, the disk is read for 306 passes (over 1 billion bits). This test takes approximately 3 hours to complete.

The display indicates the progress of the subtest while the disk is being read, showing the disk pass number, blocks read, bits read, and the current number of soft and hard errors. Refer to "Troubleshooting" at the end of this section for a description of soft and hard errors.

If the System Diagnostic software is in LOOP MODE, the total number of disk passes, blocks read, etc., for all the times the subtest was executed, are also shown in the display. The display is updated at the end of each disk pass.

6. Random block I/O

This subtest tests the floppy disk drive's worst case ability to read, write, and seek. It is identical to the Soft Error Rate test except that the block number is chosen at random. A seek to the chosen block is followed by writing the worst case data pattern and reading it back. The total number of blocks tested is 800. The soft and hard errors are handled the same as in the Soft Error Rate Test.

System Diagnostics Software

VGK (Video/Graphics/Keyboard Interface)

The VGK menu includes the following subtests:

1. Alignment pattern

Displays the alignment pattern used for the initial factory setup of the CRT and permits later checking for shift of the display.

2. Keyboard

A picture of the keyboard is displayed on the screen. Each time a key is pressed on the 1722A keyboard, the corresponding key on the display toggles either on or off. Follow the instructions to light all the keys on the display and then touch the screen to continue. The diagnostic software records an error if a keystroke was not detected.

3. Touch-Sensitive Overlay

The Touch-Sensitive Overlay (TSO) grid is displayed. Each square covers exactly one TSO touch pad. Light each square by touching it. Press each one again to turn it off. The subtest passes if each touch pad responds at least twice. If a square does not work, exit the subtest by pressing the ABORT switch on the 1722A front panel.

256K RAM Option -006

Up to five units can be tested at once by selecting the unit numbers from the Test Menu. Each unit number corresponds to a specific switch setting as described in the information supplied with the option or in the section of the 1722A System Guide entitled 'Options'.

The menu for the 256K RAM option includes the following tests:

1. Non-Destructive RAM Test

This subtest operates the same as the SBC Non-destructive RAM test.

2. Destructive RAM Test

This subtest operates the same as the SBC Destructive RAM test. The test may take several hours to complete depending on how many Option -006 modules are installed.

System Diagnostics Software

512K RAM Option -007

Up to five units can be tested at once by selecting the unit numbers from the Test Menu. Each unit number corresponds to a specific switch setting as described in the information supplied with the option or in the section of the 1722A System Guide entitled 'Options'.

The menu for the 512K RAM includes the following tests:

1. Non-Destructive RAM Test

This subtest operates the same as the SBC Non-destructive RAM test.

2. Destructive RAM Test

This subtest operates the same as the SBC Destructive RAM test. The test may take several hours to complete depending on how many Option -007 modules are installed.

System Diagnostics Software

RS232/IEEE Option -008

The subtest for the RS232/IEEE option operates the same as SBC Loop Tests. The cables described in the section on SBC subtests are also used for the IEEE and RS-232 port tests for the -008 option. For the IEEE Port-to-Port test, however, switch position 5 and 6 on the SBC are set to the "ON" position and switch positions 5 and 6 on the Option -008 module are set to the "OFF" position. Here is a list of the subtests for Option -008.

1. RS-232 Internal Loop
2. RS-232 External Loop
3. RS-232 Port-to-Port Loop
4. IEEE-488 Internal Loop
5. IEEE-488 Port-to-Port Loop

NOTE

This test requires the user to remove the SBC or Option -008 module from the 1722A chassis in order to verify proper switch settings. It is not necessary to run this test unless there are IEEE-488 bus problems that cannot be identified using the Standard Test Configuration supplied with the System Diagnostic software. If it becomes necessary to run this test, refer to the discussion on "Installing Hardware Options" in the section entitled "Options" in the 1722A System Guide. This discussion explains how to remove the rear panel to gain access to the SBC and Option -008 module. Also, be sure to return the SBC and -008 option to their initial switch configuration after running the test.

System Diagnostics Software

Additional System Diagnostic Software

There are four additional diagnostic programs on the System Diagnostic disk. They are used to test other 1722A options and peripherals. The four programs are listed below:

1. MBXTST

This program tests up to three Bubble Memory Modules (Option 17XXA-004 or 17XXA-005). The program writes test patterns to the Bubble Memory to check for bubble collapse errors (a "1" bit turning into a "0") and pattern sensitivity problems with the Formatter/Sense Amplifier (FSA). Before executing the test, the program checks to see if there are any files on the bubble devices MB0: through MB3: and the user is asked to confirm whether he wants the files deleted. The bubble devices must be formatted in order for the test to execute properly. The bubble memories were formatted at the factory and should not need to be reformatted unless there is a problem with the module. Any errors found during the test will be displayed on the screen and summarized at the end of the test. If the test will not execute properly try formatting the bubble memory using the File Utility Program (refer to Section 4 of the System Guide).

2. PIBTST

This program tests up to three Parallel Interface Modules (Option 17XXA-002). The program performs three separate tests including writing to a port and reading back from the same port (Readback), writing to one port and reading back on the other port (Loopback), and an Interrupt test. When the program runs, the numbers of the modules under test are displayed across the top of the screen and the tests that are executing are displayed down the left side of the screen. In order to pass the Loopback test, a special test cable (JF/PN 632968) must be connected between the two ports on the module. If the user does not have a test connector, the Readback and Interrupt tests may be run individually by touching the PASS/FAIL block on the screen at the bottom of the column corresponding to the module under test. At this point a second menu is displayed. The user may run the tests individually on either port of the selected module by touching the screen at the appropriate point.

System Diagnostics Software

3. MFXTST

This program tests up to two 1760A or 1761A Disk Drive Systems. Refer to the section entitled "Options" in the 1722A System Guide or the information supplied with the 1760A or 1761A for instructions on switch settings and connecting the unit to the 1722A. The program will check the disk drive speed and disk detection logic, then seek, format, write and readback data from a disk installed in each drive. The program will erase any files on the disk. Refer to the 1760A/1761A Manual for more information.

4. WDXTST

This program will test the 1765A/AB Winchester Disk Drive. The test selections are displayed on the screen and are selected by touching the desired menu item. The tests include a self test of the 1765A/AB Winchester controller board and a verification of all of the blocks on the disk. If a bad block is found on the disk, that block is no longer used for storing data and an alternate block is automatically assigned.

To use these diagnostic programs, load the System Diagnostic disk as described in step 1 of the operating instructions in this section. When the first menu appears, press the ABORT button on the Controller's front panel.

When the FDOS> prompt appears, type the name of the desired program followed by <RETURN>. The software prompts for additional information if it is required. More information about the individual options may be found in Section 4 or in the section entitled 'Options' of the 1722A System Guide.

TROUBLESHOOTING

When the System Diagnostic software encounters an error during the execution of a test, an entry is made in an error log. If STOP ON FAIL has been selected from the Main Menu, an error message is displayed on the screen. This message includes the name of the module under test and the particular subtest being executed when the error occurred.

Generally, the module under test is at fault whenever an error occurs. If an error is reported, check that the switch settings are correct on the module in question (if applicable), then run the test again. If the error condition persists, contact your local Fluke Service Center for information about replacing the faulty module. A list of replacement module part numbers and authorized Fluke Service Centers is included at the end of this section.

System Diagnostics Software

If you are experiencing difficulty in getting the System Diagnostic software to load and execute properly, the following paragraphs provide some general guidelines for diagnosing problems with the 1722A.

WARNING

These service instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

Power-up Problems

When the 1722A is first powered on, the fan on the rear panel starts up, and two beeps can be heard; one from the 1722A chassis and one from the keyboard if it is plugged in. If these things do not happen, check to see that the line cord is properly installed and that the fuse is intact. Also verify that the line voltage indicated on the rear panel matches your line power source. If everything is in order, the power supply is faulty.

If the fan is running but there is no beep from the chassis, either the VGK or the PUP (power-up) assembly are faulty.

Display Problems

After the 1722A has been on for at least one minute, messages should be visible on the display. If the display is completely blank, except for a blinking cursor, try a cold start. Press the RESTART and ABORT switches on the 1722A front panel simultaneously. If the problem persists, the VGK, CRT, and video electronics are functional and the SBC is probably faulty.

If there is no display at all after a power-up or cold start, but there is a beep from the chassis, the VGK is functional, and either the CRT, video electronics, or associated cables are faulty.

System Diagnostics Software

Floppy Disk Drive Problems

After the 1722A has executed the power-up self-test sequence, it attempts to load the operating system (FDOS2.SYS) from the floppy disk. The message "LOADING" should be displayed on the screen, and the disk drive activity light on the front panel should come on. If the disk drive activity light does not come on, either the disk drive or associated cables are faulty.

If the disk drive activity light comes on, but the operating system does not load, an error message appears on the screen. Refer to Sections 3 and 4 of the 1722A System Guide for a description of the self-test and system error messages.

A soft error is any single failure to read a block correctly. It can be caused by improper seating of the disk or by a dust particle momentarily passing under the read/write head. An occasional soft error is of no concern. Ten successive soft errors are considered a hard error and indicate a problem either with the disk or the disk drive.

In general, whenever a disk error occurs, the disk should be reseated by opening and reclosing the disk drive door. If the problem persists, try another disk. If this solves the problem, the original disk was faulty.

If the problem cannot be solved by using another disk, then the disk drive is either faulty or out of calibration. One other possibility is that the disk controller on the SBC is out of calibration. In either case, calibration should only be performed by authorized service personnel. Contact your local Fluke Service Center.

Keyboard Problems

During a power-up or cold start, the keyboard should emit an audible tone, and both the CAPS LOCK and PAGE MODE indicators should light momentarily. If this does not occur, the keyboard is faulty.

After the operating system is loaded, it may be necessary to use the keyboard to access some of the diagnostic programs. If the keyboard does not respond when a key is pressed, press <CTRL>/T to reset the keyboard and display. If this doesn't help, unplug the keyboard from the front panel and then plug it in again to perform a power-up reset of the keyboard. If the problem still persists, the keyboard is faulty.

System Diagnostics Software

Other Problems

Once the System Diagnostic software is loaded, if there are problems with the appearance of the menus, the VGK may be faulty. The software makes extensive use of block graphics and video attributes. If some of the reverse video blocks or highlighted characters do not appear to be correct, replace the VGK.

If the display does not respond when a menu block is touched, try other menu blocks. Keep in mind the possibility of parallax error as discussed in Section 2 of the 1722A System Guide. If the problem persists, the Touch-Sensitive Display is faulty.

If you experience other problems with the 1722A that are not discussed in this section, call your local Fluke Service Center for further assistance.

REPLACEMENT PARTS

This list gives part numbers for all replacement modules in the 1722A Instrument Controller, as well as part numbers for the various loopback cables and connectors required for the IEEE-488 and RS-232 tests.

DESCRIPTION	PART NUMBER
3A Fuse, (115 Volt operation)	109199
2A Fuse, (230 Volt operation)	109173
Power Up Assembly (PUP)	704353
Power Supply	718064
Floppy Disk Drive	661629
Single Board Computer (SBC)	705285
Video/Graphics/Keyboard Interface (VGK)	661587
CRT and Video Electronics	718056
Touch-Sensitive Overlay	661678
Keyboard	718106
PIB Loopback Cable	632968
RS-232 Loopback Connector	731216
RS-232 Null Modem Cable	Y1705
IEEE-488 Cable (shielded)	Y8021
System Diagnostic Disk	(reorder 1722A-200U)

FIELD SERVICE KIT

Additionally, a Field Service Kit is available which contains all the above modules under Fluke P/N 729343. These kits are intended for use by qualified Service Personnel. Using Module Exchange as backup support, one kit should be sufficient to support approximately ten 1722A units.

1722A USER INFORMATION

Option 17XX-006/007

Memory Expansion Module

INTRODUCTION

The Option 17XX-006/007 Memory Expansion Modules provide additional memory for the 1722A. This added memory can also be configured as Electronic disk.

The Operating System treats memory configured as E-Disk as an electronic version of a floppy disk. This means that files are stored and retrieved from E-Disk in a formatted fashion like a floppy disk. See the File Utility Program in Section 4 of the System Guide for instructions on how to configure E-Disk space.

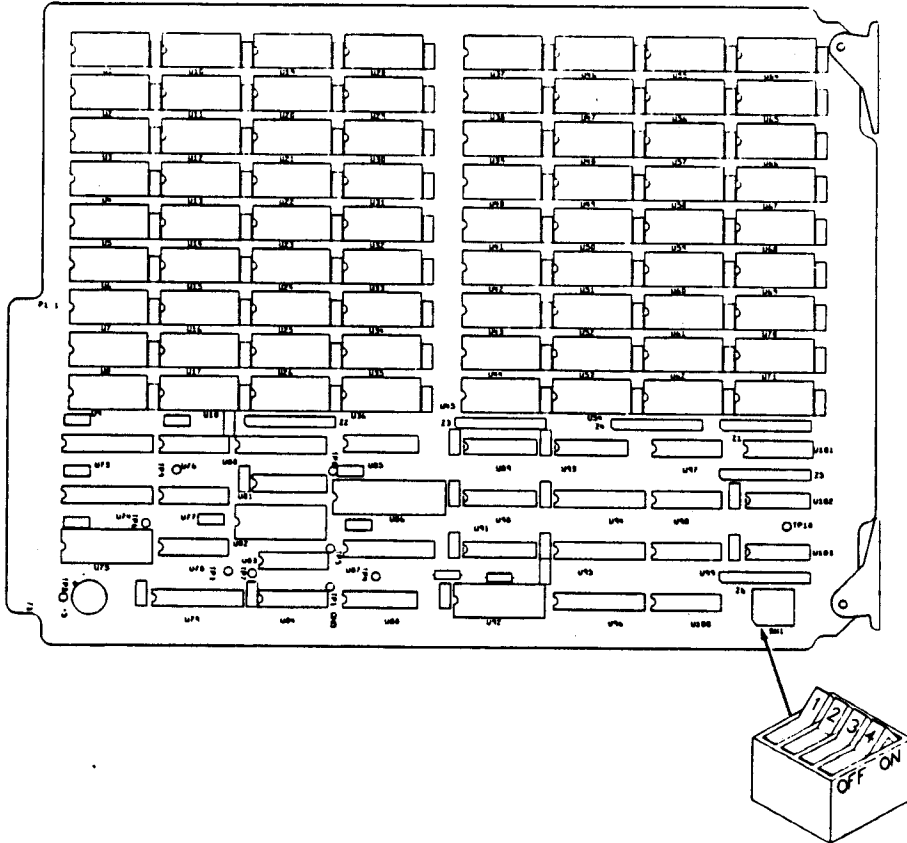
The 17XX-006 Memory Expansion Module contains 256K bytes of dynamic RAM; the 17XX-007 module contains 512K bytes. Any combination of up to five modules can be installed in a 1722A at a time. If all of the slots are filled with 17XX-007 boards, then the total expansion memory added to the 1722A would be over 2.6M bytes.

PRE-INSTALLATION CHECKOUT

Inspect the shipping carton for damage. Notify the shipper immediately if the carton appears to have been damaged in shipping. Unwrap the module and inspect it for damage. If everything seems to be in order, go on to the next step, setting the board's address switch.

Board Addressing

In order for the Operating System to operate properly using expanded memory, each memory board installed must have unique addresses set. Each module has a memory switch, located in the drawing below.



The 1722A has five slots available for options. Expansion memory modules can be installed into any or all of them. To assure proper operation of diagnostics, the first module added should be given the address for Unit One as shown in the table below. Subsequently added modules are given addresses in ascending unit number order. The SW1 address switch settings shown below are identical for Option -006 (256K bytes) or Option -007 (512K bytes).

UNIT NUMBER	ADDRESS CODE	SWITCH POSITIONS			
		1	2	3	4
1	1111	off	off	off	off
2	1101	off	off	on	off
3	1011	off	on	off	off
4	1001	off	on	on	off
5	0111	on	off	off	off

NOTES

- 1) "0" = on and "1" = off on the option's address switch label.
- 2) Although the Controller may operate properly with addresses set out of order, setting them in the recommended order ensures that diagnostic software can correctly identify faulty components, and will prevent possible bus contention problems when mixing -006 and -007 options.

Example:

Two -007 Options, and two -006 Options are to be installed. In this case, we will set the addresses for the larger memory sizes first by setting their switches to 1111 and 1101. Next, the first -006 option's switches are set to 1011, and the second one to 1001.

These settings leave a 256K byte gap between the memory addresses occupied by the -006 modules. This gap is transparent when the module is in use.

INSTALLATION AND CHECKOUT

1. Follow the directions in the Options Section titled "Installing Hardware Options" to install the module into the Controller's card cage. Be sure to turn the power off.
2. To check the new memory module, power up the system and load the Operating System software. Observe the amount of memory message that appears when FDOS loads. It should indicate the additional memory that is now available, both in bytes and blocks. (1 block = 512 bytes.)
3. To exercise the new memory, use the File Utility Program to configure all available free blocks as E-Disk, then transfer a large amount of files to the E-Disk, and see that they can be read to the screen. If everything is in order, this is an adequate check that the Memory Expansion Module is operational. Section 4 of the 1722A System Guide, Devices and Files, explains all the operations of the File Utility Program.
4. If any trouble develops, first recheck your work. Make sure that the address selection switches are set properly, and that the module is properly seated into the connector on the motherboard. If everything seems to be in order, refer to Appendix G, System Diagnostics, or call your Fluke Technical Service Center for assistance in tracking down the trouble. The Memory Expansion module is included in Fluke's Module Exchange Program.

1722A USER INFORMATION

Option 17XXA-008 IEEE-488/RS-232C Interface

INTRODUCTION

This section of the 1722A System Guide covers the Option 17XXA-008 IEEE-488/RS-232 Interface Module. The module provides the 1722A Instrument Controller with one additional IEEE-488 port, and one additional RS-232 port.

As shipped, the standard 1722A Instrument Controller has a single IEEE-488 port and one RS-232 port. The IEEE-488 port has the device name GP0: when used as a serial device (output only), and Port 0 when used by a program as an instrument port. The standard configuration RS-232 port has the device name KB1:.

The IEEE-488 port on the -008 option has the device name GP1: or Port 1, and the RS-232 port has the device name KB2:. See Section 4 of the System Guide for more information on devices.

PRE-INSTALLATION CHECKOUT

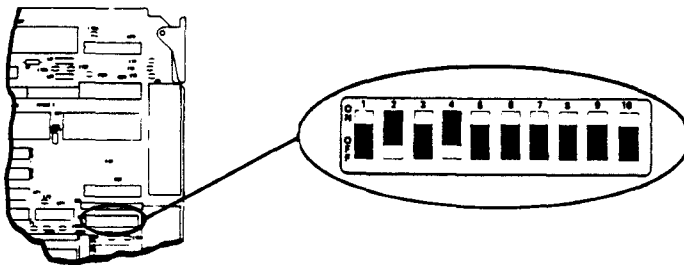
Inspect the shipping carton for damage. Notify the shipper immediately if the carton appears to have been damaged in shipping. Unwrap the module and inspect it for damage. If everything seems to be in order, go on to the next step, Installation.

INSTALLATION

1. Refer to the drawing below to locate and set the configuration switches. The initial setup establishes the module's IEEE-488 address as 0, and its function as "system controller". This switch setting also sets the RS-232 port to 4800 baud for power up, but the baud rate can easily be changed later using the Set Utility Program. See Section 5 of the System Guide for details.

NOTE

Both the standard IEEE-488 port and the one added by the -008 option can be set up as "system controller", because the two ports are effectively two separate systems. However, if both of them will be connected to the same bus, then one of the ports must be set up as "controller in charge".



SWITCH 1

1	2	3	4	5	6	7	8	9	10	
—	S2	S1	S0	SC		A4	A3	A2	A1	
x						unused				
						IEEE-488 ADDRESS				
						0	0	0	0	0
						0	0	0	1	1
						0	0	1	0	2
						0	0	1	1	3
						0	1	0	0	4
						0	1	0	1	5
						0	1	1	0	6
						0	1	1	1	7
						1	0	0	0	8
						1	0	0	1	9
						1	0	1	0	10
						1	0	1	1	11
						1	1	0	0	12
						1	1	0	1	13
						1	1	1	0	14
						1	1	1	1	15
						IEEE-488 CONTROLLER				
				0	0					System Controller
				1	1					Idle Controller
						BAUD RATE				
				0	0	0				110
				0	0	1				300
				0	1	0				600
				0	1	1				1200
				1	0	0				2400
				1	0	1				4800
				1	1	0				9600
				1	1	1				19200

2. Once the switch has been set, use the directions in the Options section "Installing Hardware Options" to install the -008 option into the 1722A.
3. Power up the Controller and test the new interface by using the System Diagnostic software. Appendix G of the System Guide explains how to use the System Diagnostic software to test the -008 option.
4. In case of problems with the new module, recheck your work to ensure that the board is fully seated in the card cage, and that port connectors are attached securely. If everything is in order but the failure continues, refer to Appendix G for troubleshooting information, or call your local Fluke Service Center. The IEEE-488/RS-232 Interface module is included in Fluke's Module Exchange Program.

1722A

INSTRUMENT CONTROLLER

System Guide



1 How To Use This Manual

2 Setting Up the Controller

3 Software Configuration

4 Devices and Files

5 Communications

6 Creating and Editing Programs

7 Automating System Functions

8 Display

9 Options

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1722A

INSTRUMENT CONTROLLER

System Guide



WARRANTY

John Fluke Mfg. Co., Inc. (Fluke) warrants this instrument to be free from defects in material and workmanship under normal use and service for a period of ninety (90) days from date of shipment. Software is warranted to operate in accordance with its programmed instructions on appropriate Fluke instruments. It is not warranted to be error free. This warranty extends only to the original purchaser and shall not apply to fuses, computer media, batteries or any instrument which, in Fluke's sole opinion, has been subject to misuse, alteration, abuse or abnormal conditions of operation or handling.

Fluke's obligation under this warranty is limited to repair or replacement of an instrument which is returned to an authorized service center within the warranty period and is determined, upon examination by Fluke, to be defective. If Fluke determines that the defect or malfunction has been caused by misuse, alteration, abuse, or abnormal conditions of operation or handling, Fluke will repair the instrument and bill purchaser for the reasonable cost of repair. If the instrument is not covered by this warranty, Fluke will, if requested by purchaser, submit an estimate of the repair costs before work is started.

To obtain repair service under this warranty purchaser must forward the instrument, (transportation prepaid) and a description of the malfunction to the nearest Fluke Service Center. The instrument shall be repaired at the Service Center or at the factory, at Fluke's option, and returned to purchaser, transportation prepaid. The instrument should be shipped in the original packing carton or a rigid container padded with at least four inches of shock absorbing material. **FLUKE ASSUMES NO RISK FOR IN-TRANSIT DAMAGE.**

THE FOREGOING WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE OR USE. FLUKE SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.

CLAIMS

Immediately upon arrival, purchaser shall check the packing container against the enclosed packing list and shall, within thirty (30) days of arrival, give Fluke notice of shortages or any nonconformity with the terms of the order. If purchaser fails to give notice, the delivery shall be deemed to conform with the terms of the order.

The purchaser assumes all risk of loss or damage to instruments upon delivery by Fluke to the carrier. If an instrument is damaged in-transit, **PURCHASER MUST FILE ALL CLAIMS FOR DAMAGE WITH THE CARRIER** to obtain compensation. Upon request by purchaser, Fluke will submit an estimate of the cost to repair shipment damage.

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

List of Software Versions

BASIC Interpreter Program	1.0
Edit Program	1.0
File Utility Program	1.0
Fluke Disk Operating System Program	1.0
Set Utility Program	1.0
System Generation Utility Program	1.0
Time and Date Utility Program	1.0

NOTE

This publication describes the operation of the listed programs at the levels of revision shown. Software programs may not be compatible in other combinations. Consult your local Fluke Service Center to determine compatibility of other combinations.

1722A

INSTRUMENT CONTROLLER

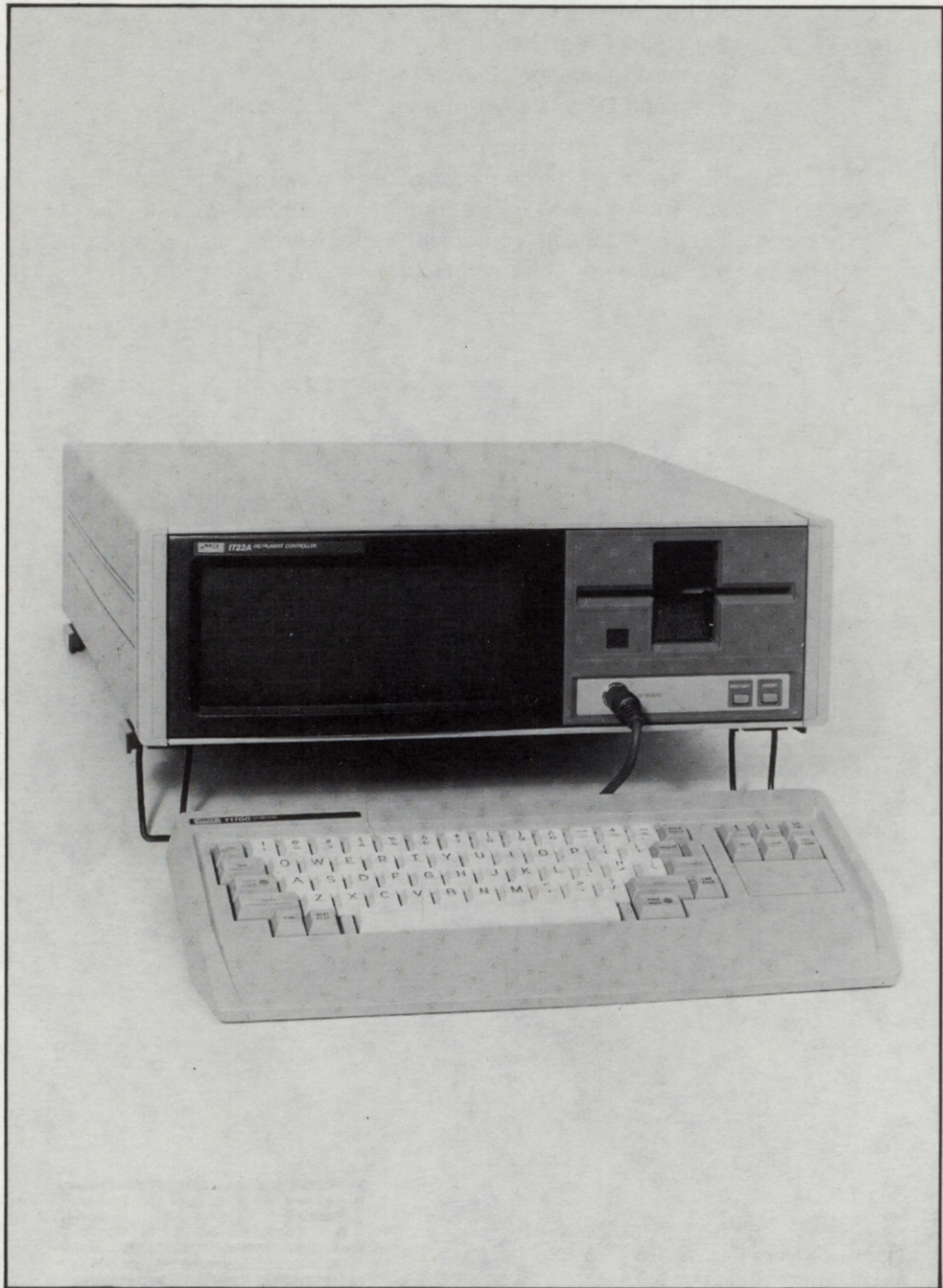
System Guide

P/N 716621

OCTOBER 1983

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1722A Instrument Controller

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Section 1

How To Use This Manual

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INTRODUCTION

This manual is the primary reference for the Fluke 1722A Instrument Controller. The 1722A System Guide is part of a manual set that supports the Controller, and covers hardware and software.

The purpose of the System Guide is to provide an easy to use source of information for a variety of users. Whether this is your first exposure to programmable instrumentation, or whether you already have extensive programming experience, our intention has been to anticipate and meet your needs for accurate, well organized information.

First-time users should read the *Getting Started* manual. *Getting Started* is designed to help set up the Controller and begin using it. The Fluke BASIC Programming Manual and other language manuals describe how to use a programming language and its available software tools.

ORGANIZATION

Section 1 How to Use This Manual

Describes the organization of the System Guide, and the conventions used in the manual.

Section 2 Setting up the Controller

Provides a first look at the Controller, and contains unpacking and set-up information. It illustrates controls, indicators, and connectors, and includes start-up procedures.

Section 3 Software Configuration

Describes the Operating System software, and the other programs on a new System disk.

Section 4 Devices and Files

Describes the system's resources and how to use them. This section contains a complete description of the File Utility.

Section 5 Communications

Tells how to use the Controller to send and receive information using the ports for the IEEE-488 bus and the RS-232 interface.

Section 6 Creating and Editing Programs

Explains how to use the Editor program to write and modify programs.

Section 7 Automating System Functions

Explains how to use the various software and hardware resources to automate the functions of the Controller.

Section 8 Display

Explains how to use the Controller's graphics capabilities to design detailed and informative displays.

Section 9 Appendices

Contains useful reference material, including a list of options and accessories and a glossary of terms.

The material in this manual is organized in categories of tasks, in the order that most persons would perform those tasks. If more information about a specific topic is needed, consult the Index.

USAGE GUIDE

Evaluators

If you are evaluating the 1722A Instrument Controller for a particular application, the section titled Setting Up the Controller describes the general capabilities and functions of the unit. You might also read the introductions to each of the other tab-divided sections to assess the software packages and hardware configuration. The Specifications are given in Appendix A.

Beginning System Designers

For those with little or no experience in designing a programmable instrumentation system, Getting Started is the recommended place to begin. This handy stand-alone volume with its accompanying disk will familiarize you with the basic operations and layout of the Controller. Then you can use the System Guide as a reference for a variety of topics, or branch off to one of the language manuals (BASIC, Pascal, etc.) If you need more familiarity with the IEEE-488 bus, see Section 5, Communications, or Appendix C, IEEE-488 Interface References. More information is available in Fluke Application Bulletin AB-36, IEEE Standard 488 Digital Interface for Programmable Instrumentation, and Fluke Technical Bulletin C0076, Troubleshooting Information for IEEE-488 Systems.

Programmers

If you already have some experience in programming, the sections on Software Configuration or Automating System Functions are a good place to start. Section 4, Devices and Files, can help you become familiar with the file conventions used in the 1722A. You may also wish to refer to the Communications section for information about the IEEE-488 bus and the RS-232 port.

Operators

An Operator's Guide has been included after the appendices in this manual. The Guide shows the location and operation of all controls, care of the floppy disk, routine maintenance procedures, and what to do if things don't go as expected. Additional copies can be ordered using Fluke Part Number 718163.

HOW TO READ SYNTAX DIAGRAMS

A syntax diagram is a graphical representation of how to construct a valid command or statement in a programming language. It is a kind of "shorthand" way of writing down all the rules for using the elements of a language. Since they are used throughout this manual, learning how to read them can be a great time saver.

WORD

Words inside ovals must be entered exactly as they are shown.

RETURN

Words inside boxes with rounded corners indicate a single key must be pressed, such as RETURN or ESC.

<space>

This indicates a space in the statement. (Press the spacebar.)

<CTRL>/C

To create a control character, hold down the control key (CTRL), then press the other key. This one is a Control C; it causes a break in the program.

filename

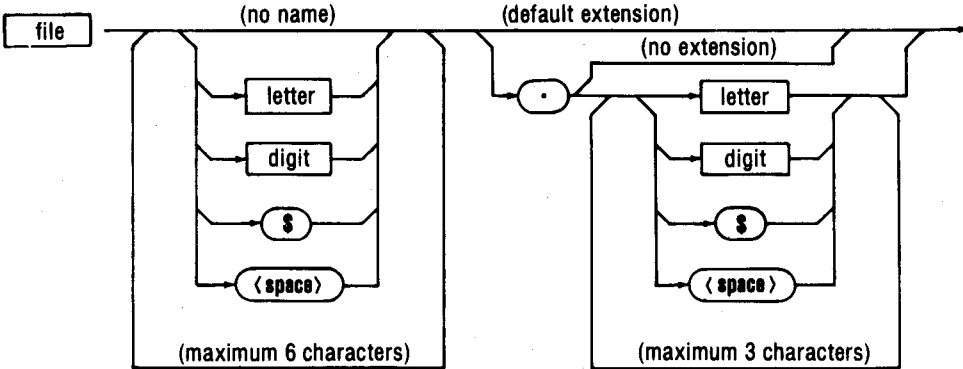
A box with lower-case words inside means that you supply some information. In this case, you would enter a filename.

(explanation)

Words in parentheses are explanations of some kind. They give added information about the nearest block or path, or indicate a default value.

Sample Syntax Diagram

From the left, any path that goes in the direction of the arrows is a legitimate sequence for the parts of a statement. This sample shows the correct syntax for naming a file. The translation is given below.



- A line exits the top of this diagram with no keyboard input. This indicates that it is possible to not specify the filename or its extension. In this case, the file would have no name, and the system would assign a “default extension”.
- Further down the diagram, you can see that there are other possibilities. They are explained by the remarks, “maximum of 6 characters” for the name, and “maximum of 3 characters” for the extension.
- The filename can be any combination of letters, digits, the \$ sign, and spaces (up to six characters), and the extension can be up to three of those characters.
- The filename and extension must be separated by a period, as shown in the oval block at the top center.
- The remark “no extension” means that it is not necessary to specify an extension, even though a file name is given. Notice however, that this remark occurs after the period, so the period is necessary if a name is specified.
- Here are some examples of valid filenames according to the syntax illustrated in the diagram:

TESTIN.\$3A 1722A.INC \$\$\$\$\$\$.\$\$\$

NOTATION CONVENTIONS

The conventions listed here are used for illustrating keyboard entries and to differentiate them from surrounding text. The braces, { }; brackets, []; and angle brackets, < > ; are not part of the keystroke sequence, but are used to separate parts of the sequence. Do not type these symbols.

- <xxx>** Means “press the xxx key”.
Example: <RETURN> indicates the RETURN key.
- <xxx>/y** Means “hold down key xxx and then press y”.
Example: <CTRL>/C means to hold down the key labeled CTRL and then press the key labeled C.
- [xxx]** Indicates an optional input.
Example: [input filename] means to type the name of the input filename if desired. If not, no entry is required, and a default name will be used.
- xxx** Means to type the name of the input as shown.
Example: BASIC means to type the program name BASIC as shown.
- {xxx}** Indicates a required user-defined input.
Example: {device} means to type a device name of your choice, as in MF0: for floppy disk drive 0.
- (xxx)** This construction has two uses:
1. As a separate word, (xxx) means that xxx is printed by the program. Example: (date) means that the program prints today's date at this point.
 2. Attached to a procedure or function name, (xxx) means that xxx is a required input of your choice; the parentheses are a required part of the input. Example: TIME(parameter) means that a procedure specification is the literal name TIME followed by a parameter that must be enclosed in parentheses.

Section 2

Setting Up The Controller

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INTRODUCTION

The Fluke 1722A is a programmable Instrument Controller designed to manage a multiple instrument system using the IEEE-488-1980 instrumentation bus. It is able to command and communicate with various devices over this industry-standard bus.

User programs give the Controller the ability to collect data, process it, make decisions, respond to instrument service requests, and to format the results of these activities to meet the unique needs of the user.

The 1722A stores programs and the collected data on disk. A floppy disk drive is a standard built-in feature of the Instrument Controller. A general purpose RS-232 port is also standard; it permits the Controller to send information out to many types of peripheral devices, including modems and printers.

The programmer enters programs at a detachable keyboard. The system communicates with the programmer by way of a CRT display. After a program is entered, it can be stored in memory, on floppy disks or hard disk for later use.

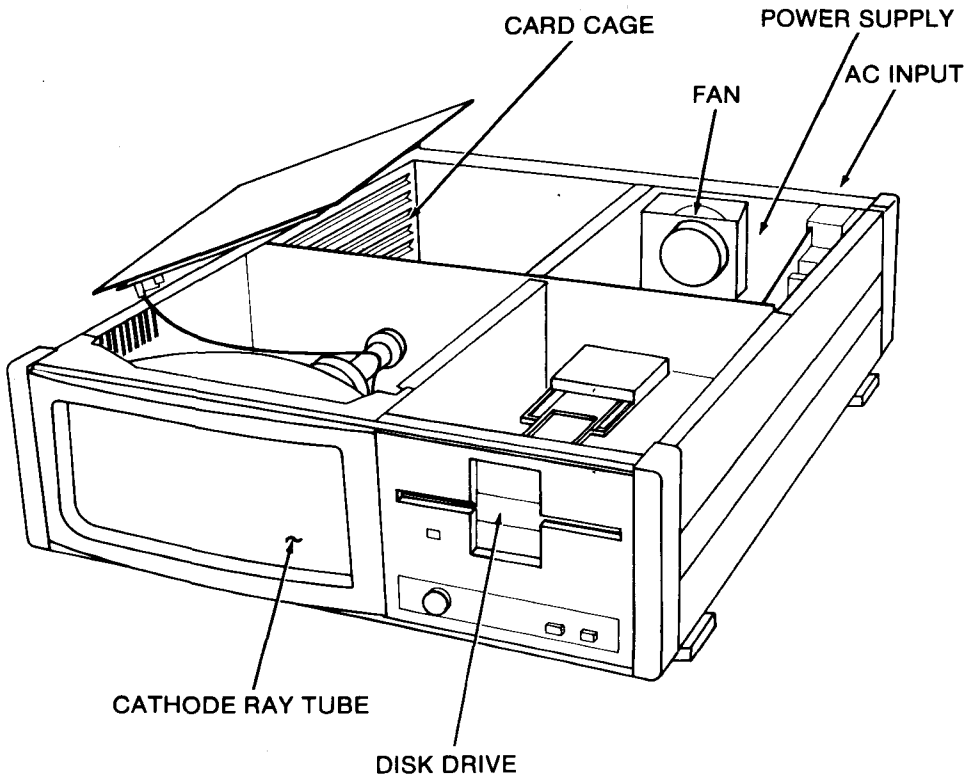
During operation, the keyboard can be detached. In this mode, the operator uses the Touch-Sensitive Display to respond to directions from the program, and to give inputs to the system.

FEATURES

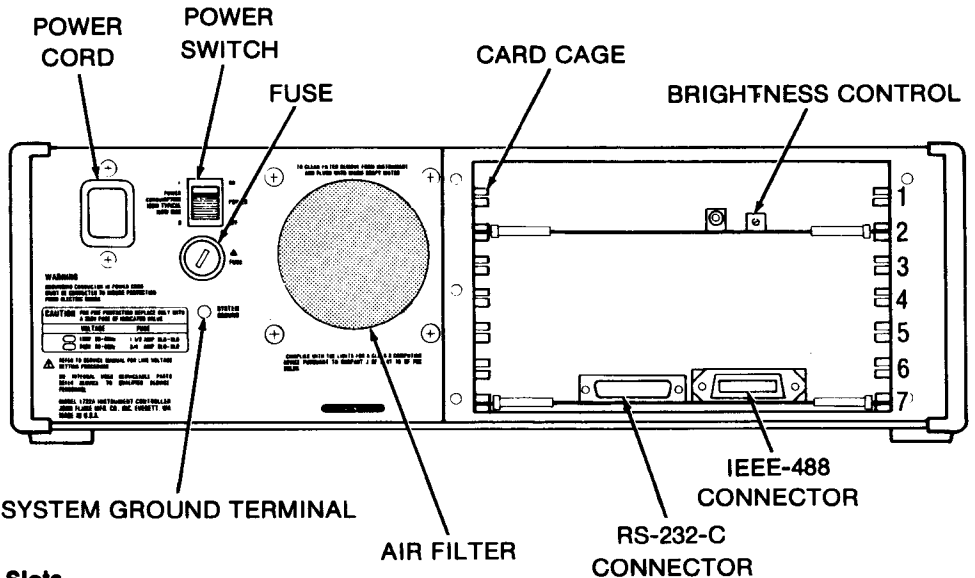
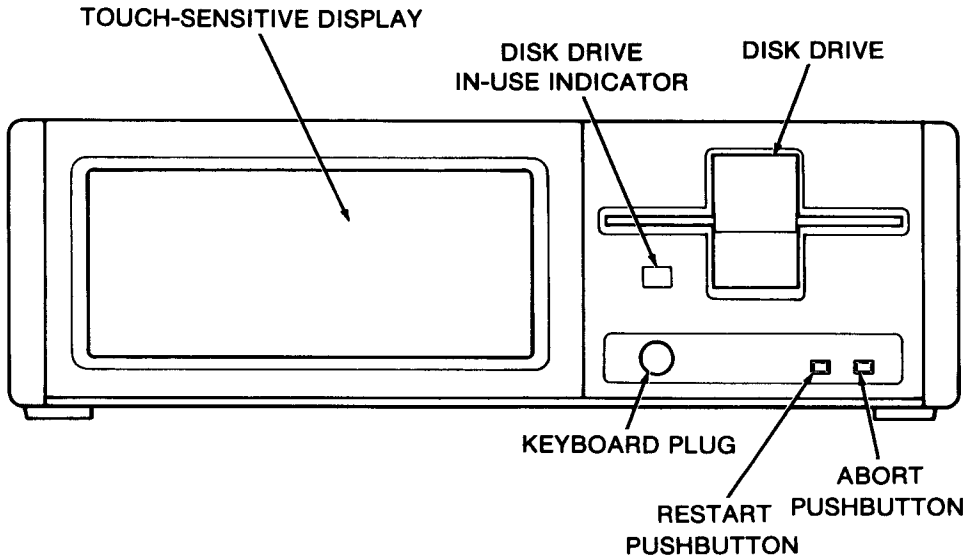
- A 16-bit single-board microcomputer with 136K bytes of on-board memory. Approximately half is available for storing user programs.
- Programmable graphics; 640 x 224 pixel resolution.
- Video character enhancements that include double-size display, highlighting, blinking, and reverse video.
- A Touch-Sensitive Display for the operator; resolution to 60 finger-tip sized areas.
- 400K byte floppy disks for storage and back-up. Can be formatted for either single or double sided operation.
- Battery-supported real time and calendar clock (program-accessible).
- Standard IEEE-488-1980 Interface.
- Standard RS-232-C Interface.
- Composite video output for connection to an external video monitor.
- Detachable keyboard.
- Rackmountable.
- Extensive set of options for upgrading system capabilities as user needs increase. Memory can be increased to approximately 2.7M bytes; up to seven serial ports or six parallel ports can be added.

Setting Up The Controller

PHYSICAL LAYOUT



Setting Up The Controller Physical Layout



Slots

Single Board Computer	7
Video/Graphics/Keyboard Interface	2
Options	1, 3, 4, 5, 6
Memory Expansion Options	1, 3, 4, 5, 6
Input/Output Options	1, 3, 5
Non-Input/Output Options	4, 6

Unpacking

The 1722A is carefully packed for shipping to ensure that it arrives in good condition. Unpack all the containers and check the 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 occurred, notify the shipping agent immediately. Then call a Fluke Sales Office or Customer Service Office. Use this checklist to be sure the shipment is complete:

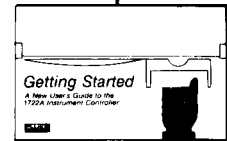
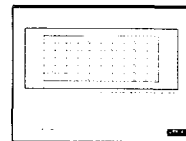
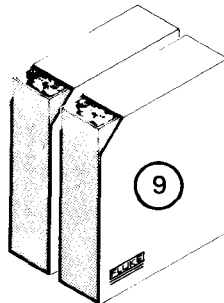
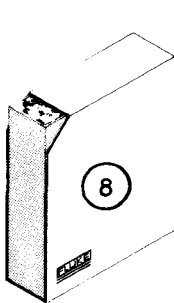
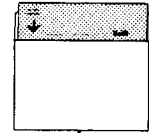
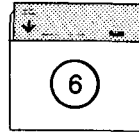
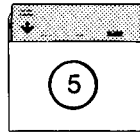
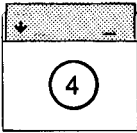
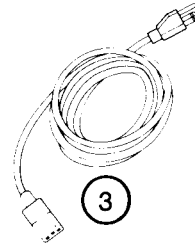
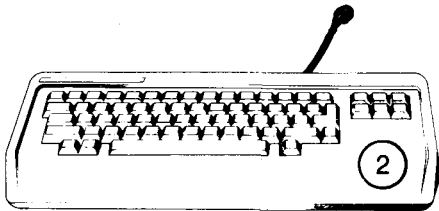
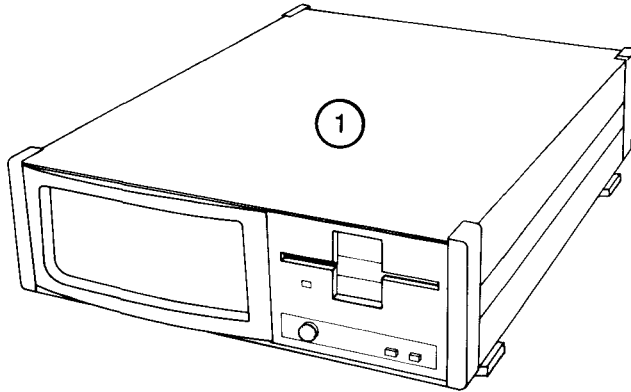
Unpacking Checklist

1. Controller Mainframe
2. Keyboard
3. Power cord
4. System disk
5. Data disk
6. Diagnostic disk
7. Getting Started disk and manuals
8. System Guide
9. BASIC Programming Manual
10. Programming Worksheets (pad of 50)

Other options or accessories may be included with the shipment. Check the contents against the original order to ensure that all items have arrived. A list of options and accessories is given in Appendix B.

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

Setting Up The Controller Unpacking



INSTALLATION

Introduction

Any microprocessor-based piece of equipment is made up of two parts: hardware and software. Installation usually involves a physical installation and some sort of software configuration. This section describes the physical installation of the 1722A Instrument Controller. Software configuration is covered in Section 3.

Before using this section to install and checkout the Instrument Controller, be sure you are familiar with the location of all the connectors and controls. Doing so will assist you in setting up the instrumentation system.

Environment

It is important to ensure that the location meets the environmental requirements listed in the Specifications. Heat and humidity are two of the worst enemies of electronic equipment, particularly the floppy disk and its drive. Allow at least 10 cm (4 inches) between the back of the unit and the wall to allow the fan to cool the unit adequately.

Floppy disks are more sensitive to storage environments than the Instrument Controller. If a disk becomes colder than 10°C (50°F), or warmer than 50°C (122°F), allow it to reach room temperature and humidity before placing it in the Controller. The Check-Out Instructions include other disk handling precautions.

CAUTION

Low humidity environments can contribute to static buildup. Static discharges can permanently damage circuitry within the 1722A, and erase information recorded on the floppy disk. To prevent such damage, always make sure that the humidity is above the minimum specified level and that the instrument is properly grounded.

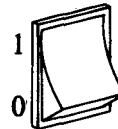
Pre-Installation Checkout

1. Place the 1722A on a suitable table. Check the label on the rear panel to ensure that the unit is set up for the proper line voltage, and that the proper fuse is in place. If either of them are incorrect, notify your Fluke Technical Service Center.
2. Check to see that any ordered options are installed. If "installed" was specified on your order, the options should already be in the Controller. Otherwise they will be packed separately.
3. Install any options that were not specified to be factory-installed. (Refer to the manual provided with the option.)
4. Release the door latch on the floppy disk drive by pressing in on the top. Remove the protective shipping insert from the disk drive.

CAUTION

Do not attempt to operate the Controller before removing the protective shipping insert. Doing so can damage the disk drive.

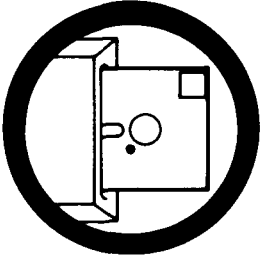
5. Attach the keyboard and line cord. Plug in the line cord and turn on the power switch (rear panel).
6. Following the disk handling precautions on the next page, gently insert the System disk (label up) into the disk drive.



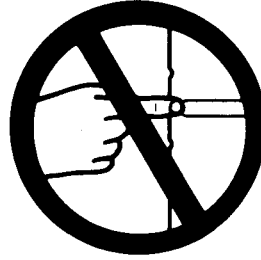
NOTE

Floppy disks supplied by Fluke use reinforced center rings to help seat the disk on the spindle. If floppy disks without such rings are used, first insert the disk, and gently close the door without latching it. Reopen the door slightly, then close and latch it. This insures that the disk seats on the spindle, and improves the reliability of reading and recording data.

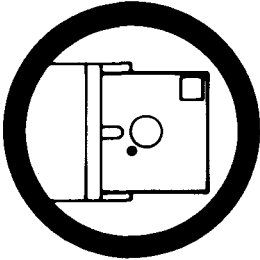
Setting Up The Controller
Floppy Disk Care



Insert Carefully
Insertar
Insérer avec soin
Sorgfältig Einsetzen
插入注意



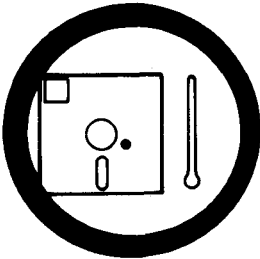
Never
Nunca
Jamais
Nie
絶対禁止



Protect
Proteger
Protéger
Schützen
保護



Never
Nunca
Jamais
Nie
絶対禁止



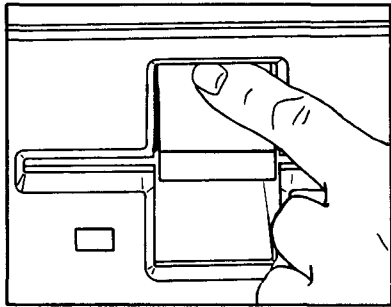
10°C - 50°C
50°F - 122°F



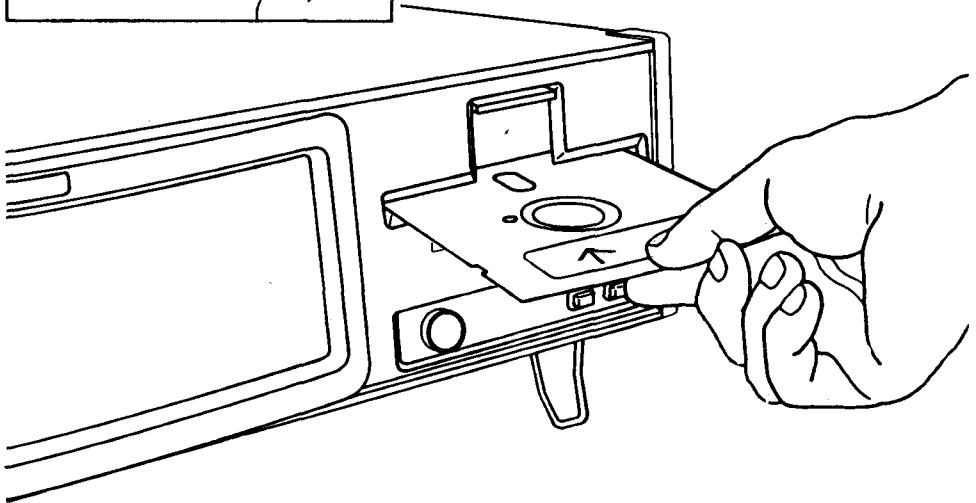
No
No
Non
Falsch
注意

Setting Up The Controller
Loading a Disk

7. When the disk is fully seated, latch the drive closed by pressing in on the bottom of the latch.

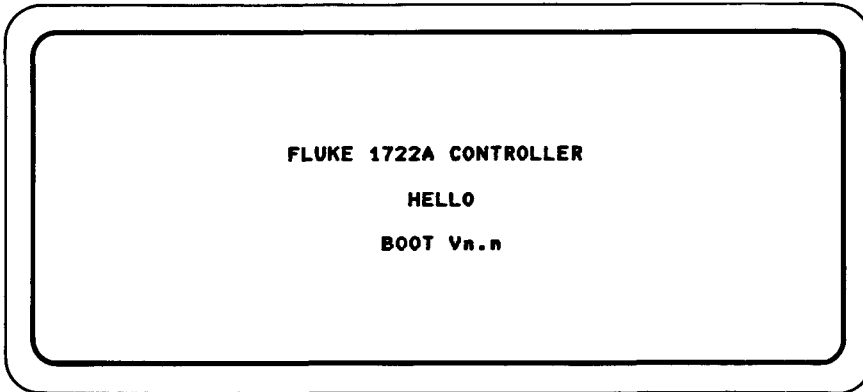


PRESS TOP OF DOOR LATCH TO RELEASE

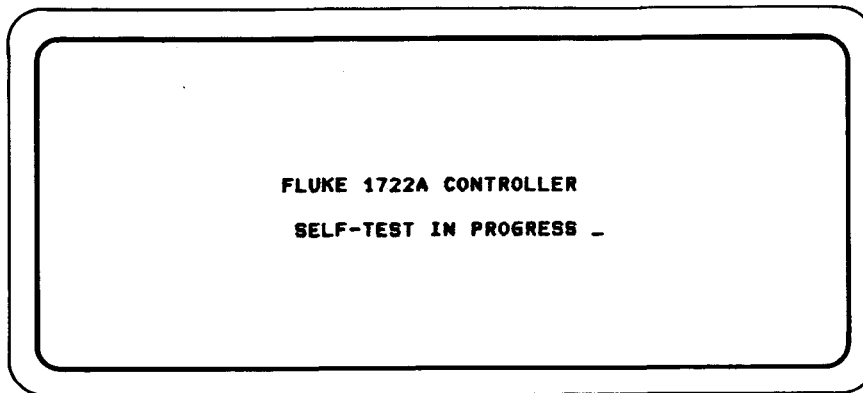


Setting Up The Controller
Power Up

8. Press **RESTART** and watch the display. It should read:

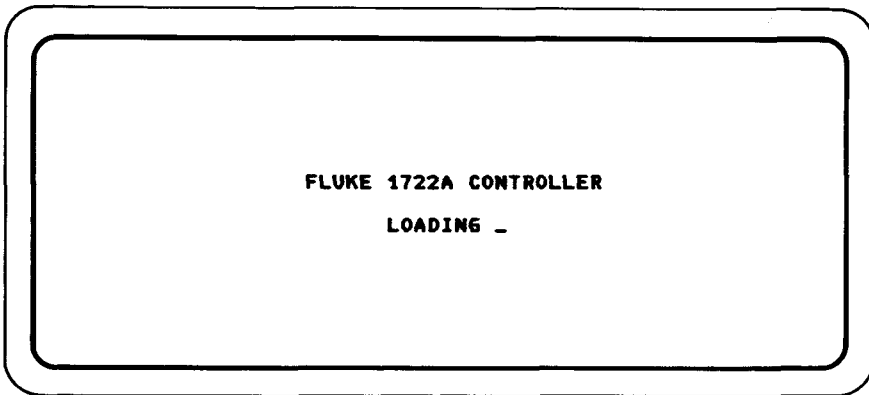


9. Verify that the version number is covered by this manual (see frontispiece). If it is not, call a Fluke Customer Service Center for advice.
10. Following this display, the 1722A performs a self-test that checks out the internal circuitry. The display changes to read:

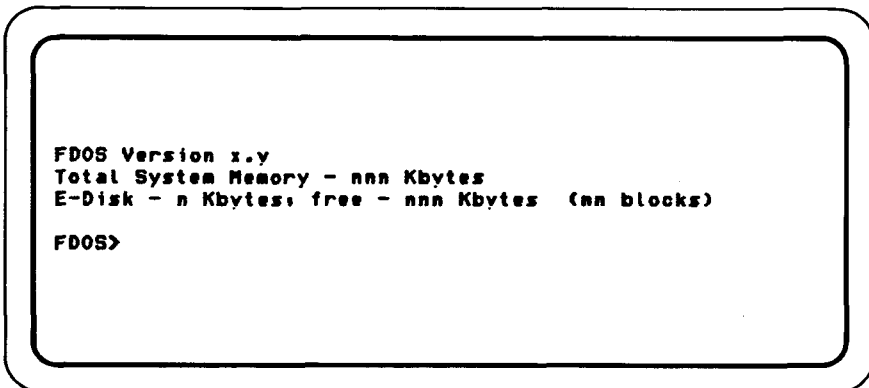


Setting Up The Controller
Power Up

11. If the self test is not successful, an error message is displayed on the screen. If this happens, recheck the previous steps. For continuing failure, see the list of Self Test error messages in section 3. If everything seems to be in order, service may be required. Contact your Fluke Service Center.
12. After the self-test is successfully completed, the 1722A loads the Operating System software into main memory from the System disk. The display again changes to read:



13. When the Operating System has been loaded from the floppy disk into memory, the system asks for the correct time and date to be set. When this has been done, the prompt for the Fluke Disk Operating System is displayed:



Setting Up The Controller

- If all these steps have been successful, the 1722A Instrument Controller is fully functional, and the Pre-Installation Checkout is complete. There is a more complete discription of the system's power up activities in the next section, Software Configuration.

NOTE

Altered system software may not ask for the time and date, nor show the FDOS\ prompt. The programmer can tell the installer how the successfully loaded software will appear.

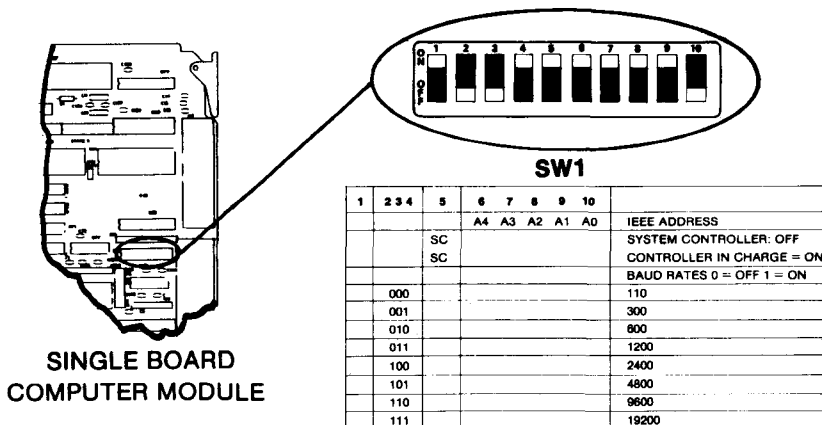
SYSTEM INSTALLATION

Introduction

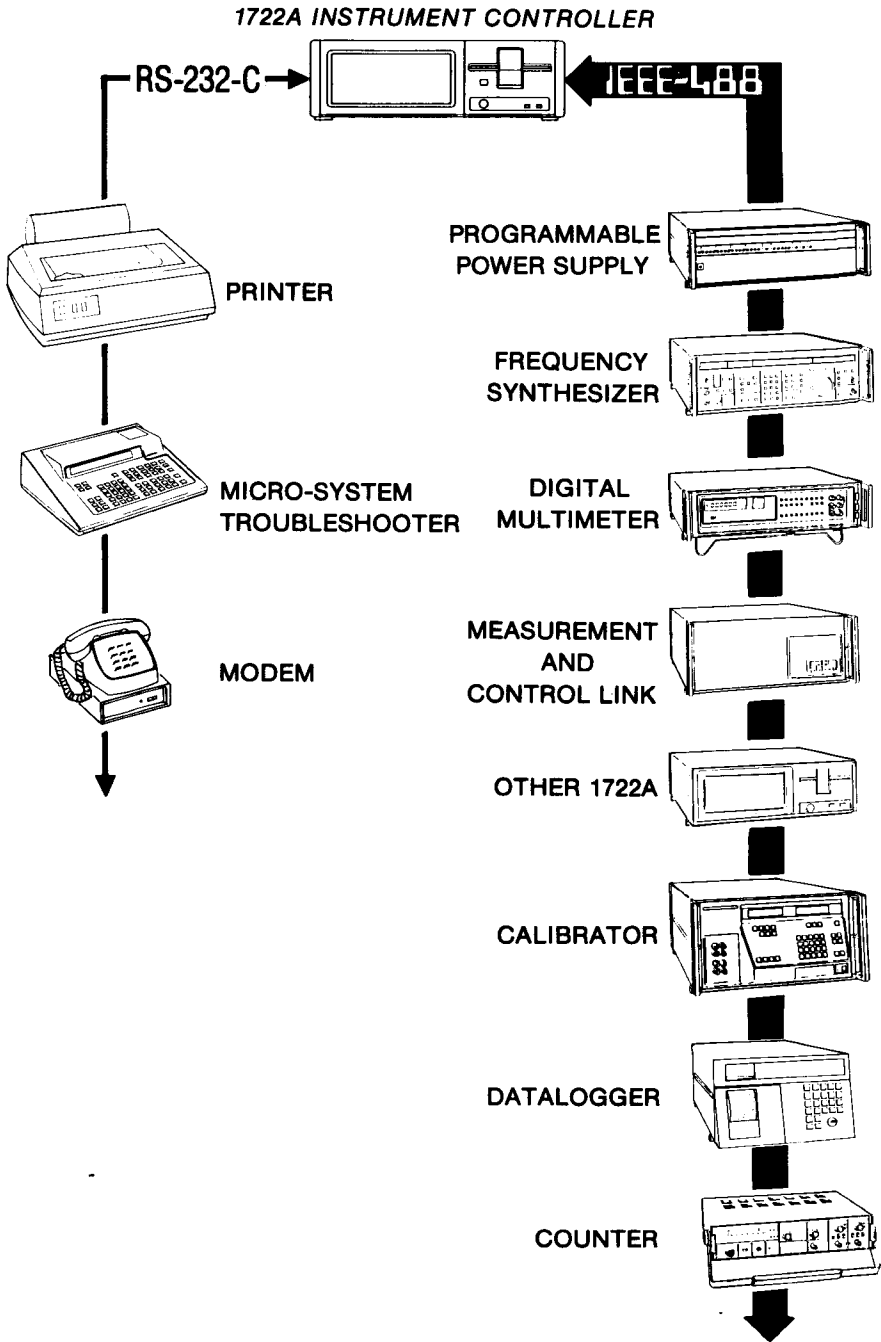
Because of the versatility of the 1722A Instrument Controller, it is not possible to give more than general guidelines on how to configure it into a system. The drawing on the next page can help give a feel for the possibilities. Please consult the Configuration Table in appendix B for details.

Multiple Controller Systems

The IEEE-488 Instrumentation standard allows more than one controller on the bus. However, only one may be designated as the system controller at any one time. The drawing below shows how to set switch 1 on the Single Board Computer module for the 1722A to be designated either as a "system controller" or "controller in charge" at power up. Refer to Section 5, Communications, for a complete discussion, and directions on how to set up the 1722A in a system with more than one controller.



Setting Up The Controller System Installation



Situating the System Components

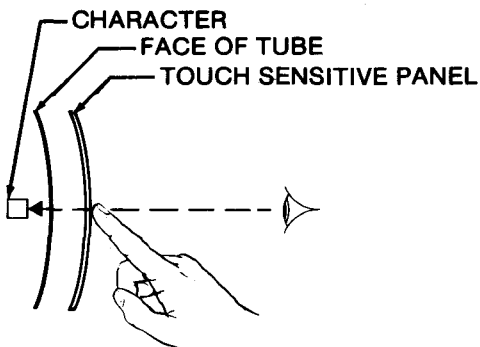
Like any system instrument, the 1722A can either be rack-mounted or used on a bench. Rack mounting is preferred for more permanent installations, or in those cases when the system will be set up in an assembly-line application. Research and development facilities, scientific or engineering laboratories, or in those places where the Controller will be used in various locations, generally either do not rack-mount the system, or else mount it into a moveable rack.

Wherever the installation site is, try to choose a location where the display will not be subject to glare from overhead lights or windows.

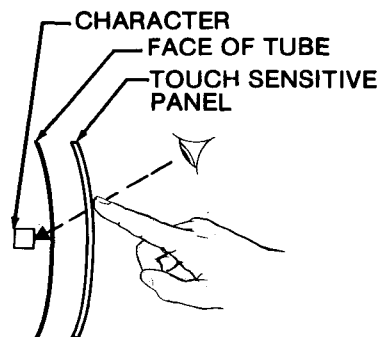
Workbench Installation

Normally, little thought is given to planning how to set up a test fixture on a work bench; wherever things fit is usually where they are put. However, a little planning can make the installation much more versatile, efficient, and pleasant to work with.

1. Find a location for the Controller where the Touch Sensitive Display will be as close to eye level as possible. This will avoid long reaches for the operator that can become tiring, and ensures that a parallax error will not cause the operator to touch the screen at the wrong location.



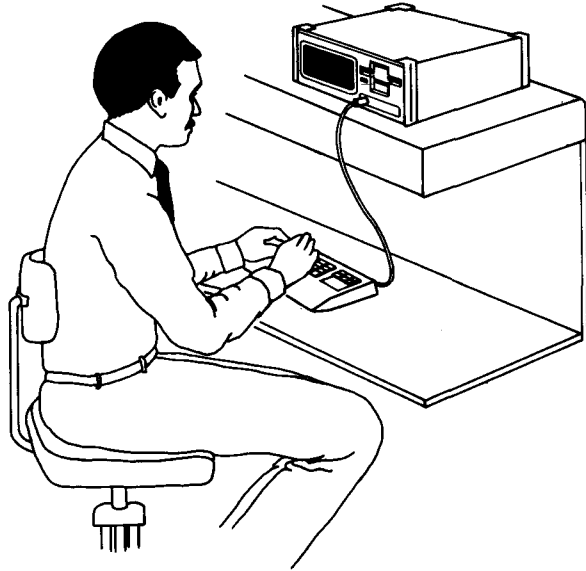
RIGHT



WRONG

Setting Up The Controller System Installation

2. Position the keyboard so that the programmer is able to sit directly in front of the screen, rather than off to one side.



3. If repeated connecting and disconnecting of instruments is going to be done, make sure the back of the workbench is open and not against a wall. This makes connectors on the rear panel more easily accessible.
4. Arrange other instruments on the bench so they are easy to see and operate.
5. To protect information on the floppy disks, never place an oscilloscope, soldering iron, or other source of high voltage or electromagnetic fields near the disk or disk drives.
6. Keep the equipment cables neatly organized. Dressing the cables ensures that long cables will not degrade signal quality among the instruments, keeps the work area neat, and helps trace any problems that might occur.

Rack Mounting

Installing the Controller in an equipment rack requires more planning than a bench top installation because it is more difficult to change if things don't work out. Here are a few things to keep in mind as you plan a rack-mounted installation:

1. Plan for a way that the keyboard can be easily used after the installation. Even though the keyboard will not be attached during normal operation, the keyboard may be needed later to change programs. If the Controller can be left in the rack, time and effort can be saved.
2. If the programs will have a high degree of interaction between the operator and the Touch Sensitive Display, consider mounting the Controller so that it will be at eye level from the operator's normal working position. If the operator stands, the Controller should be mounted about 1.5 meters (5 feet) from the floor. If the operator sits, then it can be mounted lower. This will avoid long reaches and parallax errors.
3. If programs will not require much interaction, place the instrument with which the operator will be working most frequently directly at eye level, and fill the rack outward from there with those instruments used less frequently.
4. To protect the information on the floppy disks, position any instruments that radiate electromagnetic fields as far as practicable from the Controller.
5. Observe good cable dress to ensure good signal quality and to help trace any problems that might occur.

Connecting the IEEE-488 Bus

One of the features of the IEEE-488 connector is that it is both a male and female connector. Because of this, it is possible to stack all of the connections (up to the maximum of 14) into one location, or to arrange them in any other configuration desired. However, it is probably a better idea to distribute the IEEE-488 connectors among the instruments for two reasons:

1. In such an arrangement, the connectors do not extend as far, and connector stress that could cause intermittent problems later is eliminated.
2. Using a distributed connector pattern, it is easier to change any connector's position than if the bus connections were all at the same place.

The IEEE-488 standard states that total cable length in a system should not exceed 20 meters (about 60 feet), and that no single cable should exceed four meters (12 feet). Allow 2 meters (6 feet) of cable per piece of equipment.

Note

When it is shipped from the factory, the 1722A Instrument Controller meets or exceeds the requirements of FCC part 15-J and VDE 0871. To ensure continued compliance with these standards, any cables connected must be shielded and incorporate 360° metal connector bodies. These are available from John Fluke Mfg. Co. Inc. using these part numbers:

IEEE-488

2 meter: 658526

1 meter: 682401

4 meter: 682419

RS-232

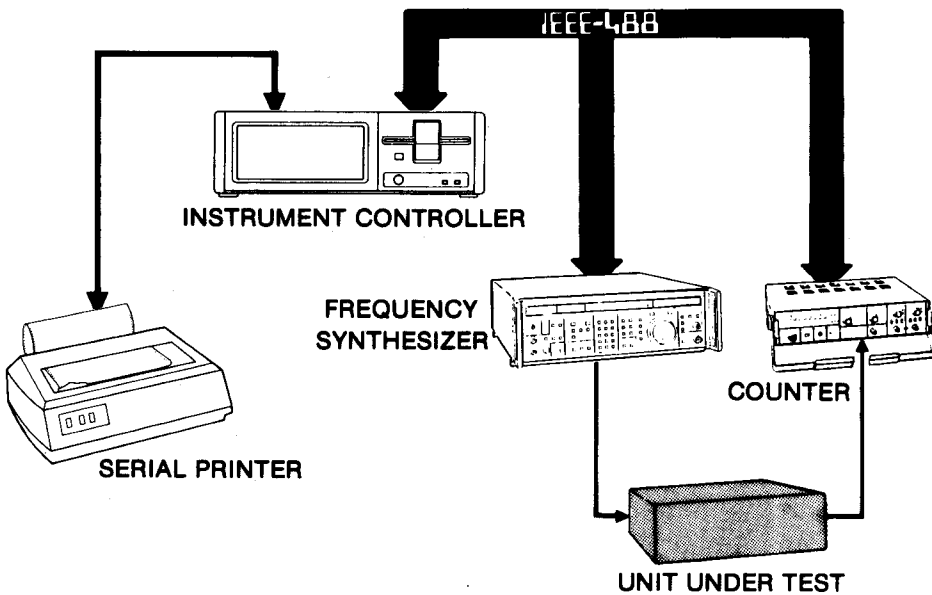
2 meter: 706688

10 meter: 706846

BRINGING THE SYSTEM UP

This section can be used in two ways. First, it can help you plan for the eventual test configuration by providing some ideas about how to test the system as it is built. Secondly, it provides some guidelines on actually bringing the system up once it is designed.

Below is a representation of a "typical" instrumentation system. In the guidelines that follow, this system is used as a sample of how to ensure success in bringing the system up.



This system has 5 devices connected:

- 1722A Instrument Controller
- 6160B Frequency Synthesizer
- 1953A Digital Frequency Counter
- 1776A Serial Printer
- Unit Under Test

All the devices except the Unit Under Test and the Serial Printer are connected to the IEEE-488 bus. The printer connects to the RS-232 port, and the Unit Under Test connects to the measurement instruments.

In this example, a short software test routine should be written that programs the synthesizer's output frequency and then listens to the frequency counter to see that it has measured the same value that was programmed into the synthesizer. The last step in the test program would be to send the results to the serial printer for a hard copy.

This same example system is used in Section 7, Automating System Functions, to explain in detail how this test program would be developed.

1. Set up the IEEE-488 bus addresses of each device on the bus. This is usually done by installing or removing jumpers or by a switch setting. The exact procedure depends on the instrument.
2. Connect the IEEE-488 instruments. One cable is required for each instrument.
3. Connect the frequency counter to the synthesizer.
4. Power up the system, and run the test program. If it is successful, the test validates the bus. Also, the software that was written for the test is a development tool for the actual system that will result. It will have verified that the correct addresses are programmed into the IEEE-488 instruments, and that the programmer is able to talk and listen to each of the instruments.
5. Turn the system off and connect the RS-232 printer. Then power up the system and run a second test routine that sends the data to the printer. This data may be the result of the test, or it might simply be a short data file that includes a full character set of the printer.
6. Power down again, and connect a known good unit as the Unit Under Test. Run the second test routine, and see that the correct readings result.

If all of these tests are successful, the instrumentation system is fully functional. The value of setting up this kind of minimal system before a more comprehensive one is that it verifies both hardware and software, and provides a building block approach to the final configuration.

CONCLUSION

In this section, the emphasis has been on physically setting up the Controller. However, the instrumentation system cannot be set up until the system software is configured, and the test programs are written that verify the hardware installation.

In the next section, the next step in setting up the Controller, configuring the software, is discussed. Section 6, Creating and Editing Programs; and Section 7, Automating System Functions describe how to program the Controller.

Section 3

Software Configuration

CONTENTS

Introduction	3-2
Loading The System Software	3-3
Bootstrap Loader	3-3
Self-Test Error Messages	3-4
Other Errors	3-5
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Setting the Time	3-7
The Operating System	3-9
Command Line Interpreter	3-10
Utility Programs	3-10
Making a New Operating System	3-12
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A Note About Software Compatibility	3-12
Necessary Files	3-13
Optional Files	3-13
Using the System Generation Utility	3-14
Conclusion	3-15

INTRODUCTION

The last section discussed how to set up the Instrument Controller from a physical point of view. This section describes the software, which, together with the hardware, make up a functional Instrument Controller. The section includes a description of the software that is shipped with each new Controller. The topics in this section are:

- Loading the System Software
- The Startup Command File
- Setting the Time
- The Operating System
- The Command Line Interpreter
- Utility Programs

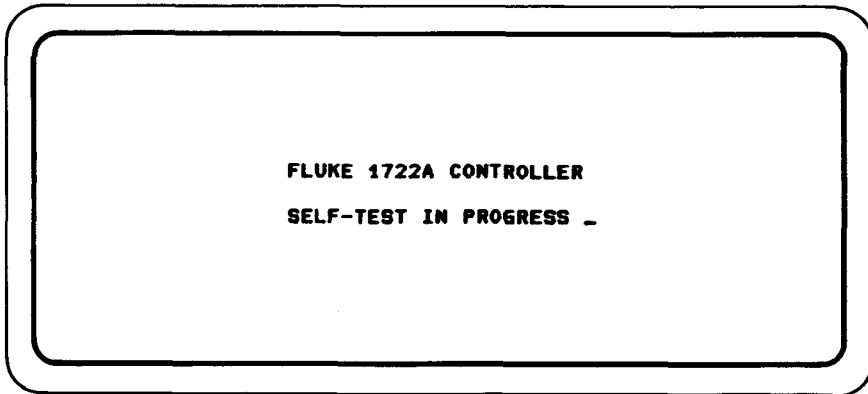
LOADING THE SYSTEM SOFTWARE

Bootstrap Loader

When the Controller is powered up, a small program that is permanently recorded in a memory has control of the internal microprocessor. This program, the Bootstrap Loader, first says "HELLO", then performs two very important functions:

- It checks out the Controller with a self test to make sure all the hardware is operating properly.
- It loads the system software.

The Self test checks the memory, processor, and the interfaces.



The benefit of this automatic test at power up is that if it is successful, the Controller's hardware is verified as operational and if a problem occurs later, the hardware can be eliminated as the fault. If the test fails, press RESTART and try again. If the problem persists, contact your Fluke Customer Service Center.

Self-Test Error Messages

If an error occurs during the self test, a message will be displayed that takes the form:

FAILED: - xxx Test.

The xxx will be replaced by the failing component, and may be any of the following:

- ROM Test
- RS-232 Port Test
- Memory Mapper Test
- Macrostore Memory Test
- On-board Memory Test
- IEEE Controller Test
- Floppy Disk Controller Test

All of these messages indicate a non-recoverable hardware failure. Try resetting the Controller first, but if the error continues, make a note of the test that failed, and contact your Fluke Service Representative.

After the Self test, the Bootstrap loader attempts to load the operating system.

The Bootstrap loader searches for the system software on the floppy disk, Electronic disk, then in the bubble memory if one is installed. If the system software is found, it is loaded into main memory. The device from which the system software was loaded is made the system device. (For more information about the system device, see Section 4, Devices and Files.)

As soon as the operating system is loaded, it takes over from the Bootstrap Loader, and the instructions recorded on the software disk direct the controller's activities from that point.

Other Errors

Some errors can occur during the power-up self-test, or anytime during the operation of the Controller. They are always preceded by a question mark indicating that they are "non-recoverable"; the Controller continues to return the same error unless you take some corrective action. These errors and the corrective action required are:

Message	Meaning
? Disk Not Ready	Insert or reinsert the System disk. Either there is no disk in the drive, or it has been inserted incorrectly. Make sure the disk drive door is latched.
? Illegal Directory	The disk is faulty and must be replaced before the Controller will operate properly. It may be possible to save the files from the bad disk by using the File Utility program.
? Device Error	The system is having difficulty reading the floppy disk. Check to be sure it is a System disk, and that it is inserted properly. If so, RESTART and try again. If the failure continues, try another System disk.
? No System On Device	The Controller does not recognize the disk in the drive as a System disk. Try another System disk. The wrong disk may be inserted or it may be inserted incorrectly.

The Startup Command File

On a standard System disk, the operating system loads a special command file called `STRTUP.COM`. A command file is a collection of keyboard commands that would otherwise have to be typed in. Command files serve to automate commonly performed functions. For more details, see section 4.

The `STRTUP.COM` file on a standard disk loads two more programs: The Time and Date Utility and the BASIC Interpreter program.

The `STRTUP.COM` file is easily changed. After gaining some familiarity with the Controller, you may want to modify the startup file to customize the Controller's functions at power-up. There is a complete description of how to do that in Section 7, Automating System Functions.

- If the file `STRTUP.COM` is found, it is loaded, and the FDOS prompt will not have been displayed. Instead, the display reads:

```
FDOS Version 1.0
Total System Memory - 640 Kbytes
E-Disk - 1 Kbytes free - 10 Kbytes (10 blocks)

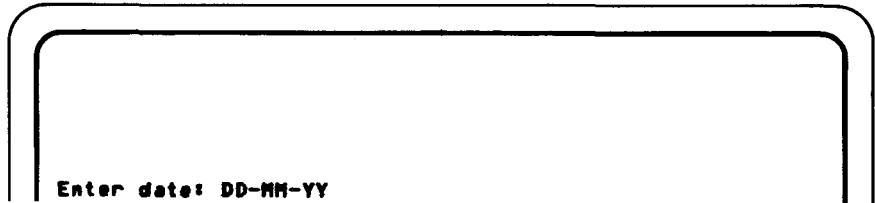
Startup Command File Execution in Progress

Please Standby...
```

- If the file `STRTUP.COM` is not found, the Operating System takes control. This would happen if the disk being loaded is not the System Disk supplied with the Controller, or if the `STRTUP.COM` file has been renamed or deleted.
- The `STRTUP.COM` file on the System Disk supplied with the 1722A first checks the Time and Date Utility to see if the time has been set. If it has, it loads the BASIC Interpreter program and transfers control to it.

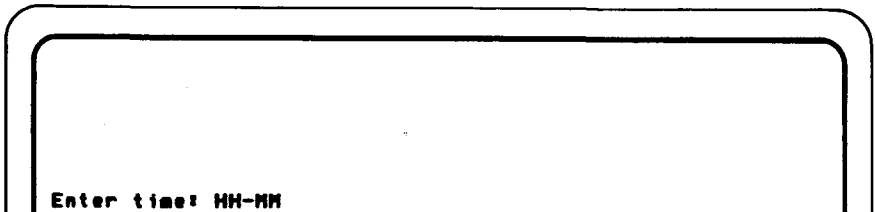
Setting the Time

- If the time clock has not previously been set, the display will next read:



Enter date: DD-MM-YY

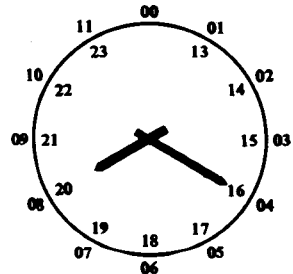
- Type in today's date in numeric form, starting with the day, then the month, and then the year. The entries must be separated by a hyphen or other non-numeric character. Use the DELETE key to correct any mistakes. Press <RETURN> and the display reads:



Enter time: HH-MM

- Enter the time in 24-hour format: first the hour, then the minutes. Separate the two by any non-numeric character. Press <RETURN> to complete the operation.

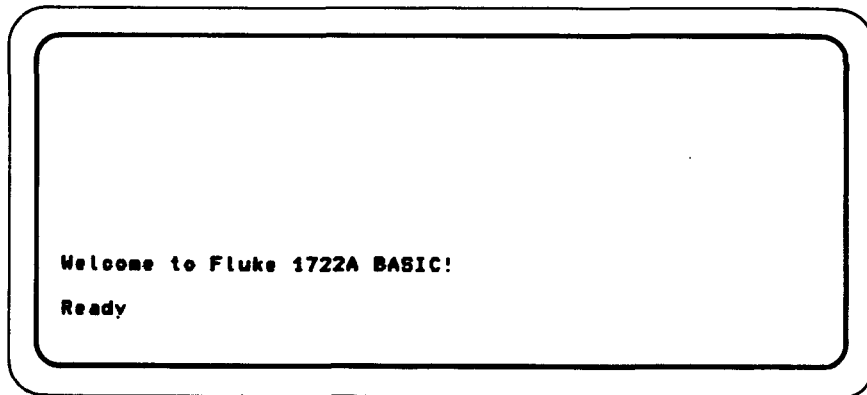
*The time on this clock is 8:20.
If it is before noon, enter 08 20;
if it is evening, enter 20 20.*



Software Configuration

Power Up

- Once the date and time have been set, the BASIC Interpreter program is loaded. The display reads:



- The “Ready” prompt indicates that the BASIC Interpreter program is running in the Immediate Mode.

If all these things have happened as described, the Controller is operating properly. The “Ready” prompt indicates that the Controller has passed the Self Test, that the STRTUP.CMD program has run properly, and that the Controller is now ready to receive commands in the BASIC language.

If you do not want to begin by programming in BASIC, it is a simple matter to exit the BASIC Interpreter program, and begin working with the Command Line Interpreter. To do that, type EXIT <RETURN> . The prompt for the operating system is FDOS)

To get back to BASIC, just enter the word BASIC, and then <RETURN>

Below is a description of the software modules that make up the operating system on a new system software disk.

The Operating System

Because the Instrument Controller is a programmed instrument, its functions are controlled by a master operating program. In the 1722A, this program is the Fluke Disk Operating System Program (filename FDOS.SYS) The program's name is usually shortened to 'the Operating System'.

The Operating System program controls the hardware components of the Controller. It takes instructions from the keyboard or from a program, and directs the functions of ports, manages the memory, and manipulates files to convert the instructions into action.

The Operating System is a soft-loaded program, which means that it is recorded on a disk, rather than being permanently in the memory. The advantage of making the Operating System soft-loaded is that it can be easily maintained and updated. Also, new software can easily be added without having to install special hardware. Soft-loaded operating systems are loaded at the beginning and remain in use while the instrument is turned on.

For this reason, the Operating System file (normally the standard 1722A System disk) must be in place when the power is turned on, or when the RESTART button on the front panel is pressed. However, the file FDOS.SYS is not sufficient for proper bootup operation. Other necessary files are:

ALIAS.SYS

MACRO.SYS

These files are explained in more detail in Sections 6 and 7.

Since it possible to relocate the Operating System into Electronic disk or the optional Bubble memory, and since the Bootstrap loader looks at these places besides the floppy disk drive, it is not necessary to have the System disk physically in place to load the Operating System. In fact, the loading process can be considerably speeded up by recording the Operating System into memory, and loading from there rather than from the disk.

Command Line Interpreter

The part of the operating system that receives instructions from the keyboard is called the Command Line Interpreter. The Command Line Interpreter can accept either single command lines (instructions) from the keyboard, or the instructions contained in a Command file. Instructions can be entered either in lower case or upper case. To distinguish commands from other text, this manual shows only upper case.

Automating the 1722A using Command Files is described in detail in Section 7, Automating System Functions.

Utility Programs

Four Utility programs are provided to assist you in configuring the Controller and in developing software:

- TIME** The Time and Date Utility. [filename TIME.FD2]
This utility program is used to set or read the time and and date maintained by the 1722A calendar/clock circuitry. Once the clock is set to the correct time and date, it can be used to imprint programs or data. It can also be used to display the current setting. Battery power keeps it accurate when the power is turned off. The Time and Date Utility program is discussed in more detail in Section 7, Automating System Functions.
- SET** The Set Utility. [filename SET.FD2]
This program changes the parameters at the RS-232 port. These parameters govern the way information is sent and received between the Controller and any devices connected to the serial communications port. One parameter, the length of time out, can also be changed for the IEEE-488 port. The Set Utility program is discussed in more detail in Section 5, Communications.
- FUP** The File Utility program. [filename FUP.FD2]
The File Utility is used to to create, delete, rename and copy files, and to channel them between the various devices in the Controller. The File Utility program is described at the end of the next section, Devices and Files.

SYSGEN The System Generation program. [filename
SYSGEN.FD2]
This program is used to create operating system software
to support configurations that include options.

Other programs on the disk are:

EDIT The Editor program [filename EDIT.FD2]
A program used to create and edit other programs. The
Editor program is a powerful tool, designed to assist in
writing and changing programs. Among its many
features, it permits you to insert and delete varying
amounts of the programs (e.g., single characters, lines,
phrases), or to search for and replace an existing
character, line, phrase, or string. The Editor program is
described in a Section 6, Creating and Editing Programs.

BASIC This is the program that permits the Controller to run
BASIC language programs. The Fluke BASIC
Programming Manual that is supplied with the
Controller is a complete reference for the BASIC
language.

MAKING A NEW OPERATING SYSTEM

Introduction

The System Generation program is provided on the System Disk with the filename SYSGEN.FD2. It is a tool for making a new Operating System. When options are added, the Operating System must be modified to include the programs that drive them. You must use the System Generation program when these optional hardware modules are installed:

- Winchester hard disk drive
- Parallel Interface module
- Bubble Memory module
- External Mini-floppy drive
- Other modules as they are developed

A Note About Software Compatibility...

The System programs are software modules supplied with the Controller as files on the System Disk. These machine-language programs are interdependent and are compatible in the combinations supplied with the Controller.

System programs are easily copied and erased, since they are treated as any other file. The portability and copying ease of system software allows you to take advantage of Fluke's continuing program of software development. However, it is possible to inadvertently record incompatible modules onto the same disk. Therefore, it is important to keep track of the various software modules on your disks.

Use caution when copying new or updated software to make sure that the modules are recorded in the same combinations as the original disk. If a mistake is made, the operating system may not load the incompatible module, and display an error message.

Experienced programmers often suggest keeping a record of any changes made to software disks, to keep mistakes to a minimum and to make it easier to track down any problems that might occur. One way to do this is to use the /L option of the File Utility program to print a listing and keep it with the floppy disk.

Necessary Files

The System Generation program requires some files in order to build the operating system. Before beginning, use the File Utility program to make sure you have these files available:

SYSGEN.FD2 (the program that generates new FDOS2.SYS files)
FDOS2 .LIB (library of modules to build FDOS2)
FDOS2 .CFG (used by SYSGEN to generate the prompts)

Optional Files

Many of the files provided on a new System disk do not need to be included on a copy in order to have a complete, operational Controller. The File Utility program itself is such a file. Remember, though, that if the File Utility program is included, you should also include the Help file (FUP.HLP), because without it, a useful feature is lost. The optional files are:

ALIAS .SYS
BASIC .FD2
TIME .FD2
SET .FD2
FUP .FD2 (if included, FUP.HLP is helpful)
EDIT .FD2
SYSGEN .FD2 (if included, FDOS2.LIB and FDOS2.CFG are necessary)
MACRO .SYS
STRTUP .CMD
GRAPH .OBJ
PIB .OBJ
PIBLIB .OBJ

Using the System Generation Utility

Before beginning, decide if you want to keep a copy of the original Operating System configuration. If so, make a backup copy using the File Utility program whole copy option /W. Because the floppy disk contains so much more information than the Electronic disk can contain (without Memory Expansion modules) it is usually necessary to do the backup in stages. The complete sequence is described in the File Utility program Whole Copy option, /W.

Once the backup has been made, press RESTART and ABORT simultaneously to simulate a cold start, and load either of the disks.

1. From the FDOS> prompt, type SYSGEN <RETURN>.
2. When the program has loaded, the screen will display the System Generation Utility program identification, then will list the names of files it is linking to, and then begin asking if you want various drivers.
3. Answer Y to those that are desired, otherwise N. It doesn't matter if you include drivers you won't be using, but by not including them, more memory space will be available for use by your programs, and for Electronic disk.
4. After you answer all the questions, the program reads the required software modules from the file named FDOS2.LIB, and records them to FDOS2.SYS, replacing the current file recorded there.
5. Press RESTART, and allow the new Operating System to load. Test each module by using the File Utility program to scan (/S), format (/F), or zero (/Z) the devices associated with each driver.

CONCLUSION

This section has described the programs that are recorded on the System disk supplied with the 1722A. These programs are tools for the system designer to use in setting up an instrumentation system. None of these programs actually control an instrumentation system, but facilitate writing those programs that do.

To make use of these programs requires using some other tools, referred to as the system's resources: devices and files.

The next section introduces these system resources, and explains how to use each device and each type of file.

Section 4

Devices And Files

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INTRODUCTION

In the last section, the Instrument Controller was described as a machine having two components; hardware and software. Together they operate as an Instrument Controller. Both the software operating instructions and the hardware are necessary parts of a working System Controller. This section expands that view, and introduces a third aspect of the Controller: the resources with which it will perform its ultimate task of controlling an instrumentation system.

The resources of the Controller are its devices and files. A device can be thought of as a storage location, like a file cabinet. Electronic files are stored in the Controller's devices just as hardcopy files are stored in file cabinets. Devices and files are discussed together here because they are so closely related. This section describes how to use the File Utility program to manipulate devices and files. Section 7, Automating System Functions, explains how to manipulate them under program control.

Devices

Some terminology about device names is specific to the Controller. The term “device” is used in several different ways; understanding the distinctions is essential to effective programming.

Every IEEE-488 instrument is called a device, and the Controller sends information out to a device address when it sends program data to the instrument, or sends a command to the instrument to take a measurement or to send back measurement data.

Besides that kind of device, the 1722A has a number of internal devices. In this context, a device is a hardware resource that can act as a source or destination of data. There are two types of these Controller-specific devices. One type is called “file-structured”, and can be thought of as a location to store programs or data. These devices include the floppy disk, Bubble memory, and E-Disk. In general, it can be said that only this type of device can be assigned the function of “system device” (the one the Controller assumes you mean if you do not specify a device).

The other kind of internal device is usually called “serial” to distinguish it as a pipeline for information, rather than as a location of information. Notice that the term “serial” has a slightly different meaning than usual when it refers to a device. It may be that a serial device sends serial data, but not necessarily. For example, the RS-232 port is a serial device, and is used to send serial data; the IEEE-488 port is also a serial device, but the data is sent byte parallel.

On power up, a cold start, the bootstrap PROM checks the floppy disk drive for the operating system program (FDOS). If it is not there, it checks the other file-structured devices, first the Electronic Disk, and then bubble memory. If there is no system software, an error message indicates that there is “no system on device”.

When the RESTART button is pressed, the system performs a warm start. A warm start differs from a cold start in that the memory is not cleared nor is the self test performed; only the Operating System is loaded. If there are any files stored in the Electronic disk, they remain intact.

Devices and Files
Introduction

The table below defines each of the Controller's devices. Notice that all device names must have two alphabetic characters, followed by a number, and ended with a colon. The colon must always be included because it is part of the name.

DEVICE NAME	SYSTEM RESOURCE	TYPE
Standard System		
KB0:	Keyboard (Input)	Serial
	Display (Output)	
KB1:	RS-232 Port	Serial
GP0:	IEEE-488 Port	Serial
MF0:	Mini-Floppy Disk Drive	File-structured
ED0:	Electronic Disk	File-structured
Optional Resources		
KB2:	Optional RS-232 Port (Option -008)	Serial
GP1:	Optional IEEE-488 Port (Option -008)	Serial
MF1:-MF4:	Optional Floppy Drives	File-structured
MB0:-MB3:	Optional Bubble Memory	File-structured
WD0:, WD3:	Optional Fixed Disk Drives	File-structured

Files

A file is an organized record of related information. The file type can usually be identified by its extension (the three characters following the file's name, and separated from the filename by a period). The 1722A uses several types of files.

System Level Files

FILE TYPE	EXTENSION	DESCRIPTION*
System	SYS	Reserved for 1722A System Operations
Command	CMD	A collection of keyboard commands
FDOS	FD2	Binary machine language
Configuration	CFQ	Used by SysGen to generate FD0S2
Help	HLP	Data file for Help screens
Place holder	BAD	Indicates bad areas during packing
Source	BAS	Default extension
Lexical	BAL	Results when a file is SAVELed
Backup	BAK	Created by System editor program
Source	FTN	FORTRAN

Other Files

Assembler Source	ASM	Output of ASMPP, input to ASM
Error File	ERR	Output of BC
Library	LIB	Input to LE, LM, and LL
General List	LST	Output of ASM, FC
Map File	MAP	Output of LL, LE
Object	OBJ	Output of BC, FC, ASM; input to LE, LL, LM
Preprocessor	PRE	Input to ASMPP
Temporary	TMP	Temporary file for BC, FC and LE

* Description abbreviations

ASM = Assembler
 ASMPP = Assembler Pre-Processor
 BC = BASIC compiler
 FC = FORTRAN compiler
 LE = Linkage Editor
 LL = Linkage Loader
 LM = Linkage Manager

DEVICES

RS-232 Ports

All of the KB devices are serial. They are RS-232 ports, and provide an entry and exit point for serial communications between the Controller and other RS-232 compatible equipment. RS-232 is a designation for a standard digital communications interface, and describes the connector and voltage levels used in bit-serial communications. The standard permits many of the operating characteristics to be changed, to allow the connection of many types of equipment. Section 5, Communications, gives more information about the standard, and about how to change the Controller's RS-232 port parameters.

KB0:

KB0: is both an entry and exit point for information between the Controller's program and the outside world. As an input port, it is the Y1700 Keyboard. As an output, it is the display itself. KB0: is sometimes called "the Console Device". None of the operating parameters of KB0: can be changed except the baud rate, but it should only be changed when using an external terminal. Otherwise, an error will result.

KB1:

KB1: is the built-in RS-232 port for connecting the 1722A to other equipment that uses the standard interface. It is set to a standard configuration on power up, and it can be customized to different characteristics using the Set Utility program. See Section 5 for a detailed discussion of this utility program. KB1: does not exist unless the Video module is installed in the Controller.

KB2:

This device name is used for an optional RS-232 port, and is used if Option -008 (IEEE-488 / RS-232 Interface) is installed. It operates exactly like KB1:. Consult the manual provided with the option for more information.

IEEE-488 Bus Devices

GP0:

GP0: is the name for the IEEE-488 General Purpose Instrumentation Bus. It is not necessary to specify a device name in a program that uses the IEEE-488 bus for instrument control, but this device is included to give more direct access to the port than by way of a program. One application for GP0: is to use an IEEE-488 compatible printer as a listing device. Rather than writing a "PRINT" program, information can be sent out simply by specifying GP0: as the destination device.

GP1:

The device name GP1: is used for the optional IEEE-488 port, and is only implemented if Option -008 (IEEE-488 / RS-232 Interface) is installed. Its purpose and operation are identical to GP0:.

Floppy Disk Drives

MF0:

The integral 5-1/4" floppy disk drive provides the Controller with removable storage media (MF stands for mini-floppy). Using the floppy disk drive, a collection of programs can be built up, so that for each set of tests, a different floppy disk would be used.

Floppy disks must be formatted prior to use. Formatting is the process of sectioning off the disk so that information written onto it is allocated to the proper location, and so that the Controller is able to locate it again after it is recorded. Floppy disks can be formatted either as single- or double-sided (see File Utility program for details).

All floppy disk operations can be simplified by using File Utility commands in a Command file, and by using the Controller's Alias file.

The MF0: device is the default device at power up. It is possible to designate another device as the location of system software, however. See the discussion of the File Utility program's Assign command.

MF1: MF2: MF3: MF4:

Four other disk devices can be connected to the Controller at the IEEE-488 connector. The Fluke model 1760A is a single 5-1/4" unit, and the 1761A has two drives. In this usage, each device will act similar to MF0:.. Operation over the IEEE-488 bus is transparent to the user.

Electronic Disk

ED0:

The ED0: device designates the Electronic Disk (E-Disk). The programmer can designate portions of memory as "Electronic Disk". Any area of memory not used by the Operating System can be designated as E-Disk. When E-Disk is used, it must first be configured, a process that allocates how much space is to be used for E-Disk. For details, see the File Utility program /C command later in this section.

Because the E-Disk device is implemented in random access memory, it will perform any operation more than 100 times faster than if the floppy disk is used. However, the memory is volatile, so any programs or data stored in E-Disk are lost when the system is turned off.

Bubble Memory

MB0: - MB3:

These are the device names for Bubble Memory Options -004 and -005, 512 and 1024 blocks respectively. A block of memory is 512 bytes.

Regardless of the capacity of the Bubble Memory module(s) installed, each module is a separate device, whose device designation is selected by a switch setting on the board. Up to three Bubble Memory modules can be installed in the 1722A card cage.

The optional Bubble Memory modules provide the Controller with a large amount of additional non-volatile storage capacity.

Winchester Drive

WD0: - WD3:

WD0: through WD3: are the devices associated with the Winchester Disk Drive, an optional 5-1/4" hard disk. It is connected to the Controller at the IEEE-488 connector, just as any optional floppy disk drives would be. If a 5M byte drive is installed, two devices are available: WD0: and WD1:. If the drive is the 10M byte version, all four devices are available for additional on-line storage.

When a Winchester drive is added to a system, the System Generation Utility program must be used to create new software to include the necessary driver routines.

FILES

A file is a structured collection of information which the Controller can use to hold programs or data for later use. Most of the files supplied with the Controller contain programs. The program type is usually indicated by the extension (three characters after the filename). Extensions are always separated from the filename by a period.

System Files

System files have the SYS extension. Together, they make up the collection of programs that are the Controller's system operation programs.

Alias File

The alias file is a special type of system file that makes it possible to condense long commands into shorter, more easily remembered ones. The system alias file (filename ALIAS.SYS) is discussed in greater detail in Sections 6 and 7.

Command Files

A Command file is a collection of keyboard commands. It has the extension CMD. Using Command files makes it possible to automate keyboard commands to the Operating System through the Command Line Interpreter.

The Startup Command File

Command files are powerful tools of the 1722A because they make it possible to customize the system. The Startup Command file (filename STRTUP.CMD) is executed whenever the Controller is powered up or RESTARTed.

The STRTUP.CMD file on the System disk supplied with the Controller checks the time and date clock to see if it has been set, then returns control to the Operating System. The Getting Started disk is considerably different. Its Startup Command file loads the BASIC Interpreter program, and then loads and runs a BASIC program called the Getting Started program that demonstrates system operations without operator intervention.

Other Command Files

In addition to the Startup Command file, others can be created to automatically perform any sequence of keystrokes. The real usefulness of a Command file is that it automatically performs commands that otherwise would have to be keyed in individually each time the system was used.

Command files are discussed in more detail in section 7, Automating System Functions.

Machine Executable Files

These are binary machine language programs that can be run directly by the microprocessor. They usually use the FD2 extension. Because they are actual binary machine instructions, FD2 programs do not have to be translated from a higher level language before the microprocessor can perform their operations, as other programs must.

New files of this type are created using an optional linkage editor/loader program.

FD2 files were called "Core Image Load" files in the 1720A, and used the extension CIL.

Language-Dependent Files

Each programming language has unique properties just as human languages do. Among these unique properties are the file types that they use. In an effort to keep this discussion away from individual languages, only generic file types are explained. For detailed explanations of the file types used by a specific language, refer to the individual programming language manual.

Source Files

Source files contain programs that are written in high-level language. An optional assembler or compiler program translates source files into an executable form.

Object Files

An object program is the result of the translation of a source program. It may be an intermediate step to a machine-executable program, or it may be a directly executable form of a program written in a high-level language.

THE FILE UTILITY PROGRAM

Introduction

The File Utility program is a utility software file supplied on the System Disk with the file name FUP.FD2. It gives the user control over the files in any of the devices. A flexible structure provides other useful capabilities. The examples in this section illustrate the many ways that the File Utility program can be used.

Entering the File Utility Program

From the FDOS > prompt, type FUP <RETURN>. The screen will display the identification and prompt of the File Utility program:

```

FDOS> FUP

File Utility Program  Version 1.y

FUP>

```

The Help Command

From the FUP > prompt, type ? <RETURN> to see a listing of the command options.

This command causes the file FUP.HLP to be displayed. As supplied on the System Disk, this file is a one-screen summary of command options. An error message indicates if the file FUP.HLP is not found.

```

Quick Summary of FUP Commands
Assign system device ..... <device>/s
Configure E-Disk ..... sd0:/e<size>
Copy a file .... <[device]>=<[file]>E/I
Delete ..... <[file]>/dE/I
Extended directory list ... <[device]>/e
Format ..... <[device]>/fEs]Es]Es]
Directory list ..... <[device]>/l
Merge ..... <[file]>=<[file]><[file]>/m
Pack ..... <[device]>/p
Protect ..... <[file]>/PEI
Quick directory list ..... <[device]>/q
Rename ..... <[file]>=<[file]>/r
Scan for bad blocks ..... <[device]>/s
Defeat error checking <[file]>=<[file]>/t
Unprotect ..... <[file]>/-EI
Whole copy <[device]>=<[device]>[file]>/w
Zero directory .. <[device]>/zEs]Es]

Wildcards: "?" matches single character; i.e. "alias.s?s" matches "alias.szs"
"o" matches any characters; i.e. "o.bas" matches all basic programs
Individual: place an "!" after commands; i.e. ! o.bak/d!; o.fd2/-!

```

Devices and Files
FUP)

All the command options are listed below with examples. There is an explanation of each option later in this section.

	USAGE	EXAMPLE
Options		
no option	Transfer	MF0:TEST.BAK=ED0:TEST.BAS
/A	Assign System Device	ED0:/A
/B	Binary File Copy	MF0:FUP.SYS=MB0:FUP.SYS/B
/C	Configure E-Disk	ED0:/C (block size)
/D	Delete a File	TEST.TMP/D
/E	Extended Directory	MF0:/E or ED0:/E or /E
/F	Format a Disk	ED0:/F or MF0:/F3
/L	List Directory	MF0:/L or KB1:=ED0:/L or /L
/M	Merge ASCII Files	TEST.NEW=TEST.1, TEST.2/M
/P	Pack a Device	MF0:/P or ED0:/P or /P
/Q	Quick Directory	ED0:/Q or MF0:*.BAS/Q
/R	Rename a File	TEST.1=TEST.OLD/R
/S	Scan for Bad Blocks	MF0:/S or /S
/T	Transfer w/o Error Check	ED0:TEST.BAD=MF0:TEST.BAS/T
/W	Whole Copy	ED0:MF0:/W
/X	Exit FUP	/X
/Z	Zero File Directory	ED0:/Z or MF0:/Z or /Z
/+	Protect a File	ED0:1722A.INC/+
/-	Unprotect a File	MF0:RZDZ.WIZ/-
Switches		
/FD, /FS	Format disk 1 or 2 sides	MF0: /FD or MF0: /FS3
/I	Individual Switch	ED0: =MF0: *.* /I
Wildcards		
*	Match all characters in field	MF0: *.* /-I
?	Match single character	ED0: =MF0: TEST?.BAS

Directory Allocation

Unless otherwise specified during formatting, all of the Controller's file-structured devices provide a directory that can contain 72 filenames. If more files are needed, the File Utility program can allocate additional segments for directory space. Each additional segment can also contain 72 entries.

This capability can be particularly valuable when large file-structured devices are added (e.g. Winchester drive, RAM Expansion modules), or in those cases where a great many small files are to be recorded on a floppy disk. Notice that when an Extended Directory Listing (/E) is requested for a device with multiple directory segments, the segments may be separated by <not used> entries, even if the device is packed.

The command for allocating additional directory space on the floppy disk, E-Disk, or Bubble Memory is /F, followed by the number of directory segments desired. Formatting Winchester disks requires using the WDUTIL program provided with the hard disk drive.

Using the File Utility Program

If an option affects more than one device or file, the first must be the destination, and the second the source. If no device is specified, the system defaults to the SY0: device. If no filename is specified, the system uses a null filename. Finally, if no extension is specified, the system uses the BAS extension. When both a device and filename are specified, they are separated by a colon (:).

The complete name of a file takes the form:

dev:filename.ext

This is called a *pathname*. Often, a pathname can be specified without directly naming each of its parts. This is done using defaults and wildcards, which will be discussed in more detail later in this section.

CAUTION

If an existing file is specified as the destination, it will be deleted without warning and replaced by information from the specified source.

This manual uses upper case letters to indicate commands; however, both upper- and lower-case entries are allowed. Each command line must contain only one command.

All commands can be automated from FDOS through Command files and aliases.

Wild Cards * and ?

A wild card is a character that can be used in place of another character or string of characters. The File Utility program can use two wild cards in the filename: the ? character, and the * character. Wild cards cannot be used when specifying devices.

* matches all characters from the wild card until another character or the end of the filename or the extension.

Usage: A*.BAS would match AA.BAS, A1.BAS, and AA1.BAS.

*.BAS matches all files with the BAS extension.

. matches all files.

Example: To list all BAS files on the floppy disk:
*/L

To delete everything stored in the E-Disk:
ED0:*./DI

? matches any character in that position.

Usage: A?.BAS matches A1.BAS and AA.BAS, but not AA1.BAS.

Example: To print the BASIC files named TEST1, TEST2, TEST3, TEST4, TEST5, TEST6, TEST7, TEST9, and TESTA that are currently recorded on the floppy disk, using a serial printer connected to the RS-232 port:

KB1:=MF0:TEST?.BAS/T

Protection States + and -

All files are assigned a protection state. A protected file (+ state) may not be erased or rewritten. It is as if the protected file had a write protection tab. If an attempt is made to erase or overwrite a protected file, an error message indicates that the file must be unprotected before continuing.

Newly created files are unprotected (- state), to allow them to be changed easily. Once the file is complete, or in final form, it can be made into a protected file to prevent accidental erasure or write-over.

The protection states are shown in extended directory listings, and are changed with the /+ and /- command options.

CAUTION

The protection state is ignored during zeroing (/Z) and formatting (/F) floppy disks, and during configuring E-Disk space (/C). These commands delete all files associated with the device regardless of protection state. Be sure to backup any desired files before using these options.

Example 1.

To change the protection state of a file called DUTCH.PIM on the floppy disk:

```
MF0:DUTCH.PIM/+
```

Example 2.

To unprotect all the files on the system device, using the individual switch to insure a message before proceeding:

```
*.*/-I
```

Switches I, D, and S

A switch modifies a command, and always follows it. Two are available: the Individual switch and the Density switch.

The Individual switch permits individual selection of files to be copied, transferred, deleted, and protected or unprotected. When the Individual switch is used with a file deletion command, a message indicates which files are protected.

When the Individual switch is used with the no option command, separate the two device names with an = sign. The system requests confirmation before completing the transfer. For more details about the Individual switch, see the no option Transfer command, and the /B, /D, /T, /+, and /- options. The Individual switch cannot be used with a file merge (/M) command, nor with any commands that apply only to a device, such as /A, /C, /S, or /P.

Example 1.

To delete selected BAK files from the E-Disk:

```
ED0:*.BAK/DI
```

Example 2.

To transfer selected files from the floppy disk to the display:

```
MF0:.*=KB0:/I
```

The “D” switch selects double- or single-sided formatting for the floppy disk. For double-sided, use the argument D after the Format option. For single-sided, use the argument S. See the /F option for more details about formatting floppy disks, the /C option for information about configuring the Electronic disk, and /Z for details about zeroing the directory of any disk device.

Example

To format the floppy disk as single-sided, with 5 segments:

```
MF0:/FS5
```

Alphabetical Listing of Commands

(no option) Transfer

If no option is specified, a communication channel is established between the specified destination and source(s).

- Up to eight sources may be specified.
- When the destination is a file device (MF0:, ED0:) and no destination filename is specified, the names of the source files are used.
- If the source is not a file device (no name can be identified), the resulting destination file will have the null name, unless one is specifically named.
- If a single file is named as the destination for multiple files, only the last file specified will effectively be copied. Use the /M option to merge files.

The examples below show the ways in which the no option Transfer command can be used. A short description precedes each example.

Example 1.

To make a copy called FILE.NEW of FILE.OLD (both on the System Device):

```
FILE.NEW=FILE.OLD <RETURN>
```

The result will be that two identical files exist, one called FILE.OLD, the other called FILE.NEW.

Example 2.

The display (KB0:) is specified as destination, and T44.BAS on the floppy disk (MF0:) as source. This will display the file. Use Page Mode if the file is longer than 16 lines.

```
KB0:=MF0:T44.BAS <RETURN>
```

Example 3.

This command is equivalent to Example 2, if the System Device is the floppy disk, and the Console Device is KB0:. By using defaults, 13 of the 17 keystrokes have been eliminated in transferring T44.BAS from the floppy disk to the display. The default filename extension is BAS.

T44 <RETURN>

Example 4.

To transfer ASCII data from the keyboard (KB0:) to a printer connected to an optional serial port 2 (KB2:) In this example, a <CTRL>/Z would terminate the transfer.

KB2:=KB0: <RETURN>

/A Assign the System Device

The /A command option assigns the named device as the the System Device, SY0: (the default file device).

The example assigns the Mini-Floppy Drive (MF0:).

```
MF0:/A <RETURN>
```

/B Binary Transfer

The Binary Transfer option is only implemented to assist those who have become proficient using the Fluke 1720A Instrument Controller. For normal transfer of 1722A programs and data, use the no option or /T commands. No errors will result.

The 1720A /B option transfers binary-coded data, such as system and utility software files, lexical-form BASIC programs and virtual array files. Up to eight individual source files can be specified, and wild cards can be used to increase the number.

This example uses wild cards to transfer a group of date-coded files (for the month of July) named RAC from the Electronic disk (ED0:) onto a floppy disk (MF0:).

```
MF0:=ED0:??0783.RAC/B
```

/C Configure Electronic Disk Space

The /C option is followed by a number to indicate how many blocks of Electronic disk are to be created. To determine how many blocks maximum can be allocated, observe the FDOS power up display. If the number argument is left out, the E-Disk will be de-allocated. An argument of zero blocks (/C0) also de-allocates the Electronic disk.

After configuring E-Disk space, use the /F option if more than one segment is desired.

NOTE

Though specified in blocks, space is allocated by the page. Each page (4096 bytes) has 8 blocks, so the actual number of blocks allocated will be a multiple of 8.

/D Deleting Files

The **/D** option is used to delete up to eight specified files (more using wild cards). Deleting a file leaves a gap in the file structure. Refer to the Pack (**/P**) command option. When no file is specified, the null file is deleted. A single command line can be used to delete files from more than one device.

This example uses wild cards to delete all files having a **.TST** extension from the System Device, and all files whose names start **RZDZ** from the floppy disk.

```
*.TST,MF0:RZDZ.* /D
```

/E Listing a Directory (Also /L and /Q)

There are three ways to list directories. As with all File Utility program options, the device must first be specified unless the directory of the System Device is desired. If no destination device is specified, the Controller assumes that the directory is to be sent to the display.

Wild cards can be used with all three listings to see only files whose names or extensions match, and the directory entry for a single file can also be obtained by specifying the file in the command line.

/E yields an Extended Listing. The extended listing includes all unused file areas and the protection state of each file.

Packing a File Structured Device, below, tells how to restructure the disk to remove unwanted blank areas.

/L is the normal listing of all files on the specified device. It displays all 5 fields, but does not include the unused areas.

/Q gives a Quick listing. It does not display the file size, nor the date the file was last updated. The filenames and their extensions are displayed, six columns across the screen, rather than one column as in the other two types of directory listings.

Here is a portion of the extended directory for a 1722A System Disk:

```
FUP> MFD:/E
Directory of MFD: on 15-Jul-83 at 08:36

name .ext  size  prot  date
FOOS2 .SYS  39    [+ ]  1-Jul-83
MACRO .SYS  10    [+ ]  1-Jul-83
ALIAS .SYS   1    [+ ]  1-Jul-83
FUP   .FD2  11    [+ ]  1-Jul-83
SET   .FD2  10    [+ ]  1-Jul-83
TIME  .FD2   2    [+ ]  1-Jul-83
BASIC .FD2  65    [+ ]  1-Jul-83
```

There are five fields: the **name** and **extension** of all the files appear in the first two fields. The size field indicates the number of blocks the file occupies. Each block is 512 bytes.

The **prot** field indicates the protection state of the file, and **date** is the last date the file was updated.

Two entries may appear in the Extended Directory list that do not appear in either the normal list or the quick listing:

<not used> indicates a blank area within the structure of the disk, left when a file was deleted. The Pack command /P packs all unused blocks into the end of the segment.

<temp ent> indicates that some problem occurred when a file was open (being transferred or edited). Some typical examples would be that the power was removed, or the RESTART button was pressed during operation on an open file. The system places a temporary entry in the segment to indicate that the file no longer exists. To delete the temporary entry, pack the disk with the /P command.

Here is what the screen looks like when a Quick Listing is done for the MF0: device:

```
Directory of MF0:  
MACRO .SYS  FDOS2 .SYS  SET  .FD2  FUP  .FD2  TIME .FD2  ASMPP .FD2  
ASM  .FD2  LE  .FD2  EDIT .FD2  LL  .FD2  HDT  .FD2  GREP .FD2  
BASIC .FD2  FDOS2 .DAT  SYSGEN.FD2  GRAFIX.OBJ
```

In this example, a quick listing is sent to the optional serial port 2 (KB2:) of the directory of the floppy disk (MF0:) and the Electronic disk (ED0):

```
KB2:=MF0:,ED0:/Q <RETURN>
```

/F Format a File Device

The /F option prepares a floppy disk (MFx:) or optional bubble memory device (MBx:) to receive files by creating a completely new magnetic structure on them. Because formatting writes new block identification codes and standard data patterns throughout the device, any device that is formatted will also be erased. Take care not to format disks that have data or programs that you want to save.

When formatting the bubble memory or a floppy disk, a number can follow the /F command to indicate the number of directory segments to be established. For more information see the discussion "Directory Allocation" at the beginning of this section. If no number is given, the default is 1 segment, a useable amount for floppy disks, but restrictive for the bubble memory, because it would not take full advantage of the large amount of memory available. Since the directory for any one segment can contain only 72 entries, selecting one segment results in a maximum of 72 files, which is fine for most floppy disk applications, but is not an efficient use of the mass storage available in bubble memory or Winchester hard disks.

If a disk has suffered media damage, a message will display indicating that it is not able to be formatted. If this happens, the disk is not useable and should be replaced.

This option formats either floppy or Electronic disks, or Bubble Memory devices.

Example 1:

This example formats, zeroes, and verifies a floppy disk:

```
MF0:/F <RETURN>
```

Example 2:

This example formats a bubble memory device with 12 segments (864 possible files):

```
MB0:/F12 <RETURN>
```

Example 3:

This example uses the double-sided switch to format a floppy disk as double-sided, with 6 segments:

```
MF0:/FD6
```

/I Individual Transfer

Besides its use as a command modifier, /I can be used alone to transfer individual files. Just as with other transfer commands (no option, /B, and /T), wildcards are allowed. If no destination is specified, the default device is KB0:. If no source pathname is given, the System Device SY0: and the null file are assumed.

Example:

This example transfers selected files from the E-Disk to the floppy disk.

```
ED0:=MF0/I
```

/L Listing a Directory - See /E for all directory listings.

/M Merging ASCII Files

The /M option merges up to eight ASCII source files into one destination file. Binary files, such as System and utility software files, lexical form BASIC programs (BAL extension), and virtual array files cannot be merged. The source files remain intact, unless the destination has an identical filename (on the same device). Wild cards and the Individual switch cannot be used.

When the destination is a non-file device, the /M option removes the <CTRL>/Z character (ASCII EOF) from the end of all but the last file.

CAUTION

When merging two BASIC programs, duplicate line numbers can cause problems. When the BASIC Interpreter program encounters a duplicate line number, the latest occurrence of that line number is retained, and the previous occurrence is deleted. Use the REN statement to renumber the programs to different line number ranges before merging.

Here are two examples of how to make efficient use of the /M option:

Example 1.

This example creates a file on the floppy disk (MF0:) called PROGRAM.T44. The new file contains TEST1.BAS and TEST2.BAS from the floppy disk. The original files all remain intact.

```
MF0:PROGRAM.T44=MF0:TEST1,TEST2/M <RETURN>
```

Example 2.

This example appends keyboard input directly to the end of an existing file without creating a new one. The destination file DEST.CPT contains the old file DEST.CPT followed by keyboard inputs. A keyboard entry of <CTRL>/Z terminates the keyboard portion of the input.

```
DEST.CPT=DEST.CPT,KB0:/M <RETURN>
```

/P Packing a File-Structured Device

The /P command option reorganizes a file-structured device. When files are deleted, blank areas are left within the file structure. (See /F for more information.) The /P option compacts these areas into one contiguous space. It may be possible to make room for a file that previously wouldn't fit by packing the device. When this option is used, the file structure is maintained. During packing, the keyboard is disabled from display, but keystrokes are buffered. This feature makes it possible, for example, to give the command /E during packing. When packing is complete, the extended directory listing will display.

This example will pack the System Device:

```
/P (RETURN)
```

This example packs the Electronic disk and the floppy disk:

```
ED0:,MF0:/P (RETURN)
```

/Q Quick Directory - See /E for all directory listings.

/R Renaming a File

The /R option is used to rename a file. It has no effect on the size or location of a file, because it only operates on the directory.

This example renames the file TEST4.BAS on the System Device to PROG.T4:

```
PROG.T4=TEST4/R (RETURN)
```

/S Scanning for Bad Blocks

The /S option scans a file-structured device for bad blocks, and sends a result message to the specified destination. Each block is read and checked for errors. A check character is compared with one recorded with the block. Any mismatches cause an error message.

Scanning for bad blocks is done to check for a faulty floppy disk or Bubble Memory device. If you are having trouble reading or recording on a disk, use the /S option to determine if the disk is useable. If bad blocks are indicated, attempt to transfer the files to another disk, then discard the faulty one. Bad blocks are a result of wear, age, or abuse.

If no destination is specified for the result, any errors found will be displayed on the console.

To scan the System Device and see the results displayed:

```
/S <RETURN>
```

This example scans the floppy disk and sends the results to serial port 1:

```
KB1:=MF0:/S <RETURN>
```

/T Transferring Files Without Error Check

Except for inhibiting error checks, this command is identical to the no-option command. It transfers files just as the no-option command does, but does not check for device errors. If errors should occur, they are ignored, and the file is transferred as is. This option can be used to create backup copies of files that are suspected to contain errors.

/W Whole Copying a File Device

The /W option transfers some or all of the files on a file device at one time using a single command. This option simplifies duplicating a floppy disk.

The source and destination devices should be different. (If they are the same, the result would be merely to record a file back to the same place it was read from.) To duplicate all or part of a floppy disk, first copy files into ED0:. Then insert a formatted disk and copy from ED0: to MF0:.

If the disk already contains files having the same name as those being copied, the whole copy command deletes the existing file and replaces it with the one being copied.

If E-Disk space is less than the total size of the files to be copied, break the task into smaller parts by copying only some of the files on several passes.

The display indicates the name of the file being copied. The whole copy process can be terminated before all files are copied by typing `<CTRL>/C` during the copy of the last file desired. The file copy in progress will be completed before the operation stops.

CAUTION

If `<CTRL>/P` is used to terminate a whole copy, the file copy in progress is aborted and the resulting partial file is closed. Use `<CTRL>/C` to terminate whole copies.

In this example, a whole copy is started by temporarily placing the floppy disk contents into E-Disk storage. The wild card character indicates the name of the first file to be copied. Note the display for the last file copied, in case a second pass is needed.

```
ED0:=MF0:TEST.* /W  <RETURN>
```

In the second part of the example, the floppy disk is exchanged for the one which will contain the copied files. After noting the last file copied, insert a disk that has been formatted (see /F). This command line then copies the files to the disk from the E-Disk.

```
MF0:=ED0:/W  <RETURN>
```

If a second pass is needed, first zero the E-Disk (see /Z option below). Now use the * wild card to start the whole copy again, beginning at the first file that matches the wild card.

Notice the subtle difference in how the * wildcard character operates in a whole copy from its normal use in transferring, copying, deleting, protecting, and so forth. When used with the Whole Copy option, the * in the filename indicates that the copy is to begin with the first file that matches the extension.

For example, the command `MF0:=ED0:*.BAS/W` would not necessarily copy all the files with the BAS extension, but would begin the whole copy with the first file that had a BAS extension.

/X Exit

This command exits the File Utility program, and returns control to the shell.

/Z Zeroing a File Directory

The **/Z** command zeroes the directory of one or more file devices.

The result of the **/Z** option is similar to the **/F** option if the device is already formatted: no files are accessible when the operation is complete. However, formatting is more time-consuming, and is not necessary if the intent is merely to delete all files from a device.

Zeroing is not equivalent to formatting. The files remain after zeroing a directory, but they are not able to be accessed because there is no directory. After zeroing, the device retains the prior format. The Single- and Double-sided switches are ignored.

Because zeroing deletes the directory of all files from the specified device, the program requests an affirmative before proceeding. Entries accepted as affirmative are YES, Y, yes, and y.

If a floppy disk or bubble memory are zeroed, the number of directory segments does not need to be specified, because the current structure remains intact. To change the structure, see the **/F** Format option.

This example zeroes the Electronic disk (ED0:)

```
ED0:/Z <RETURN>
```

This example zeroes the directory of the Electronic disk, and creates four segments:

```
ED0:/Z4 <RETURN>
```

/+ and /- Assigning Protection State

The /+ and /- commands change the protection state of a file. Directory listings indicate the current state inside brackets, and the system automatically assigns the unprotected state (-) to newly created files. A file must be unprotected before it can be deleted.

This example protects a file called SHDS.PAT that is currently recorded in the bubble memory:

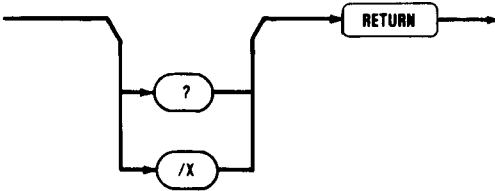
```
MB0:SHDS.PAT/+ <RETURN>
```

This example uses a wild card to unprotect all files in the System device having a TMP extension. The Individual switch ensures that confirmation is given before the unprotection.

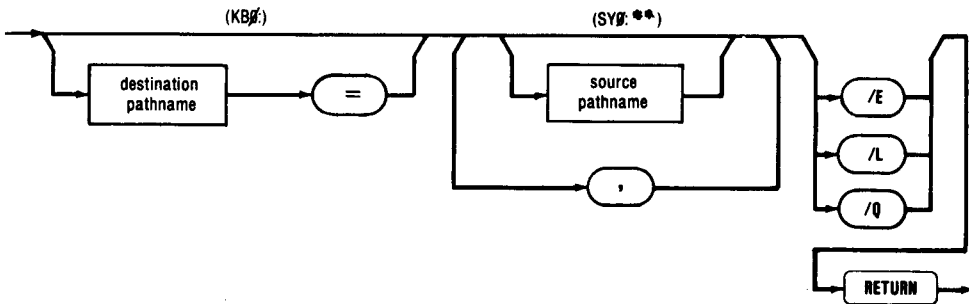
```
*.TMP/-i <RETURN>
```

Syntax Diagrams

Directly Executed Commands

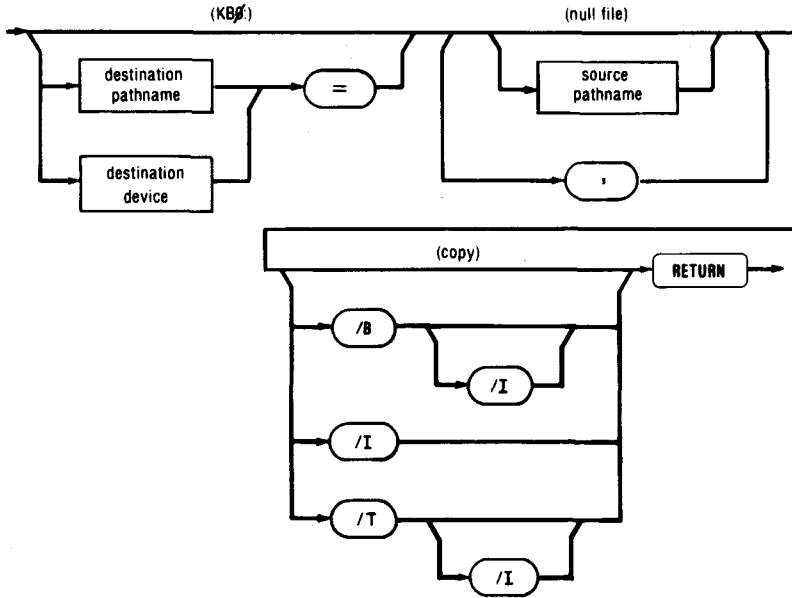


Directory Listing Commands



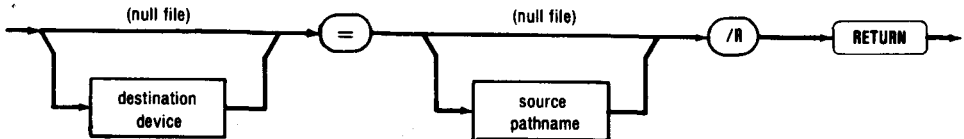
- A pathname can include device + filename + extension.
- All directory listings can use wildcards.
- If the device is not specified in the source pathname, the system device or the last device specified will be used.
- If no destination device is specified, the default is to KB0:.

File Transfer (Copy) Commands

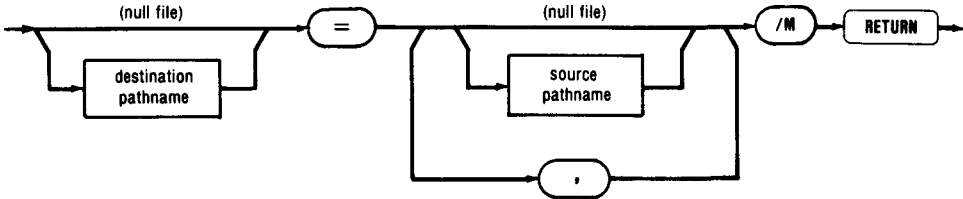


- A pathname can include device + filename + extension.
- All transfer options can use the Individual Switch and wildcards.
- If the device is not specified in the source pathname, the system device or the last device specified will be used.
- If no destination device is specified, the default is to KB0:.

File Rename Command

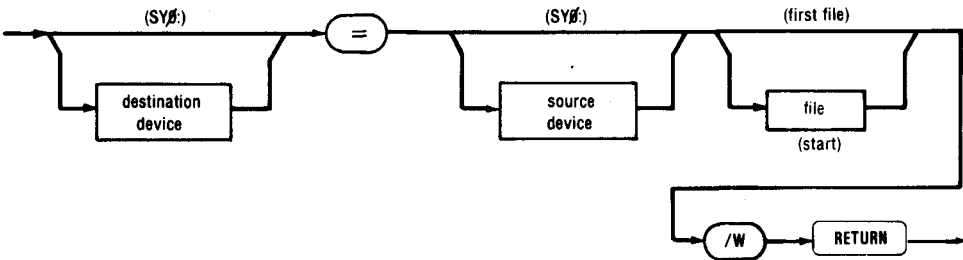


File Merge Command



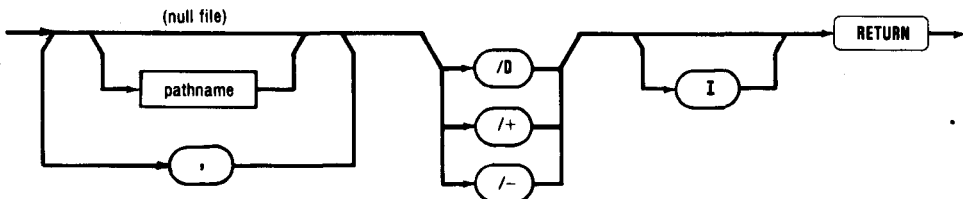
- ❑ Wild cards and the Individual switch are not allowed.
- ❑ Each pathname must be separated by a comma.

Whole Copy Command



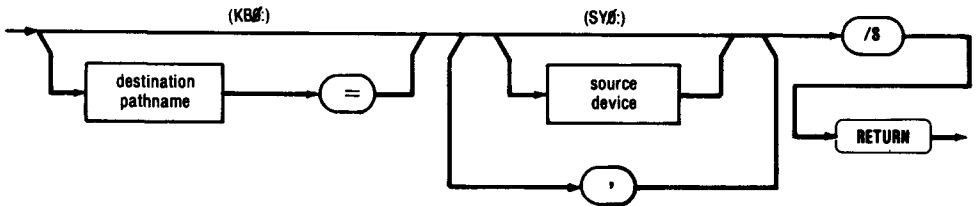
- ❑ Wild cards are allowed for the source filenames.

File Deletion and Protection Commands



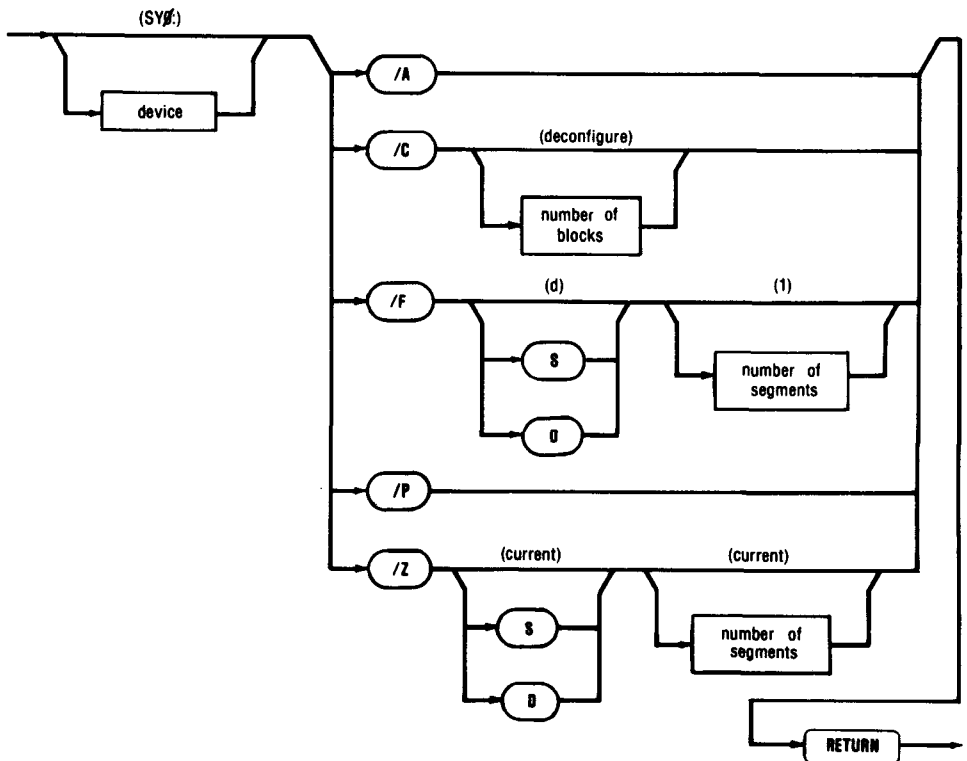
- ❑ If device is not specified in the pathname, the system device or the last device specified is used.
- ❑ The Individual switch can be used to insure confirmation is requested before deleting or changing the protection state.
- ❑ Wild cards are allowed.

List Bad Blocks Command



- If device is not specified in the pathname, the system device or the last device specified is used.
- Wild cards are allowed.

Device Control Commands



System Messages

Messages from the system are a normal part of operation, and do not always signify that an error has been made, though they are generally referred to as "error messages". Here are the meanings of messages you might see from time to time when using the File Utility program. The messages are listed alphabetically:

MESSAGE	MEANING
? Device error	A non-recoverable error was detected during transfer to or from the floppy disk or Electronic disk. This may also occur when writing on an unformatted floppy or Electronic disk.
? Device not ready	The device is not ready. This usually means that the disk is not inserted, or the disk drive door is not shut.
? Devices do not match	A rename was attempted for files not on the same device.
? Directory overflow	Too many files exist for another to be copied or transferred to the device because the directory is full. To recover, first backup all files, then use the /F option to reformat a disk with more segments.
? File already exists	A rename was attempted using a file name already in use.
? File protected	The specified file has a + protection state assigned to it. Use the /- command option to unprotect the file before deletion.
? Help file not available	A "?" was entered and the file FUP.HLP could not be located on the System Device.

- ? **Illegal file/device name** A name in the command contains too many characters or contains characters other than letters, numbers, spaces, or "\$" signs.
- ? **Illegal directory** The directory on the device is faulty. If the device is a floppy disk, it is damaged and should be replaced. Backup all files first using the /T option.
- ? **Illegal option** The command option selected was not recognized. This is usually caused by typing errors.
- ? **Illegal option for device** A command was given that would be legal for some other device, but not for the one specified.
- ? **Incompatible format** An option was specified for a device that does not accept the format. For example, attempting to configure the E-Disk as double-density.
- ? **Input queue overflow** The RS-232 port was receiving data, and some of it was lost. Use the Set RS-232 Utility program to slow down the baud rate or to enable the Stall Input/Output feature.
- ? **No end-of-file** An ASCII source file was not terminated with <CTRL>/Z. Can also be caused by running out of storage space before the <CTRL>/Z is transferred.
- ? **No room on device** A copy or merge operation was attempted, but the resulting file would not fit on the specified device.
- ? **No such device** A device was specified that is not on the list of recognized devices at the beginning of this section. This is usually caused by misspelling.

Devices and Files

FUP > Messages

- | | |
|---------------------|---|
| ? No such file | The file could not be found on the device specified. This is usually caused by misspelling, although the wrong device may have been specified. |
| ? Not enough memory | An attempt was made to configure more E-Disk than is available in memory. |
| ? Medium changed | The disk drive door was opened and the disk removed during a read or write operation. |
| ? Number too large | The number specified in the command is too large. This message occurs if the number of directory segments specified is more than the device is able to contain. |
| ? System error | This error should not occur under normal use. It indicates an error in the operating system or the File Utility program. Contact a Fluke Service Center and make an accurate report of the conditions at the time the error occurred. |
| ? Syntax error | The form of the command input does not match the requirements of a File Utility program command. This is normally caused by typing errors. |
| ? Too many files | More than eight source files were specified. Either break the task into smaller parts, or use wild cards. |
| ? Write protected | A write operation was attempted on the floppy disk, but it has a write protect tab. |

CONCLUSION

This section has described the Controller's resources in some detail, and explained how to use the File Utility program to manipulate files. The devices can be thought of as names for the various hardware parts of the system. Files are programs.

The next section, Communications, details the way that information can be sent out of the Controller, or brought into it by means of two industry-standard connection methods: the IEEE-488 Instrumentation Standard, and the RS-232C Digital Communications Interface.

Section 5 Communications

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INTRODUCTION

The Controller communicates in two ways: by way of the IEEE-488 General Purpose Instrumentation Bus, and the EIA RS-232-C Data Communications Interface.

These two standards were developed to serve two different purposes: the IEEE-488 as a standard connection between measurement instruments, and the RS-232 as a standard connection for serial data communications.



THE IEEE-488 BUS

In 1975, the Institute of Electrical and Electronic Engineers (IEEE) published a "*Standard Digital Interface for Programmable Instrumentation Systems*". This standard was revised in 1978, and a supplement was published in 1980. The IEEE-488 standard has gained acceptance throughout the instrumentation industry because it permits a wide variety of measurement equipment to be connected easily to form a programmable instrumentation system. The 1722A implements the most recent version, including the 1980 supplement.

The IEEE-488 standard describes a bus architecture and defines the timing and handshaking that occurs on the bus. Devices connected to the bus may be *talkers, listeners, or controllers*.

The 1722A is able to control up to 14 instruments directly from the single standard IEEE-488 connector. An additional Interface module can be added to allow the 1722A to control more instruments.

The next few pages describe how the interface operates. Much of this discussion is theoretical, and has been included here to help first time users visualize an instrumentation system. Though it may appear that the operation of an IEEE-488 system is a complicated matter, in fact it is quite easy to use, and most of the details of bus operation are transparent to the user.



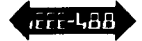
Bus Functions

The Controller establishes the role of each of the connected instruments by sending commands to them and setting up the correct communications channels. Each piece of equipment recognizes its own address, which is set into it by configuration switches when the system is assembled. Each connected instrument can then respond to polling and receive or send data. Depending on its role in the system, each instrument can also perform these functions:

- Handshaking to establish and confirm the connection
- Single address talking or listening
- Request service to notify the controller that a function is complete
- Respond to poll to answer the controller's request for status
- Clear to return to a default state
- Trigger to respond to the controller's command to perform a function

The controller can perform these functions:

- Command devices to listen, talk, or perform a function
- Trigger devices to perform a pre-programmed function
- Clear devices to an initial state (defined by the device)
- Poll devices for their status serially or in parallel (one device at a time, or all at once)
- Command devices to abort current operations
- Command devices to enter the remote mode of operation
- Pass control to another controller



Interface

There are 16 signal lines on the IEEE-488 bus; all are active low TTL levels. The lines are divided into three categories:

1. Eight data lines
2. Three handshake lines
3. Five bus management lines

For your reference, Appendix C has a pinout diagram of the standard interface connector and a description of each of the lines.

Bus Operating Modes

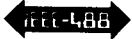
The bus operates in either command or data mode. A controller uses the command mode to control the various instruments connected to the bus. A talker or a controller uses the data mode to transfer information or device dependent commands on the Data I/O lines. The three handshaking signals officiate transfers on the bus.

Command Mode

The controller places the system into Command Mode by sending an attention signal. All devices on the bus must then interpret the data byte as a command message. Only a controller may issue commands.

There are four types of commands:

1. Addressed Commands (all devices are addressed to listen).
These are used to control a selected group of devices. The command is preceded by a device address, because only those devices previously commanded to listen must respond.
2. Universal Commands (all devices).
These commands are used to control all system devices. They do not need to be preceded by an address because all devices that are able to must respond to them.



3. **Addresses (all devices).**
The controller uses these commands to designate devices as talkers or listeners.

4. **Secondary Commands (all devices are enabled by a primary address or command).**
These are the second byte of a two byte address, and are used by the controller to implement "extended" talk and listen functions. Secondary commands are used to send a second address if the primary address has been accepted as part of the address command.

Each type of command has a specific function in the activity of the bus, and they are all designated by three letter mnemonics. All of these bus functions are implemented in each of the programming languages available for the 1722A. In some cases, a single command performs more than one function; for example, the Fluke Enhanced BASIC command TRIG (Trigger) addresses a set of instruments as listeners and then triggers them.

Appendix C contains a complete listing of the Command Messages. Refer to the appropriate programming language manual for information about how to implement each of the commands in a given language.

Data Mode

The controller places the system into the data mode by setting the attention line false. In this condition, all devices treat the information on the bus as data. This data can originate from either a talker or the controller. Data can flow from device to device on the bus (talker to listener) in any mutually understood code or format, or the 1722A can act as an interpreter, accepting data from the talker and sending it out to a listener.

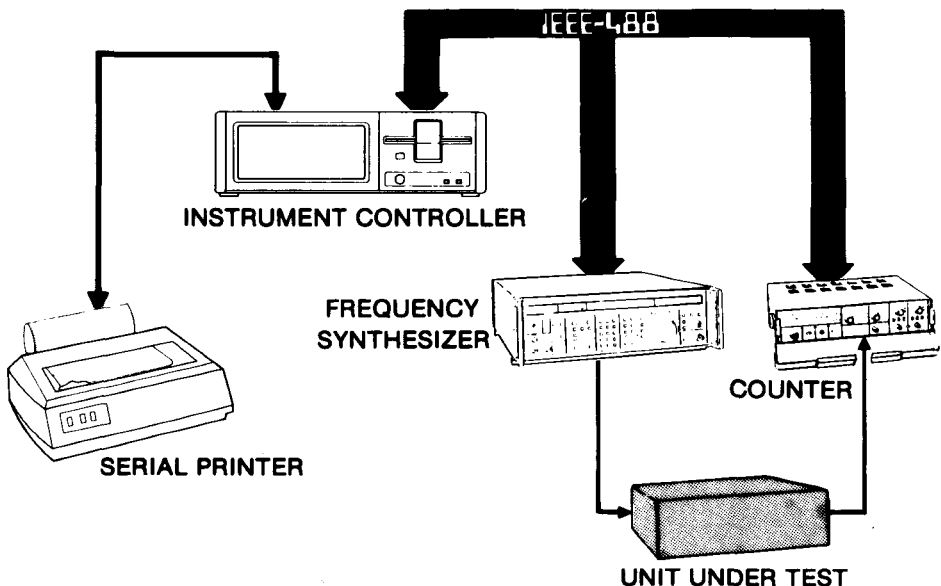
Three-Wire Handshake

All IEEE-488 bus devices use a three-wire handshake to manage the exchange of data. The signals are:

- DAV- (Data Valid)
- NRFD- (Not Ready For Data)
- NDAC- (Not Data Accepted)

A Typical Instrumentation System

The typical system shown below was first introduced in Section 2 to illustrate how to set up a system. The same example system is used here to illustrate how the IEEE-488 interface can handle a variety of tasks. In Section 7, the same sample setup shows how to automate these functions.



In this example system, a sequence of events describes how a specific measurement task would be accomplished. In general terms, the Controller programs the instruments and initiates the measurements. The resulting data is returned to the Controller, which then routes it to the serial printer for printout.

Sequence

1. The Controller initializes the interface devices.
2. The Controller commands all devices to set their internal conditions to a predefined state by sending a device clear message.
3. The Controller sends the listen address and program data to the frequency synthesizer. The program data tells the frequency synthesizer the output frequency and level.
4. The Controller sends the unlisten command to the synthesizer, then sends the listen address and program data for the frequency counter. (Function and range, for example.)
5. The Controller sends a program code to trigger the measurement.
6. The Controller sends the unlisten command, addresses itself to listen, then sends the talk address of the measurement device.
7. When it completes its internal measurement cycle, the frequency meter sends a request for service to the Controller. When its request is recognized, it sends (talks) the measurement data to the addressed listener, the Controller.
8. Under program control, the Controller gathers the measurement data and sends it via the RS-232 port to the printer (first addressing the printer as a listener, as before).

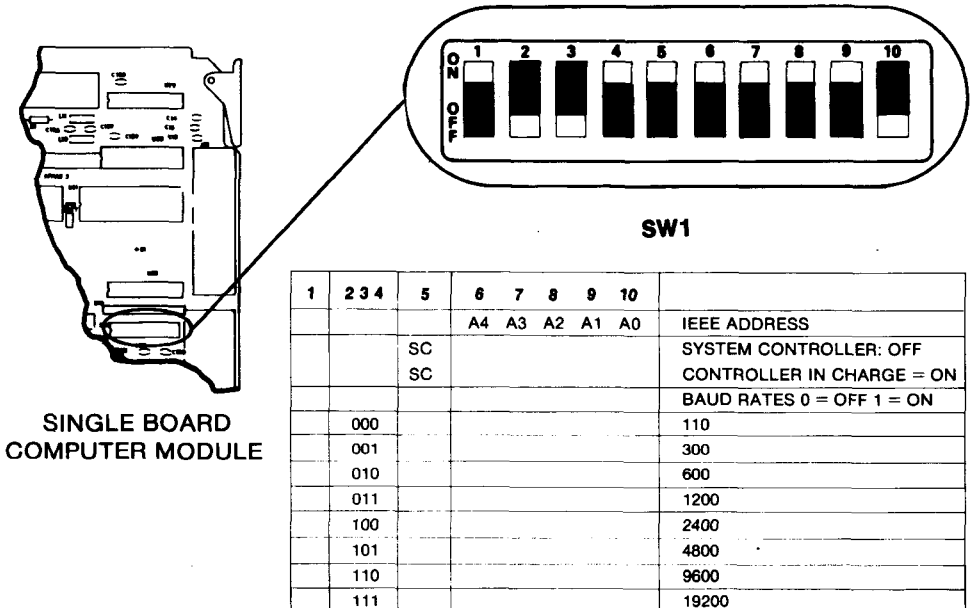
This example shows how a typical system is connected and describes the way the Controller directs the tests. The program required to actually do these steps depends on the programming language used. Each programming language manual includes examples such as this one to assist the programmer. In Section 7, Automating System Functions, a BASIC language program is developed that will show how a test program might be written to test this system.



The basic system can be expanded by adding options to the Controller so that many more instruments can be connected. These options provide a great deal of flexibility to the system designer. For example, the RS-232 ports could be used to transmit the data via a modem to a larger computer for analysis. Because of this flexibility, it is recommended that you consult your Fluke representative in the early design stages so the final system will perform efficiently in your application.

Multiple Controller Systems

At power up, the 1722A can be designated either as the "system controller" or as a "controller in charge". The system controller is the only connected device that is able to manipulate the control lines INTERFACE CLEAR and REMOTE ENABLE. The controller in charge is the controller that has had control passed to it either by the system controller or the prior controller in charge. A switch on the Single Board Computer module (slot 7) designates the power condition of the 1722A either as the system controller or as the controller in charge. The other switches of SW1 set the 1722A default baud rate (the rate used unless changed by the SET Utility program), and the 1722A's IEEE-488 bus address. Refer to the drawing below to set the switch.





IEEE-488 BUS ADDRESS SWITCH SETTINGS

Address	Switch Position				
	6	7	8	9	10
0	0	0	0	0	0
1	0	0	0	0	1
2	0	0	0	1	0
3	0	0	0	1	1
4	0	0	1	0	0
5	0	0	1	0	1
6	0	0	1	1	0
7	0	0	1	1	1
8	0	1	0	0	0
9	0	1	0	0	1
10	0	1	0	1	0
11	0	1	0	1	1
12	0	1	1	0	0
13	0	1	1	0	1
14	0	1	1	1	0
15	0	1	1	1	1
16	1	0	0	0	0
17	1	0	0	0	1
18	1	0	0	1	0
19	1	0	0	1	1
20	1	0	1	0	0
21	1	0	1	0	1
22	1	0	1	1	0
23	1	0	1	1	1
24	1	1	0	0	0
25	1	1	0	0	1
26	1	1	0	1	0
27	1	1	0	1	1
28	1	1	1	0	0
29	1	1	1	0	1
30	1	1	1	1	0

1 = Up Position (ON)
0 = Down Position (OFF)

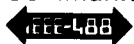


IEEE-488 COMMUNICATIONS UNDER PROGRAM CONTROL

Each programming language available for the 1722A Instrument Controller includes specific commands to handle the IEEE-488 communications. The standard was developed to permit the easy connection of an instrumentation system, but two important rules should always be kept in mind as you begin programming:

1. There may be any number of listeners at a given time.
2. There may only be one talker at a time.

There are other constraints, but these mostly depend on the capabilities of the connected instruments. An example is the Fluke 8502A Digital Voltmeter, which must be allowed a three-second wait between the time it is reset and the time it is programmed. Be sure to adhere to the requirements of each particular instrument to simplify your programming task.



Example Commands from the BASIC Language

Here is a synopsis of the commands used in Fluke BASIC to control communications over the IEEE-488 bus. For complete definitions and requirements, see the BASIC Programming Manual.

INIT	Initializes the bus.
CLEAR @ n	Addresses the specified device number as a listener, and issues a selective device clear.
WAIT	Followed by a number, suspends program execution for the length of time indicated (milliseconds).
INPUT @ n	A command string (in quotes) following this command addresses the instrument as a listener, and programs it.
PRINT @ n	A variable follows this command to address the instrument as a talker, and return the measurement data to the Controller.

Sample BASIC Program

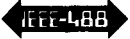
This sample program shows how the most important bus commands would be included in a BASIC language program to take a reading from the Fluke 8502A Digital Voltmeter. Some features of the program are:

- Between resetting the meter and sending it program data, there is a 5-second wait to allow the meter to stabilize.
- Ten readings are taken to insure accuracy of the returned measurement data.
- A 3-second wait is inserted between the last reading and the display of measurement data.

```

10 ! Program for 8502A DVM
20 !
30 DIM R (9) ! dimension array
40 INIT PORT 0 ! initialize the bus
50 CLEAR @ 2 ! clear instrument 2 (dvm)
60 WAIT 5000 ! let dvm settle
70 PRINT @ 2, "VR2TO" ! program dvm
80 FOR IX = 1% TO 10% ! loop for 10 readings
90 PRINT @ 2, "?" ! trigger dvm
100 INPUT @ 2, R (IX) ! get readings, send to array
110 NEXT IX ! return for next reading
120 WAIT 3000 ! let bus settle
130 FOR IX = 1% TO 10% ! loop to display readings
140 PRINT IX; R (IX) ! print value of I
150 NEXT IX ! return for next value
160 END

```



Here is a line-by-line explanation of the sample program:

- 10 Program identification.
- 20 Blank line for readability.
- 30 Dimensions an array called R to hold up to ten readings (0-9).
- 40 Initializes Port 0, the built-in IEEE-488 bus.
- 50 Clears and addresses as a listener the DVM whose address is 2. (Set up by switches in the instrument.)
- 60 Wait for 5 seconds to allow the DVM enough time to respond to the clear signal, and to set up internally as a listener.
- 70 Programs the instrument with the command "VR2T0", which this particular instrument reads to mean, 'use 10 volts DC scale, and take single readings synchronously with the line (60 Hz)'.
- 80 Sets up an integer counter (I) within a 'FOR-NEXT' loop that will take ten readings, and return them to the Controller.
- 90 Addresses 2 as a listener, and sends a "?" which triggers the measurement.
- 100 Addresses 2 as a talker, and puts the returned reading into the location specified by I% within array 'R'.
- 110 Program returns to line 80, which increments the value of I%, so that as the FOR-NEXT loop is repeated, the next reading goes to the next available location in the array R. After ten passes through the loop, the program continues at line 120.
- 120 All measurements are complete, so this program step waits 3 seconds for the bus to settle.
- 130 Sets up another FOR-NEXT loop to display all ten readings.
- 140 Prints each value of I% within the array R.
- 150 Sends program back to line 130 to increment I%, and display the next reading.

In actual practice, this program could be greatly simplified. It is shown here for illustration purposes only, although it could be used as is. Some of the simplifications might be:

- Trigger the DVM ten times, but then send a command to have it average the readings (many programmable instruments include such mathematical abilities). The DVM would then return the average, rather than ten readings.
- If the meter is unable to perform the mathematics, have it return all ten readings, but finish this subroutine with a branch to an averaging subroutine, and display only the average.

For More Information

System designers and programmers who are unfamiliar with the IEEE-488 standard should obtain a copy of Fluke Application Bulletin 36 (*IEEE Standard 488-1978 Digital Interface for Programmable Instrumentation*), and Technical Bulletin C0076 (*Troubleshooting Information for IEEE-488 Systems*). These publications provide the background needed to set up an IEEE-488 system. Appendix C of this manual provides useful reference material covering the interface connector, handshaking protocol, commands, and message formats.

For an in-depth study of the IEEE-488 standard, a copy can be obtained by writing to the Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, NY, 10017.

SERIAL COMMUNICATIONS

The RS-232 ports are connection points for devices that use the Electronic Industry Association's RS-232C Data Communications Interface Standard. Since it was first published, the RS-232 standard has gained wide acceptance among manufacturers because it allows various brands of equipment to use serial data communications to pass information.

The standard describes the physical connector, the signals on each pin of the connector, timing requirements, and the voltage levels of the signals.

The standard allows variations to accommodate different applications. Therefore, the 1722A software includes a program called the Set Utility program that permits changing the values of the parameters at the port.

Set Utility Program

The purpose of the Set Utility program is to configure the Instrument Controller to enable it to communicate with virtually any other piece of equipment that uses the RS-232 standard. The port parameters are set to default values when the Operating System is loaded, and some applications will not require changing the defaults.

These are the port characteristics that can be changed:

- Baud Rate
- Number of Data Bits
- Number of Stop Bits
- Parity
- End of Line and End of File Terminators
- Stall Input/Output Enable/Disable
- Time Out Value

Using the Set Utility Program

Here is how to use the Set Utility program:

1. From the FDOS> prompt, enter:

SET <RETURN>

2. The screen will display the prompt:

```
FDOS> SET
Set Version 1.1
SET>
```

3. Specify the port to be changed, and use the command chart on the next page to change the desired parameter(s).
4. If you would like to see the current parameters of a port, use the List command. As with all Set Utility program commands, specify the device first. Once the device has been specified, the Set Utility program will assume that device until another is specified.

KB1: LIST <RETURN> -or- KB1: LI <RETURN>

This example illustrates the default parameters:

```
SET> KB1:LI
Device          KB1:
Baud Rate       9600
Data Bits       8
Parity          Even
Stop Bits       1
End of Line     10
End of File     26
Stall Input     disabled
Stall Output    enabled
Time Out       0
```

5. To exit the Set Utility program, type:

EXIT <RETURN> -or- EX <RETURN> -or- <CTRL>/Z

Serial Communications
Set Utility Program

The Help Command

A help command lists all the available parameter selections. Type
? (RETURN) to see this display:

Command	Argument	Function	Example
BR	75,110,134.5,150,300,600,1200,1800 2000,2400,3600,4800,7200,9600,19200	Set Baud Rate	BR 2400
DB	5,6,7,8	Data Bits	DB 8
KBD:		Select Device	KBD:
EOF	<0 through 255> (decimal) or '<char>'	End of File	EOF 26
EOL	<0 through 255> (decimal) or '<char>'	End of Line	EOL 10
EX or EXIT		Exit to DOS	EX
LI or LIST		List Configuration	LI
PB	EVEN, E, ODD, O, NONE, N	Parity	PB NONE
SB	1, 1.5, 2	Stop Bits	SB 1
SI	ENABLE, E, DISABLE, D	Stall Input	SI E
SO	ENABLE, E, DISABLE, D	Stall Output	SO E
TO	<0 through 255> (seconds)	Time Out	TO 5

Command Structure

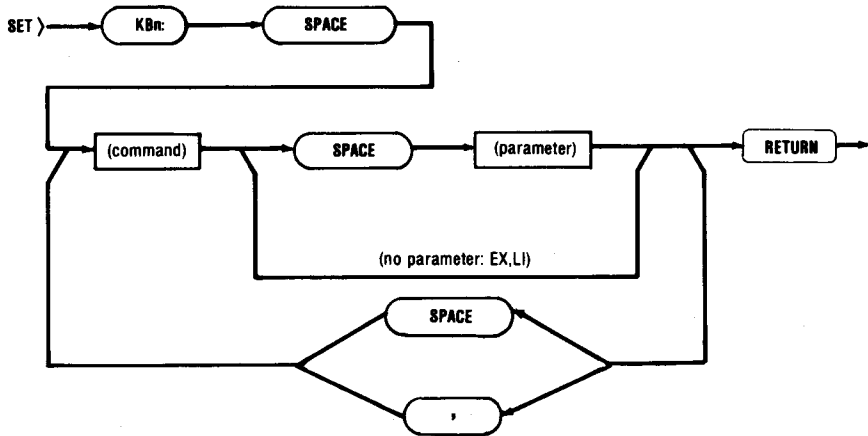
The Set Utility program features a straightforward and flexible command structure. After selecting a device, the current settings can be listed and changed in any order.

- Commands can be entered singly or combined into a multiple command line.
- Both upper- and lower-case entries are accepted.
- All commands are terminated by <RETURN>.
- All commands can be automated by command files.
- Parameters controlled by the program can be set independently for each serial port.
- Plain language messages prevent setting parameters improperly (out of allowable range, incorrect syntax, unspecified device, etc). A table of all messages is given on page 5-26.

Set Utility Program Syntax Diagram

Syntax Diagram

The syntax diagram below illustrates the proper syntax for all of the commands available in the Set Utility program.



- Any number of parameters can be specified for a port, as long as each command is separated by a comma or a space.
- The command line cannot exceed 80 characters (the capacity of one line on the screen). If more are needed, use two separate command lines.
- A single command line can be used to set parameters for more than one device as long as a comma precedes each device name after the first one.
- Any number of commands are allowed on the same command line as long as each is separated by a comma or space.

Device Selection

A port device must be selected before the Set Utility program will accept other commands. Device selection can be made a part of the single command line. Once the device is selected, subsequent commands affect that device until another is specified.

If a command is entered before specifying a device, the “no device specified” message is displayed.

Attempting to specify a device other than KB0:, KB1:, or KB2 will cause the “illegal device” message to be displayed.

All command inputs except baud rate are ignored for KB0: (the console device).

If the KB1: port is already in use for an external monitor, its parameters cannot be changed, but will return the “illegal device” message.

Setting Parameters

Baud Rate (BR)

Baud rate is the speed of information transfer. This command changes the baud rate of the selected port to that specified by the command argument.

In the following example, the baud rate of the optional Serial Port 2 is set to 2400 baud:

```
KB2: BR 2400 <RETURN>
```

NOTE

The baud rate of the keyboard and display is 19.2 Kilobaud. Setting KB0: to any other baud rate immediately disables both the keyboard and the display. This condition can only be remedied by pressing RESTART.

Character Length (DB)

The data bit command sets the number of data bits that will be included in each character.

When character length is set to a value shorter than the actual data's character length, the lower data bits (least significant) are used.

If the character length is set to a value higher than the actual data, the remaining (most significant) bits are set to zero.

The following example selects Serial Port 1, and sets the character length to 7 bits:

```
KB1: DB 7 <RETURN>
```

Parity Bit (PB)

Parity is a method of error detection that adds an extra bit after the last data bit of each word. This bit is set so that the total number of 1-bits in each word is always even or odd. The parity command defines a parity bit to be generated and checked for the selected port.

The command argument NONE or N eliminates the generation and checking of the parity bit.

During input, parity is checked as defined by the Set Utility for each character. If an error is detected, it is identified to the operating system as a device error. This error can only be cleared by closing the channel associated with the serial port.

During output, parity is generated as defined by the Set Utility program, and appended to each character.

In this example Serial Port 2 is selected, and set up to generate and check for even parity:

```
KB2: PB EVEN <RETURN>
```


Stop Bit (SB)

The stop bit command defines the number of bit-cell time periods between characters transmitted to external equipment that requires additional settling or synchronization time. This command does not affect incoming data.

The following example defines a transmission word spacing of 1.5 bit-cell time periods for Serial Port 1:

```
KB1: SB 1.5 <RETURN>
```

Stall Characters (SI, SO)

Stall Input and Stall Output implement the RS-232 X-ON and X-OFF capabilities. These two commands tell the transmitter to stop and then to resume sending the data.

Stall Input only affects data being received at the serial port. When it is enabled, the Controller sends X-OFF (decimal 19) when its input buffer is 3/4 full. When the buffer has been emptied to the 1/4 full point, the Controller transmits X-ON (decimal 17).

Stall Output only affects data being sent from the Controller. When Stall Output is enabled, receipt of an X-OFF character causes the Controller to suspend transmission until it receives X-ON.

This sample shows how both Stall Input and Stall Output would be enabled for Serial Port 1:

```
KB1: SI E, SO E <RETURN>
```

Length of Time Out (TO)

The Time Out parameter affects both input and output data. During input, if no data is received within the length of time specified by the parameter, the Controller resumes processing, rather than waiting indefinitely.

When the 1722A sends data through a serial port, it does so by filling a buffer, and creating a path between the buffer and the port. If the buffer should become full, the Controller waits for the time specified by the Time Out parameter. If the buffer has not started to empty by then, the attempted data transfer is abandoned.

This parameter insures that the Controller will not wait indefinitely for a data transfer in either direction. Instead, it abandons the attempt and continues processing.

Time Out is specified in seconds (0 to 255). The longest time out, 255 seconds, equals 4 minutes, 15 seconds.

NOTE

The Time Out value can also be used to change this parameter at the IEEE-488 ports. For this usage, specify the GPx: device, and specify the parameter as usual. This is the only IEEE-488 parameter that can be modified using this utility program.

In this example, the Time Out parameter for KB1: is set to 15 seconds.

KB1: TO 15 <RETURN>

Terminator Characters (EOL, EOF)

The terminator commands EOL and EOF define characters that will be used to identify the end of a line or file. When received with incoming data, a terminator generates an interrupt if enabled by the user program.

EOL only affects data input: All Carriage Return and Line Feed characters are deleted, but when the terminator character is received, a Carriage Return, Line Feed sequence is appended. (The system does not add a second Carriage Return or Line Feed if that character is the terminator.) The resulting data is in the internal format of 1722A data.

EOF affects both input and output data:

- During input, each file terminator defined by Set is converted to <CTRL>/Z (ASCII 26).
- During output, each <CTRL>/Z character is converted to the file terminator defined by the Set Utility.

This example shows a command line that defines a question mark as line terminator, and the ASCII character 4 (EOT code or <CNTRL>/D) as a file terminator for a port that was previously defined:

```
EOL "?" EOF 4 <RETURN>
```

Single Command Line Entry

During experimentation, one normally changes the parameters one at a time in order to find the correct combination for the device that is to be communicating with the Controller. During the development of working software, however, it becomes increasingly important to begin thinking about how to speed things up. Since any keyboard entries can become part of a command file, it is efficient to make one entry in the command file set the parameters needed at the RS-232 port.

This example illustrates how all of the above commands could be combined into a single command line to change the parameters at a serial port:

```
KB1: BR 2400 DB 7 PB E SB 1.5 EOL "?" EOF 4 SI E SO E TO 15 EX  
<RETURN>
```

Set Utility Program Messages

Error Messages

Messages from the system are a normal part of operation, and do not always signify that an error has been made, though they are generally referred to as "error messages". Here are the meanings of messages you might see from time to time when using the Set Utility program:

MESSAGE	MEANING
? Argument missing	A command was entered without the argument necessary to complete its meaning.
? Argument out of range	A command argument was entered which was beyond the range of acceptable values.
? Bad argument	A command argument was entered which was not in the list of acceptable arguments for that command.
? Illegal device	KB2: was selected when an external terminal was in use.
? No device specified	A command was entered before specifying a device.
? Unknown command	A command was entered that was not recognized.
? Attribute cannot be changed	A parameter was specified that cannot be changed for that port.

Serial Communications Under Program Control

To automatically set the parameters of the serial ports, a command file must be written that uses Set Utility program commands. The parameters cannot be modified by programs written in high level languages (BASIC, Fortran). Once the port parameters are established by the Command file, however, programs written in any language can get information into and out of the port.

Keep in mind that the command file must first enter the Set Utility program, and after parameters are changed, must exit it. Here is a portion of a command file that does just that:

```
SET  
KB1: BR 2400,DB 7,PB E,SB 1.5,SI E,SO E,TO 15  
EXIT
```

The following table illustrates the commands used in the BASIC and FORTRAN languages to send and receive information via the serial port. Notice that both languages include commands to first open the channel, then either to send or receive data through it. For more information, consult the manual that covers the programming language you are using.

BASIC

To send:

```
OPEN "KB1:" AS NEW FILE 1  
PRINT #1, "TESTING"
```

To receive:

```
OPEN KB1: AS FILE 1  
PRINT A$
```

FORTRAN

```
CALL OPEN (2, "KB1:", 4, 0, IERR)  
WRITE (2, 10) IERR  
10 FORMAT ( 'ERROR CODE: ',I5)
```

```
READ (2,20) A  
20 FORMAT (F10.4)  
CALL CLOSE (2, IERR)
```

Sample BASIC Program

This sample program shows how these important commands would be included in a BASIC language program that reads information from a floppy disk in device MF0:, and sends it out to a serial impact printer, like the Fluke model 1776A. Some features of the program are:

- Prompts the operator for the name of the file to be printed.
- Handles the most common error: specifying a file that doesn't exist.
- Regardless of the size of the file, outputs the entire file, and stops when printing is complete.

```
10 ! Program to print a specified file
20 !
30 @DIR ! list files
40 PRINT
50 PRINT 'ENTER FILENAME' ! display prompt
60 INPUT A$ ! filename is variable A$
70 IF A$ = "" THEN GOTO 330 ! graceful exit
80 ON ERROR GOTO 180 ! error handler
90 CLOSE 1 ! make sure channel is closed
100 OPEN A$ AS FILE 1 ! now open it.
110 CLOSE 2 ! make sure channel is closed
120 OPEN 'KB1:' AS NEW FILE 2 ! now open it. KB1: is printer
130 PRINT #2,CHR$(12X) ! send form feed to printer
140 INPUT LINE #1, A$ ! put one line of file into A$
150 PRINT #2, A$ ! output the line to printer
160 GOTO 140 ! repeat until done
170 !
180 ! * Error Handler *
190 ! ERR (system variable) = Last error
200 !
210 ! - Error 305 File Not Found -
220 IF ERR = 305 THEN RESUME 230 ELSE 270 ! retry if file not found
230 PRINT 'FILE NOT FOUND - TRY AGAIN'
240 WAIT 1000 \ GOTO 30 ! pause 1 sec; start again
250 !
260 ! - Error 307 End of File -
270 IF ERR = 307 THEN RESUME 280 ELSE RESUME 310 ! halt if EOF
280 PRINT 'TRANSFER COMPLETE'
290 CLOSE 1, 2 \ END ! close channels; halt
300 !
310 ! - All Other Errors -
320 PRINT 'ERROR - CANNOT TRANSFER FILE' ! halt for all other errors
330 PRINT 'RETURNING TO BASIC'
340 CLOSE 1, 2 ! close channels
350 END ! halt
```

Leaving out the comment lines, here is a line-by-line explanation of how this program operates:

- 30 The program begins by doing a quick directory listing to display the files that are available for printing.
- 40 Puts a blank line on the screen for readability.
- 50 Displays the prompt message.
- 60 Assigns the response to the prompt as string variable A.
- 70 If there is a null string (no input) terminated by a `<RETURN>`, this line provides a graceful exit. This is used, for example, if the directory listing indicates the file you want to print is not on this disk.
- 80 Beginning of the error handler. Any error encountered sends the program to line 300, where the error type is discovered, and various exits are provided depending on the error type.
- 90 The `CLOSE` command is insurance that a previously opened channel is closed prior to reopening. To `OPEN` an already open channel is an error; to `CLOSE` one that hasn't been opened is not. After this 'insurance' command, the following line opens the file designated as variable A as file 1, for input.
- 100 Opens the file.
- 110 Again, a command to insure the channel is closed before opening.
- 120 Serial port `KB1:` is opened as an output.
- 130 The printer (File 2) is sent a Top Of Form command, so that printing will start at the beginning of a sheet.

**Serial Communications
Sample Program**

- 140 Each line of the file is input and sent to A\$.
- 150 Each line is sent out to #2, the printer.
- 160 The return to line 140 gets the next line, so it can be PRINTed by line 150.
- 220 The error handler begins here. Error 305 is returned if there is no file with the name of the one specified as A\$. If the error is 305, then a message will be displayed at line 230, and allow a retry.
- 230 Prints the message that the file was not found.
- 240 After a one second wait, goes back to line 30 to display the directory again.
- 260 The error was not 305, so now it is checked to see if it was 307, the End of File. This is the exit when the entire file has been printed. All other errors fall through to ending routine that closes the channels and stops.
- 270 If the EOF was the error, prints the message that the transfer is complete.
- 280 Closes the previously opened channels, sends the program to the END statement to stop.
- 300 If the error was neither End of File or File Not Found, then it is some other error that makes it impossible to transfer the file. In this case, a message is printed, the channels are closed, and the program stops. This line could be enhanced by incorporating the actual error number for debugging purposes if this program is included within some longer one.

This program illustrates how the important BASIC language commands can be used to send data out the Serial port. While it is not comprehensive, it does show some good programming techniques. (And it works!)

Before using the RS-232 port, be sure to confirm two things:

1. The other end uses the DCE connector, rather than DTE. The 1722A Instrument Controller is a Data Terminal Equipment, and the other end must be a Data Communications Equipment. The connector is different for each end. Note that DTE and DCE do not refer to the sex of the connector, but to the electrical connection of the Write Data and Read Data lines.
2. All parameters match. Use the Set Utility program to change any that do not.

CONCLUSION

This section has described the two ways that the Instrument Controller communicates with other pieces of equipment using worldwide standard connection and protocol methods. It has also shown how to make use of the essential BASIC language commands to send and receive information over its instrumentation bus and serial data communications bus.

The next section, *Creating and Editing Programs*, will show how to begin writing your own routines with a view to automating the functions of the Instrument Controller.

Section 6

Creating And Editing Programs

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INTRODUCTION

The 1722A Instrument Controller is a special purpose computer, and like any computer, its instructions must be given in very precise language. This section is designed to assist you in the task of writing precise instructions.

There are a number of different facilities for writing and editing programs. From Immediate mode BASIC, the command EDIT presents a range of possibilities. This is the Editor of choice for programs written in BASIC, because it is so well adapted to the task, and because it is readily available, once you are "in BASIC".

For creating other types of programs, such as Command files or Alias files, the System Editor program (filename EDIT.FD2) is easier to get at. Also, you will have to use the System Editor if you are programming in FORTRAN or some other language that does not provide editing functions.

This section discusses these main topics:

- Selecting a Programming Language**
- Creating Programs Using the File Utility Program**
- The Command Line Interpreter**
- The Editor Program**

SELECTING A PROGRAMMING LANGUAGE

There are three languages that can be used for programming the 1722A. Here is a guide to help in selecting the most appropriate language for any particular application.

BASIC

BASIC is an acronym for **B**eginners **A**ll-**P**urpose **S**ymbolic **I**nstruction **C**ode. The **BASIC** language is used for about 90% of all programming applications because it is fairly common, is easy to learn, and provides most of the capabilities that are desired for instrumentation systems. There are really two forms of the **BASIC** language: the normal interpreted version, and a special compiled version.

Interpreted **BASIC** version is an enhanced version of the **BASIC** language that is common to most computers. It has a built-in editor, Immediate Mode Commands, and runs programs interactively. These features make program development easy and straightforward, even for inexperienced users. Because it is the language of choice for most applications, the interpreted version of **BASIC** is included with every 1722A.

Compiled **BASIC** is essentially the same language in a compiled form to increase its execution speed. Compiled **BASIC** programs are written using the System Editor program. They can be created in a more structured form than conventional line-oriented **BASIC** programs. The programs are compiled into a form that runs much faster than an equivalent interpreted **BASIC** program. Compiled **BASIC** should be used in applications where additional speed or a modular structure is needed while retaining the familiar **BASIC** language elements. Compiled **BASIC** is available as an optional accessory software package which contains the software required to create and maintain Compiled **BASIC** programs.

FORTRAN

FORTRAN is also an acronym. It stands for *Formula Translator*. FORTRAN is a useful language for scientific applications because of the ease with which it manipulates numbers. BASIC provides most of the same capabilities, but FORTRAN may be the better choice if many of your current programs are already written in FORTRAN, if you are experienced in programming in FORTRAN, or if the operation requires greater speed. Because it is a compiled language, FORTRAN offers high speed, but, like all compiled languages, it is more complicated to work with.

Assembly Language

Assembly Language provides the programmer with access to all of the capabilities of the TMS-99000 processor used in the 1722A. Assembly Language programs can usually be both faster and shorter than programs written in any other language. In addition, specialized Input/Output and data conversion functions not otherwise available sometimes must be written in Assembly. The penalty for this flexibility is that Assembly Language programs usually take longer to design, to write, and to debug than programs written in higher-level programming languages.

When greater performance is required for a program written in a higher-level language it is usually possible to replace time-consuming operations with a faster Assembly language subroutine. This can be a cost-effective solution if the amount of Assembly code is small compared to the total size of the program.

FILE UTILITY PROGRAM

It is possible to create, but not edit, programs using the File Utility program. To implement this capability, use the File Utility program command in the form:

(filename)= KB0: <RETURN>

Now, any keystrokes made will be filed at the System Device, and given the filename specified. The end of the file must be indicated to the File Utility program by the command <CTRL>/Z (EOF).

This facility is not used for creating long or complex programs because there is no way to edit them. If an incorrect keystroke is not seen immediately, it is necessary to either re-write the entire file, or else use an editor program to correct it.

COMMAND LINE INTERPRETER

Introduction

The central program, FDOS, is always present in the system's memory, and its facilities are used by other programs. For example, when a program written in BASIC is running, one is tempted to say "a BASIC program is running", but that would be inaccurate because it is actually the BASIC Interpreter program that is running. It calls upon the Operating System to provide file manipulation and other Input/Output. The execution of a program and the Operating System is interleaved.

In the same way, when the utility programs are in use, they direct the activities of FDOS. The Operating System takes control only when:

1. The utility program requests an I/O operation.
2. A severe hardware or software error occurs.
3. The FDOS> prompt is displayed.

An important feature of the Operating System is its Command Line Interpreter. As its name implies, this is the portion of the Operating System that accepts keyboard commands and acts on them. It permits us to type FUP, for example, and be understood as saying, "Hello, Operating System, what I want you to do is go out to the floppy disk and find a program called the File Utility program. Read it into memory, and pass control of the microcomputer to it." The File Utility program returns control when it receives the Exit command /X.

Editing Features of the Command Line Interpreter

When a command line is being written, some rudimentary editing functions are available. These features of the Operating System are great time savers, because they speed up the creation of Command files and access to utility programs. All the commands described are available from from FDOS, BASIC, and the TIME, SET and File Utility programs.

`<CTRL>/F` and `<CTRL>/R`

These are mnemonically named commands for “Forward” and “Reverse”. `<CTRL>/R` causes the last line entered to be displayed again, and repeats until the first command has been reached. When a former command has been displayed, it is available for editing, thus providing the Controller with an elegant way to avoid much repetitious typing.

Example:

Since the Controller was turned on, these commands were entered:

```
FUP
RS232.CMD
/X
TIME
03 06 83
14 35
```

The first use of `<CTRL>/R` would display 14 35, the next 03 06 83, the next TIME, then /X, RS232.CMD, and finally FUP. If `<RETURN>` is pressed when any of these are displayed (the cursor can be anywhere on the line), the system accepts the command just as if it had been typed in. If you wanted to get back to the line “RS232.CMD” to run the program, rather than having the File Utility program display it, you would use `<CTRL>/R` until the display showed that line, then press `<RETURN>`. If you go all the way back to the line reading “FUP” by mistake, just use `<CTRL>/F` to go forward.

These commands are circular. If `<CTRL>/R` were pressed once more after “FUP” was displayed, the next thing to be displayed would be 14 35.

Any time that <CTRL>/R or <CTRL>/F are used to display a previously entered command, the command can be edited using the arrow keys, DEL LINE and DEL CHAR keys, the DELETE key, or the backspace (back to left margin), or LINE FEED (to end of line). Once the line has been edited, pressing RETURN with the cursor anywhere on the line will cause the command to be executed.

Other editing features of the Command Line Interpreter are:

- | | |
|------------|---|
| <CTRL>/U | Erases the current line. |
| <CTRL>/T | Clears the screen, and positions the prompt on the first line. |
| <CTRL>/P | Aborts whatever operation is in progress, and returns control to the Operating System (FDOS prompt). |
| <CTRL>/Z | Used as the End Of File (EOF) command. |
| <CTRL>/C | Interrupts an operation, and may abort it depending on the operation in progress. |
| <DELETE> | Deletes the character at the cursor position and moves the cursor left one position. This action stops at the prompt. |
| Key Repeat | All keys, including control characters, repeat when held down. |

THE EDIT PROGRAM

Introduction

The Edit program is supplied on the System disk as a file named EDIT.FD2. This editor is a visual one, as opposed to "blind" editors. That is, the file is displayed as you edit it.

The Edit program provides a complete set of commands for performing these functions:

- Inserting Text
- Searching, Replacing, and Marking Text
- Positioning the Cursor
- Changing Editor Modes

Entering the Editor Program

From the FDOS> prompt, type:

EDIT <RETURN> or EDIT (filename) <RETURN>

In the first case, no file is specified. If this method is used as the entry to the Editor, a filename must be specified later, when exiting the program. The reverse is true if a filename is specified as you enter; one must not be specified as you exit. If different filenames are given, the result would be that two files would be created; the one specified at the beginning of the editing session will be empty.

As always, if no device name is specified, the default is to the System Device.

In this example, the file named FILE.NEW was specified:

```
EDITING FILE "FILE.NEW" [new file]
```

If the file already exists, the bracketed "new file" would not be included on the display.

If no file has been specified, only the cursor appears on the top line.

The rest of the display depends on the file contents, but if the file is being created, the display has omega symbols on the left, indicating empty lines.

```
EDITING FILE "FILE.NEW"  
Ω  
Ω  
Ω  
Ω  
Ω  
Ω  
Ω
```

Exiting the Editor Program

There are several ways to exit the Editor program. The most commonly used are:

- First record the changed file, then exit the Edit program:

⟨ESC⟩ :w ⟨RETURN⟩ write the file
⟨ESC⟩ :q ⟨RETURN⟩ exit the Editor

- Exit without recording the changes to the file:

⟨ESC⟩ :q! ⟨RETURN⟩

Other commands permit reading a file into the display while editing another file.

Operating Modes

The Editor has two modes of operation. The Insertion mode is the default, and is primarily used for inserting text, although it does allow a certain amount of cursor and text manipulation. The Command mode is used for more powerful cursor and text manipulation, searching, and exiting the program.

Many Edit program commands result in a temporary return to the Insertion mode. When these commands are used, ⟨ESC⟩ is the return to Command mode. The purpose of these commands is to save the time involved in exiting the Command mode, doing the insertion, then returning to Command mode.

To change from Insertion to Command mode:
⟨ESC⟩:@ ⟨RETURN⟩

To change from Command to Insertion mode:
:@ ⟨RETURN⟩

When either change mode command is given, the new operating mode becomes the default.

On the first entry to the Edit program, Insertion mode is the default. If Command mode is desired, the EDIT command can be modified by using the -c switch. The entire command to enter the Edit program in Command mode and begin editing FILE.NEW would read:

EDIT -c FILE.NEW ⟨RETURN⟩

Global Commands

Global commands operate in either mode. After they are executed, the Editor returns to the default mode. They are used to read or write a file, and check the status of the Editor. Global commands are always preceded by a colon (:). The most commonly used ones are:

- :w Writes the file.
- :q Quits the Editor and returns to the Operating System.
- :q! Quits the Editor without any changes from the current editing session.
- :r Reads another file in during editing.
- :s Substitutes one string of characters for another.

NOTE

When in the Insertion mode, the Global command prefix is (ESC):.

Most Used Commands

The entire command structure of the Editor program contains some redundancy; also, some commands are used infrequently enough to not require a complete discussion. Most programs can be created and edited using only a few of the available commands. The full capabilities of the Edit program are presented at the end of this section.

Cursor Positioning

In the Insertion mode, the four arrow keys on the six-key auxiliary keypad move the cursor in the direction shown by one space or one line.

In the Command mode, these keys can be preceded by a number to move longer distances. For example, 20→ would move the cursor 20 places right, and 20↓ would move it down 20 lines.

The lower-case letter “w” moves the cursor to the right by one word. If a number precedes the “w”, the cursor moves right by the number of words specified.

The lower-case letter “b” moves the cursor back by one word. If a number precedes the letter “b”, the cursor moves back by that number of words.

Text Insertion and Deletion

In the Insertion mode, any characters typed are displayed and the cursor is moved right one position. The `<DEL LINE>` and `<DEL CHAR>` keys on the auxiliary keypad delete characters or the entire line to the right of the cursor without moving the cursor. The `<DELETE>` key (just above `<RETURN>`) erases single characters to the left of the cursor, and moves the cursor left one position.

In the Command mode, typing the lower-case letter "a" returns operation to the Insertion mode. Anything typed in strikes over the already existing text, but it is displayed again when the `<ESC>` key is pressed. The upper-case letter "A" is a command to add whatever text follows, starting at the end of the line the cursor is on. To stop inserting text, press `<ESC>`.

To delete text in the Command mode, position the cursor anywhere on the line and type `<CTRL>/U`; the entire line is deleted. `<DEL CHAR>` and `<DEL LINE>` operate just as they do in Insertion mode. If a number precedes them, that number of characters or lines to the right of or down from the cursor are deleted. Similarly, the `<DELETE>` key can be preceded by a number. For example, the command `3<DELETE>` deletes three characters to the left of the cursor.

Substitution

The substitution (s) command replaces whatever text is to the right of the cursor with a specified character. The form is `[n]s{char}` where `[n]` is the number of characters to be substituted, and `{char}` is the character to be substituted.

In this example, a time delay of 200 milliseconds was found to be inadequate for a program, so the number 200 will be substituted for 1000. With the cursor positioned under the 2 of 200 the command `4s1000` changes the 200 to 1000, leaving the cursor at the end of the line.

```
      .                               .  
      .                               .  
60  WAIT 200  —————> 4s1000  —————> 60  WAIT 1000_  
      .                               .  
      .                               .  
      .                               .
```

All Command mode returns to Insertion mode are terminated by `<ESC>`.

Marking Text

Invisible markers can be placed anywhere in the text from the Command mode. There can be 26 such markers in any file, one for each lower-case letter in the alphabet. The command `ma` places a marker named "a" at the cursor position. To return to that position after subsequent editing, use the command `'a`.

Searching

Searching can only be done from the Command mode. The Find (F) command operates only on the current line, and searches for a character to the left of the cursor. The entire command takes the form `[n]F{char}`, where `n` is a number of occurrences prior to the cursor position, and `{char}` is the character to be searched for. In this example of a line from a BASIC language program, the command `F10` would leave the cursor at the line number:

```
10 DIM A$(52, 52)
```

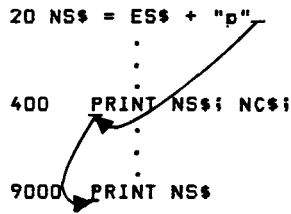


The second type of search looks for patterns rather than single characters. Each of the command characters must be preceded by `(ESC)`. The three command characters that the search command can begin with are:

- `/` searches forward throughout the buffer.
- `?` searches backward throughout the buffer.
- `!` searches forward to the end of the file.

Whichever character begins the command, search commands always take the form `[cc]{pat}` where `cc` is the command character, and `{pat}` is the pattern to search for. The pattern searches are repeatable by using the lower-case letter `n` to continue searching in the same direction, and the upper-case `N` to reverse direction of the last search.

In this example, the programmer wants to find all those occurrences in a program where something is to be printed in normal size letters. The cursor is positioned at the end of line 20. The command !PRINT NS would first locate the PRINT statement in line 400. The lower-case letter n (next) would then locate the next occurrence at line 9000.



INSERTION MODE COMMAND TABLE

ACTION	RESULT	COMMENTS
Cursor Positioning		
→	Move cursor right one position.	Ignored if cursor is at the last position on the line.
←	Move cursor left one position.	Ignored if cursor is at the left margin.
↑	Move cursor up one line.	Cursor remains in same position on next line unless it is shorter; then it goes to the end of the line.
↓	Move cursor down one line.	Acts the same as ↑
⟨BACKSPACE⟩ or ⟨CTRL/H⟩	Move cursor to the beginning of the line.	
⟨LINE FEED⟩ or ⟨CTRL J⟩	Move cursor to the last position in the line.	
Deletion Commands		
⟨DEL CHAR⟩ or ⟨CTRL D⟩	Delete character at the cursor position.	
⟨DELETE⟩	Delete character to the left of the cursor.	
⟨DEL LINE⟩ or ⟨CTRL E⟩	Delete text from the cursor to the end of the line.	

Command Mode

The Command Mode of the System Editor program provides for rapid cursor placement, complex searches, deletions, and text marking. It includes commands to move sections of a file into a “yank” buffer, so it can be placed back into the file at another location. Many commands provide a temporary return to the Insertion mode. These commands must be terminated by `<ESC>` to return to the Command mode.

Markers

Each of the lower case letters on the keyboard can be used as a marker. Markers are invisible, so if they will be used extensively, it is probably a good idea to keep a tally sheet handy to aid in remembering where each marker is placed.

To place a marker named “a” into a file, move the cursor to the desired position, then give the command `ma`.

Now that marker “a” is in place, you can always return to that spot by a search command. The marker is also used with yank buffers and delete commands (see below.)

There is no provision for deleting markers. However, they are not recorded with the file and so do not remain after the current editing session. Also, the same marker can be moved simply by placing it someplace else. The last placement is the one remembered by the Editor program.

The Yank Buffer

A yank buffer is a location in memory available to store information. Information is taken from the cursor location to a specified marker.

The yank buffer is one of the Editor’s more powerful features because it can be used to relocate portions of a program as an aid to modifying it. For example, if part of a program has inadvertently been left out, and to include it requires restructuring the program, use the yank buffer to move sections of the program from the screen and into memory, then replace them as the new section is written. Another good use for the yank buffer is as a holding area for a frequently written line of code, such as a tightly formatted `PRINT` statement or a very long line.

- `y'a` removes text from the cursor to marker a.
- `p` puts the buffer back into the text after the character where the cursor is positioned.
- `P` puts the buffer back into the text before the character where the cursor is positioned.

Search Commands

Searches can be performed from the cursor position either backwards or forwards in a file. The search can be for markers, strings of characters, lines or line positions, or to a string that matches a metacharacter.

To search for the first occurrence in a file of the word PRINT, the command most commonly used would be: !PRINT

Other variations are to use the command characters / and ? to search forward and backward on the current page.

The lower case letter n finds the next PRINT statement.

The upper case letter N locates the previous PRINT statement.

Metacharacters

Metacharacters describe patterns of characters that may be more complex than words or simple strings of characters. Metacharacters are similar to wild cards, but are only used with search commands.

- . (dot) Matches any single character in the line.
Example: ta.k matches talk, task, and tank, but not take.
- ^ (caret) Matches at the beginning of a line.
Example: ^PRINT would locate all the PRINT statements in a program, as long as there were no line numbers.
- \$ (dollar) Matches at the end of a line.
Example: RESUME 580\$ would locate all the lines in a program that RESUMEs to line 580.
- [] (brackets) Match constructed patterns.
Example: [13579] matches any single-digit odd number. [Pp]rint matches both Print and print.
- (dash) With the bracket metacharacter, specifies a range of characters (in ASCII order) as a character class.
Examples: [0-9] matches any single digit.
[- ~] matches all printable characters (ASCII 'blank' to tilde)
- ! (bang) Matches any character not in a specified character class.
Example: [!a-zA-Z] matches everthing that is not a letter.
- * (star) The closure character; matches zero or more repetitions of character(s) matched by preceding patterns.
Examples: X* matches zero or more upper-case X's in a row.
(.*) matches anything between parantheses.
- \ (backslash) The escape operator; causes the character immediately following to be treated as a literal character, even if it is a metacharacter.
Example: The pattern \\$ matches the dollar sign, not the 'end of line' metacharacter. \\ matches the backslash character.

Command Mode Commands

The command mode provides complex cursor positioning, pattern searches, text replacement, deletion, and insertion. In the section that follows, each command is explained, and a five line section of a program is used for the examples. The example program lines are shown double-spaced to better illustrate the movements involved; in actual practice, programs do not allow empty lines as shown here:

```
10 DIM A$ (5%, 5%)
20 TRACE ON 110, A$ ( )
30 FOR I% = 0% TO 5%
40 A$ (I%, 0%) = CHR$ (ASCII ( ' ')) + I%
50 GOSUB 110
```

Cursor Positioning


Moving the Cursor Forward

Command: [n]→ -or- [n]| -or- [n] <SPACE>

Purpose: To move the cursor to the right n characters.

Example: The cursor is at the beginning of line 30.
The command 12→ moves it to the equals sign:

```
30 FOR I% = 0% TO 5%
```



Command: [n]|

Purpose: To move the cursor to column n.

Example: The cursor is under 'C' of CHR\$ (column 19) on line 40.
The command 38→ moves it to column 38 (the I of I%).

```
40 A$ (I%, 0%) = CHR$ (ASCII ( ' ')) + I%
```



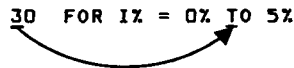
Command: [n]w -and- n[W]

Purpose: Lower-case: To move the cursor forward on a line the specified number of words.
Upper-case: Operates on strings.

A word is made up of alphabetic and numeric characters, and ends with a space, tab, or punctuation mark, or symbols such as \$, %, or &. A string can include symbols in addition to the alphanumeric characters. The cursor is left at the beginning of the word or string.

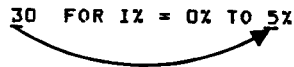
Example: The cursor is at the beginning of line 30.
The command 2w leaves the cursor under the word TO:

30 FOR IX = OX TO 5X

A diagram showing the text "30 FOR IX = OX TO 5X". A curved arrow starts at the beginning of the line (under the "30") and points to the beginning of the word "TO".

Example: The cursor is at the left margin of line 30.
The command 6W moves it to the 5 of 5%

30 FOR IX = OX TO 5X

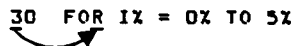
A diagram showing the text "30 FOR IX = OX TO 5X". A curved arrow starts at the beginning of the line (under the "30") and points to the end of the word "5X".

Command: [n]e -and- [n]E

Purpose: Lower-case: To move to the end of the specified word.
Upper-case: To move to the end of the specified string.

Example: The cursor is at the beginning of line 30. The command 2e positions it at the R of FOR.

30 FOR IX = OX TO 5X

A diagram showing the text "30 FOR IX = OX TO 5X". A curved arrow starts at the beginning of the line (under the "30") and points to the letter "R" in the word "FOR".

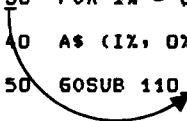
Creating And Editing Programs
The System Editor
Moving the Cursor Forward

Command: [n] \$ -or- [n] <LINEFEED> -or- [n] <CTRL>/J

Purpose: To move the cursor forward to the last position of line n; the current line if n = 1, or if no number is used.

Example: The cursor is at the left margin on line 30.
The command 3\$ moves it forward to the end of line 50:

```
10 DIM A$ (5X, 5X)
20 TRACE ON 110, A$ ( )
30 FOR IX = 0X TO 5X
40 A$ (IX, 0X) = CHR$ (ASCII ( ' ')) + IX
50 GOSUB 110
```

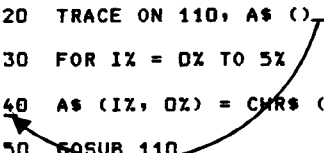


Command: [n] + -or- [n] <RETURN> -or- [n] <CTRL>/M

Purpose: To move the cursor forward to the left margin n lines down; if n = 1, the next line down.

Example: The cursor is at the end of line 20.
The command 2+ moves it to the beginning of line 40:

```
10 DIM A$ (5X, 5X)
20 TRACE ON 110, A$ ( )
30 FOR IX = 0X TO 5X
40 A$ (IX, 0X) = CHR$ (ASCII ( ' ')) + IX
50 GOSUB 110
```



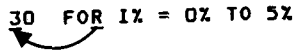
Moving the Cursor Backward

Command: [n]b -and- [n]B

Purpose: Lower-case: To move the cursor backward to the beginning of a specified word.
Upper-case: To move the cursor backward to the beginning of a specified string.

Example: The cursor is under the R of 'FOR' of line 30.
The command 1b moves it to the 3 of 30:

```
30 FOR IZ = 0Z TO 5Z
```

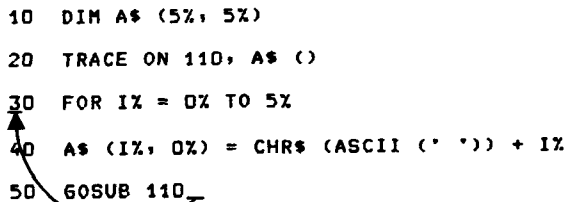


Command: [n]^ -or- [n] <BACKSPACE> -or- [n] <CTRL>/H

Purpose: To move the cursor from the current position to the left margin of the *n*th line up. If *n* = 1, the cursor moves to the left margin of the current line. The current line is also used if no number or zero are given.

Example: The cursor is at the end of line 50.
The command 3^ moves the cursor to the beginning of line 30:

```
10 DIM A$ (5Z, 5Z)  
20 TRACE ON 110, A$ ()  
30 FOR IZ = 0Z TO 5Z  
40 A$ (IZ, 0Z) = CHR$ (ASCII ( ' ' ) + IZ)  
50 GOSUB 110
```



Creating And Editing Programs

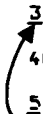
Moving the Cursor Backward

Command: [n] - -or- [n] <RETURN> -or- [n]

Purpose: To move to the left margin of the nth line up.

Example: The cursor is at left margin of line 50.
The command 2- moves it to the left margin of line 30.

```
10 DIM A$ (5%, 5%)
20 TRACE ON 110, A$ ( )
30 FOR IX = 0% TO 5%
40 A$ (IX, 0%) = CHR$ (ASCII ( ' ')) + IX
50 GOSUB 110
```

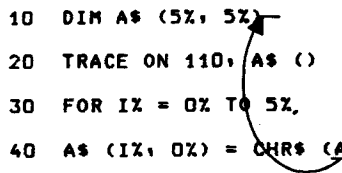
A curved arrow starts at the beginning of line 50 and points to the beginning of line 30, indicating the movement of the cursor.

Command: [n]↑ -or- [n]k

Purpose: Moves the cursor up n lines. Attempts to keep cursor positioned in the same location on the new line. If the target line is shorter, cursor moves to last position.

Example: The cursor is under the 'A' of ASCII in line 40.
The command 3↑ moves the cursor to the last position of line 10:

```
10 DIM A$ (5%, 5%)
20 TRACE ON 110, A$ ( )
30 FOR IX = 0% TO 5%
40 A$ (IX, 0%) = CHR$ (ASCII ( ' ')) + IX
50 GOSUB 110
```

A curved arrow starts at the 'A' in line 40 and points to the end of line 10, indicating the movement of the cursor.

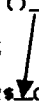
Moving the Cursor Down

Command: [n]↓ -or- [n]j

Purpose: To move the cursor down n lines. If the cursor cannot be kept in the same position because the target line is shorter, it will be placed at the last position.

Example: The cursor is at the last position of line 20. The command 2↓ moves it to the space after CHR\$ in line 40:

```
10 DIM A$ (5%, 5%)
20 TRACE ON 110, A$ ( )
30 FOR IX = 0% TO 5%
40 A$ (IX, 0%) = CHR$(ASC(ASCII (' ') + IX)
50 GOSUB 110
```



Long Cursor Movements

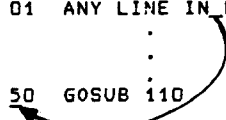
Moving to the End of the Buffer

Command: [n]g

Purpose: To move the cursor to line n of the buffer. If n is not specified, the cursor moves to the last line in the buffer.

Example: Line 50 is the last line in the buffer. No matter where the cursor is situated, the command g moves the cursor to the beginning of line 50.

```
01 ANY LINE IN BUFFER
   .
   .
50 GOSUB 110
```



Moving to the End of the File

Command:

[n]G

Purpose: Moves the cursor to the specified line of the current file. If not specified, the cursor goes to the last line of the file.

Example: Same as lower-case if the entire file is in the buffer.

Moving By Screenfuls

Command: H

Purpose: To move the cursor to the top line of the screen. (High)

Command: L

Purpose: To move the cursor to the bottom line of the screen. (Low)

Command: [n] <CTRL>/F

Purpose: On extremely long files, moves forward by an entire screenful (15 lines). The [n] indicates the number of screenfuls to go forward.

Example: The sample program lines are about 80 lines ahead in the file. The command 5 <CTRL>/F will position the cursor in the general vicinity of the program. (5 x 15 75)

Command: [n]<CTRL>/B

Purpose: To move backwards by screenfuls, as in the prior command.

Search Commands

Searching for a Single Character

Command: [n] f {c}

Purpose: To move the cursor forward to the *n*th occurrence of a character on the same line. If the character does not occur the number of times specified, the command is ignored.

Example: The cursor is at the left margin position on line 40. The command 2f\$ leaves it under the \$ of 'CHRS'

```
40 A$ (IX, OX) = CHRS (ASCII (' ')) + IX
50 GOSUB 110
```

A diagram showing two lines of code. Line 40 is '40 A\$ (IX, OX) = CHRS (ASCII (' ')) + IX' and line 50 is '50 GOSUB 110'. A curved arrow starts from the left margin of line 40 and points to the '\$' character in 'CHRS'.

Command: [n] F {c}

Purpose: Same as prior command, except searches backwards for the character.

Command: [n] t {c}

Purpose: Same as [n] f {c} except leaves the cursor at the left of the character specified.

Command: [n] T {c}

Purpose: Same as [n] f {c} except searches backward, and leaves cursor at the right of the specified character.

Searching For a Pattern

Command: /{pat}

Purpose: Moves the cursor forward to the beginning of the specified pattern. The pattern may be anywhere between the current position and the end of the buffer. If the pattern does not occur, the cursor remains, and the message PATTERN NOT FOUND is displayed.

Example: The cursor is at the first position of line 10. The command /5% positions the cursor at the 5 of 5% on the same line:

10 DIM A\$ (5%, 5%)

A diagram showing the command '10 DIM A\$ (5%, 5%)' on a single line. A curved arrow starts under the first character '1' and points to the first '5' in the pattern '(5%, 5%)', indicating the cursor's movement.

Command: ?{pat}

Purpose: Same as prior command, but searches from present position backwards to beginning of buffer.

Command: !{pat}

Purpose: Same as /{pat}, except searches forward to the end of the file.

Command: n

Purpose: To find the next occurrence of a pattern specified by the original /, ?, or ! command.

Command: N

Purpose: Same as n(ext), but in opposite direction of the original /, ?, or ! search.

Marker Commands

Placing a Marker

Command: `m[x]`

Purpose: To place an invisible marker in the text at the cursor position. The [x] must be a lower-case alphabetical character. If the same label is used a second time, the first one is deleted. All markers are deleted if the file is written (w), or when the Editor is quit (q).

Example: Place a marker named `c` at the string 'CHR\$'
Position the cursor at the 'C', and type `mc`.

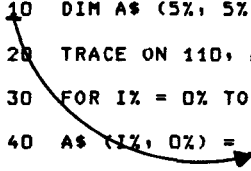
Finding a Marker

Command: ``[x]`

Purpose: To find a previously defined marker. If no marker by that name exists, the message "Mark not set" is displayed.

Example: The cursor is at the beginning of line 10.
The command ``c` moves the cursor to the previously defined marker at 'CHR\$' on line 40.

```
10 DIM A$ (5%, 5%)  
20 TRACE ON 110, A$ ()  
30 FOR I% = 0% TO 5%  
40 A$ (I%, 0%) = CHR$ (ASCII (' ')) + I%  
50 GOSUB 110
```



Text Insertion

Text can only be inserted from the insertion mode. However, for convenience, many Command mode commands provide a shortcut entry to and return from the Insertion mode. The return to Command mode is one keystroke: `<ESC>` Here are the commands:

Command: a -or- A

Purpose: To append text to existing lines. To terminate the insertion, use `<ESC>`. If upper-case, first moves the cursor to the end of the current line.

Example: A comment is to be added to line 10. Use the upper-case 'A' command to position the cursor at the end of the line, and enter Insertion mode.

```
10 DIM A$ (5%, 5%)_
```

Text can now be inserted. Space over and begin the comment with an exclamation point.

```
10 DIM (10,50) ! dimension a 5 by 5 array_
```

To terminate the insertion, press `<ESC>`

Command: i -or- I

Purpose: To insert text at the cursor, moving other text off to the right. The upper-case operates the same as lower case, but first moves cursor to beginning of current line. Terminate the insertion with `<ESC>`.

Example: In typing line 40, the word 'ASCII' was inadvertently left out. The remainder of the line is all right. Position the cursor at the space between the parantheses and type the single letter command i.

```
40 A$ (IX, OX) = CHR$ (_(' ')) + IX
```

Now type the word ASCII. The result will be:

```
40 A$ (IX, OX) = CHR$ (ASCII_(' ')) + IX
```

Terminate the insertion by typing `<ESC>`

Text Substitution

Command: [n]s

Purpose: The substitute command. The number of characters specified are substituted at the cursor.

Example: The word ASCII is accidentally typed as EBCDIC. With the cursor positioned at the A of ASCII, the command 6s will substitute EBCDIC for whatever characters follow until <ESC> is pressed. The cursor is left at the position following the substitution.

```
40 A$ (1X, 0X) = CHR$ (EBCDIC (' ')) + 1X
```

The result will read:

```
40 A$ (1X, 0X) = CHR$ (ASCII_ (' ')) + 1X
```

Command: r[c]

Purpose: The replacement command allows whatever character is at the cursor to be replaced by the specified character. This command differs from the substitute command in not entering the Insertion mode, except for the single character replaced. There is no need to press <ESC> to return to Command mode (you never left it).

Example: In line 10, the array to be dimensioned was given the arguments (7%, 5%). To change the 7 to a 5, position the cursor under the 7 and type the command r5.

```
10 DIM A$ (7%, 5%)
```

The result will be:

```
10 DIM A$ (5%, 7%)
```

Case Conversion

Command: [n]~

Purpose: To change the case of a number of characters, either upper- to lower-case, or vice versa.

Example: On line 40, ASCII was mistakenly typed ascii.

```
40 A$ (IX, OX) = CHR$ (ascii) + IX
```

Position the cursor at the first character, and give the command 5~. The cursor moves past the inverted text:

```
40 A$ (IX, OX) = CHR$ (ASCII) + IX
```

Text Deletion Commands

Small amounts of text can be deleted from the Insertion mode. The Command mode expands the possibilities, and permits deletion of text in varying amounts.

Deleting By Character Amounts

Command: [n] <DEL CHAR> -or- [n]x -or- [n] <CTRL> /D -or- [n]s <ESC>

Purpose: Delete a specified number of characters (not spaces) after the cursor.

Example: In line 20, everything following TRACE ON is to be deleted. Position the cursor at the space following TRACE ON, and give the command 7x.

```
20 TRACE ON_110, A$ ( )
```

The new line will read:

```
20 TRACE ON..
```

Command: [n] <DELETE> -or- n[X]

Purpose: Same as [n]x, except deletes from the cursor backwards.

Command: [n] d [^]

Purpose: To delete all text from the cursor to the end of the *n*th line prior to the cursor. If *n* = 1, this command uses the cursor line.

Command: [n] d [\$]

Purpose: Same as prior command, but deletes from the cursor forward.

Command: [n]s <ESC>

Purpose: This command is a special side-effect of the substitution command [n]s. It deletes the specified number of characters forward from the cursor. A block marker ■ is momentarily visible at the location to be deleted to, until <ESC> is pressed. If any keystrokes are made before the <ESC> terminator, the characters will write over whatever is currently at those positions. See also the [n]s substitute command.

Example: The cursor is on line 40. To delete the word ASCII and the space and left paranthesis after it, use the command 7s <ESC>

```
40 A* (IX, OX) = CHR* (ASCII (■)) + IX
```

The result will be:

```
40 A* (IX, OX) = CHR* ( ) + IX
```


Deleting By Line Amounts

Command: [n]dl -or- [n]<CTRL>/U

Purpose: Delete the current line, and forward the number of lines specified.

Example: The cursor is in the middle of line 10.
The command 3dl deletes lines 10, 20, and 30. An epsilon symbol is left on the deleted lines:

```
ε  
ε  
ε  
40 A$ (IX, OX) = CHR$ (ASCII (' ')) + IX  
50 GOSUB 110
```

Command: [n]D -or- [n] <CTRL>/D

Purpose: To delete forward from the cursor position to the end of the *n*th line down.

Example: As in the previous example, except that not all of line 10 is deleted. the Command 3D results in:

```
10 DIM A$ (5X, 5X)_  
ε  
ε  
40 A$ (IX, OX) = CHR$ (ASCII (' ')) + IX  
50 GOSUB 110
```

Deleting to a Marker

Command: d[x]

Purpose: Delete from the cursor forward or backward to the specified marker.

Control Commands

Opening a New Line

Command: o

Purpose: Opens a line below the cursor line, and switches to Insertion mode. Notice that the cursor line is momentarily erased, but returns when the screen repaints on leaving the Insertion mode (ESC).

Example: A line is to be added between lines 10 and 20. Position the cursor anywhere on line 10, and press the letter o key.

```
10 DIM A$ (5%, 5%)
```

```
20 TRACE ON 110, A$ ( )
```

Command: O

Purpose: Same as the lower-case command, except the line is opened above the cursor.

Joining Open Lines

Command: J

Purpose: Joins the cursor line to the line below.

Example: Lines 40 and 50 are to be combined into one line. Position the cursor anywhere on line 40, and give the command (must be upper case; lower case j is equivalent to the down arrow).

```
40 A$ (IX, OX9 = CHR$ (ASCII ( ' ')) + IX  
50 GOSUB 110
```

The result will be:

```
40 A$ (IX, OX) = CHR$ (ASCII ( ' ')) + IX 50 GOSUB 110
```

Complete the new line by using <DEL CHAR> to remove the line number 50, then separate the two statements by a backslash (\).

```
40 A$ (IX, OX) = CHR$ (ASCII)) + IX \ GOSUB 110
```

Command: <CTRL>/L -or- <CTRL>/R

Purpose: These commands eliminate unused lines by repainting the screen. Any epsilon characters that have been generated during an editing session will be dropped.

Translating Upper and Lower Case

Command: <CTRL>/A

Purpose: This command is a toggle that maps upper case to lower case and vice versa. It is only active in the Insertion mode, and can be helpful for editing FORTRAN programs or others that must be all upper-case. It allows one to enter lower-case commands (most of the Edit program's commands are lower-case) while entering upper case text.

Target Commands

Target commands have two parts, the command itself and a “target” that specifies the extent of the command. The command determines the action to be taken, such as deleting or yanking. The target specifies the direction and number of characters that the action will be performed on. Targets are the same cursor motions that were presented earlier, “w” for word, for example. The user can delete a word of text by the command “dw”. The “w” specifies that the deletion will take place over a cursor motion of one word to the right.

By entering the command twice for the “d” and “c” commands, the action will take place on the entire line. For example, the command “4dd” would delete four lines of text.

The table below explains the three Target commands:

Change text from cursor to target (Enters Insertion mode: terminate with <code><ESC></code>).	<code>[n]c {target}</code>
--	----------------------------

Delete from cursor to target.	<code>[n]d {target}</code>
-------------------------------	----------------------------

Yank from cursor to target.	<code>y[n] {target}</code>
-----------------------------	----------------------------

Creating And Editing Programs

Target Commands

The table below shows each of the Targets, and indicates the cursor movement for each of them:

CURSOR MOVEMENT	TARGET
Left margin of current line.	^
Last character of current line.	\$
One space to the right.	<SPACE>
To specified column.	[n]
Forward to the <i>n</i> th occurrence of <i>c</i> .	f{c}
Forward to the character prior to the <i>n</i> th occurrence of <i>c</i> .	F{c}
Forward to the character after the <i>n</i> th occurrence of <i>c</i> .	t{c}
Back to the character after the <i>n</i> th occurrence of <i>c</i> .	T{c}
Beginning of next word.	w
Beginning of next string.	W
End of next word.	e
End of next string.	E
Beginning of previous word.	b
Beginning of previous string.	B
To a marker.	`[mark]

Global Commands

Global commands are available from either the Insertion or the Command mode. They perform these functions:

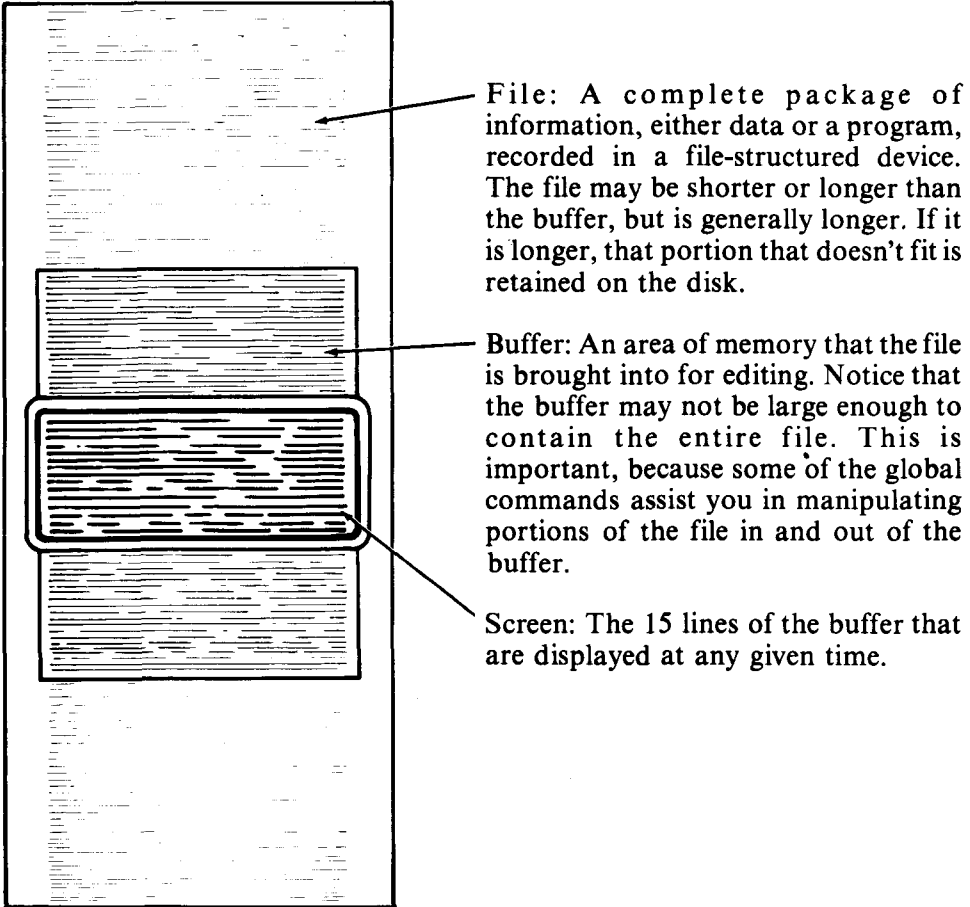
- Read from files into the buffer.
- Write from the buffer into a file.
- Page through a file.
- Toggle the default mode.
- Check amount of available memory space.
- Display the software version.
- Exit to the the operating system.

All the Global commands must be preceded by a colon (:). From the Insertion mode, they are preceded by `<ESC>`: All Global commands are terminated by `<RETURN>` or `<ESC>`.

Creating And Editing Programs

Global Commands

Before using any of the Global commands, be sure you are familiar with these terms:



Editing an Existing File

Command: :e {filename.ext}

Purpose: Reads the named file and opens a temporary file where changes will be recorded. If there is no file by the name specified, a message is displayed. This command is equivalent to exiting the Edit program, and reentering it from FDOS with the command EDIT {filename}.

Example: Work has been finished on one file, and you wish to save it and edit another. File the first one, but do not exit the Edit program. To do this, use the Global command :w to record the first file, then the :e {filename} command to begin editing the next.

Command: :e! {filename.ext}

Purpose: Discards any changes to file being currently edited, then begins editing the named file. This command is equivalent to using the :q! command to exit the editor without changing the file, and re-entering it from FDOS with the EDIT {filename} command.

Example: During editing, it is discovered that the wrong file is being corrected. To exit without incorporating any changes, but stay in the Edit program, re-file the first program, and use the :e! {filename} command to bring in the second.

Paging Through a File

Command: :p

Purpose: Writes out the current contents of a buffer into the output file, then loads the next page into the buffer, displaying the first 15 lines. This command is equivalent to :w followed by :r (see next page).

Reading a File into the Buffer

Command: : r {filename}

Purpose: To read one file, and write it (or portions of it) out to another file. The :r command is normally followed by a :w command to facilitate merging files.

Example: A subroutine has already been developed, debugged, and incorporated into a file named ACDC.BAS. It has been found to have application within another program currently being developed. While creating the new file (call it SYNCH.BAS, for example), read in ACDC using the :r command, and delete everything except the desired subroutine. Now write the new file using the :w command.

Command: : R {filename}

Purpose: Same as the lower-case :r command, except that :p will work without creating a temporary file.

Example: A program is being created, and it is thought that a particular subroutine can be incorporated. Use the :R command to bring the file to the buffer. This command allows you to page through the file without modifying it.

Command: : r -or- :R

Purpose: Read from the current input file, inserting text at the current cursor position. These commands are the same as the other :r commands, except that no filename is specified, so the file currently being edited is used.

Example: A program in development has been designed with cascaded loops, or with many repetitive lines of code. Write the module to a file, then use the :r command to repetitiously read it back to the screen.

Substituting Patterns of Text

Command: :s/ {oldpat} / {newpat} /

Purpose: Substitute one pattern for another. The patterns may be words, strings, or expressions. The substitution begins at the current cursor position, and continues to the end of the buffer.

Example: During program development, it became necessary to renumber the starting line of a subroutine. All GOSUB statements must be changed to reflect the new line number. If the old line number was 1040, and the new line number is 1060, use the command:

Command: :S/ {oldpat} / {newpat} /

Purpose: Same as the lower case example, except that this command operates on the entire file, not just the buffer contents.

Writing From the Buffer Into a File

Command: :w {filename}

Purpose: Writes the contents of the buffer to the named file. If the output file is the same as the the current input file, it is not necessary to specify a filename. This is the normal command to record a new or revised program to a file, either prior to exiting or before reading (see :r) a new file to the buffer for editing.

Toggleing the Default Mode

Command: : @

Purpose: This command changes the default mode between Insertion and Command modes. Use the Insertion mode for most normal keyboard entries of programs, and light editing, like deletions and small cursor movements. Use the Command mode for large movements, searches, replacements, marking text, and other more complicated editing.

Example: To switch to Insertion mode from Command mode:
 : @ <RETURN> -or- : @ <ESC>

 To switch to Command mode from Insertion mode:
 <ESC>: @ <RETURN> -or- <ESC>: @ <ESC>

Checking Memory Space

Command: : m

Purpose: Displays the size of the text in the buffer, the amount of text in the yank buffer, and the amount of memory space still available. The information is displayed on the top line of the screen, and is given in bytes.

Example: During an editing session in which a long program has been entered, it is desired to check the amount of memory remaining before continuing. If the text size is approaching the size of the memory remaining, it may be necessary to either clear the yank buffer before proceeding (see the Command mode command Y). The other alternative is to write the current buffer to the file, then continue (see the Global command :w).

When the `:m` command is given, the top line of the display shows:

```
Text size: 437, Yank size: 0, Space remaining: 36392
```

This display would indicate that only 437 bytes of the buffer are in use, the yank buffer is clear, and that nearly 37 Kbytes of buffer space is still available.

Displaying the Software Version

Command: `:v`

Purpose: To check the Edit program version. This is not used during normal Editing, but can be checked if needed as an aid to tracking down a problem that is suspected to be due to software incompatibility.

Exit to the Operating System

Command: `:q`

Purpose: Returns to the Operating System when an editing session is complete.

Command: `:q!`

Purpose: Same as the normal quit command, except that no changes are recorded to the file.

Example: During an editing session, some changes have been made to the wrong program, and the revision would be catastrophic if implemented, but would be a major effort to correct. Use the `:q!` command to return to the Operating System. Now the File Utility program can be used to locate the correct program. If the filename of the correct program is known, use the `:{filename}` command. (See Editing an Existing Program, above.)

Edit Program Messages

Because of the many commands and options that the Edit program provides, it is likely that some error messages will occur during editing sessions. The list below explains what each of the messages means, and is a guide to corrective actions.

MESSAGE

Illegal mark name

Mark not set

Invalid target

Illegal substitution syntax

Invalid target

Yank buffer empty

**Can't open new output
during 'e'dit**

MEANING

A mark name was given that is not a lower-case alphabetic character.

A mark was specified that has not yet been assigned.

The command does not exist, or has been entered incorrectly. Insure that the command is constructed properly.

The substitution command was ill-formed in some way. Can be caused by an improper character or added spaces in the command.

A Target command has been given for a target that does not exist. Check that the target is available, and that the command has been constructed properly.

An attempt was made to put onto the screen the contents of an already empty yank buffer.

An attempt was made to record the buffer to a file other than the input file.

MESSAGE

No output file

No previous pattern

File medium swapped

MEANING

A new file is being created, but no name was specified when the editing session was started. To write out the buffer to a file, you must specify a filename using the :w or :q commands.

A next pattern command (⟨ESC⟩ N) was attempted when no pattern was first searched for.

The disk drive door was opened, and the floppy disk removed during editing.

CONCLUSION

This section has described how to use the System Editor program as a tool for creating and modifying programs. While the descriptions are accurate and complete, the best way to become familiar with the Edit program is to actually use it. This section can be used as a guide while you are trying out the various commands, and will be a useful reference as you gain experience.

The next section shows how to use the various tools available to automate the functions of the 1722A Instrument Controller.

Section 7

Automating System Functions

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INTRODUCTION

The power of the 1722A Instrument Controller is a direct function of its programmability. This section describes how to program the Controller to perform its various functions automatically. The major topics in this section are:

Command Files

The Startup Command File

Linking to Other Command Files

Establishing an Environment - the BASIC SET SHELL Statement

Alias Files

Automating Utility Programs

Sample Instrumentation System

COMMAND FILES

The Operating System recognizes the contents of any file with the extension .CMD as a string of ASCII characters (keyboard commands) to the Command Line Interpreter. This feature provides an advantage to the user by allowing a series of keyboard entries, such as those required by a utility program, to be stored as a file. When such a file is active, it can control the utility program without requiring a long string of keyboard entries each time it is used.

In the following example a command file has been written that presets Port 1 to a state required by a printer connected there. The file is called SETPRT.CMD and is created from FDOS using the edit command. All of the Set Utility commands used in this example are defined in Section 5, and the edit program is described in Section 6.

```
set
kbl:
br 9600
db 8
pb n
sb 1
eol 13
eof 26
si e
so e
ex
```

Any time the command file is active it can be aborted by <CTRL>/C, or by pressing the front-panel ABORT switch. The message "Command file aborted" is displayed, and control of the system returns to the shell program.

Special Characters

Certain characters take on a new meaning when they occur in a command file. This section explains each of these characters, and then gives the interpretation of one command line from the Startup Command file provided on the System disk.

- ! Substituted by a line entered from the keyboard. Using an exclamation point permits the creation of interactive command files. When an exclamation point occurs in a command file, later commands are not acted on until the <RETURN> that terminates the input.
- & Causes the line immediately following to be displayed, until a <RETURN>, tilde, or exclamation point. An exclamation point or tilde can be put on the displayed line to cancel the display without a <RETURN>. In this way, the Command file can be made to wait for operator input before proceeding.
- { } Any characters between braces is displayed. If the left brace does not have a matching right brace, everything after the left one will be displayed. These characters are used to display portions of the Command file to allow easy debugging.
- ? A metacharacter that is substituted by an argument passed to the command file either from the keyboard or another command file.
- \$ A metacharacter that is followed by a single digit (0-9), to be substituted by a portion of the argument passed to the command file either from the keyboard or another command file. A portion is defined as a string of characters between the space and end-of-line delimiters. \$0 returns the name of the command file (to invoke it repetitiously); \$1 returns the first portion of the argument, \$2, the second, and so on. If no digit follows the dollar sign, it is passed through unchanged.
- ~ The tilde clears any previous entry from the Touch-Sensitive Display, and waits for the screen to be touched. Command files cannot decode the location where the screen was touched.

The backslash is the escape operator. Any character following it is interpreted literally. &\ \$5.00, for example, displays as \$5.00. There are two special cases of this character:

|e
converts to <ESC>

|b
converts to <BEL>

Sample Command Line

Assume this command line occurred in a Command file:

```
&\e[B;22H\e[5mTOUCH\e[1m SCREEN TO CONTINUE\b\e[~Thank You.
```

The meaning of this line is:

Print at cursor position 8,22 (line 8, position 22), the word "TOUCH" blinking (escape 5m), and print "SCREEN TO CONTINUE" in high intensity (escape 1m), sound a tone (\ b), and wait for the screen to be touched (~). When the screen is touched, print, "Thank You" on the same line.

The Startup Command File

The file named `STRTUP.CMD` runs automatically whenever the system is powered up. Like all Command files, the Startup file can be run by typing its name from the `FDOS>` prompt; the extension is unnecessary. The special thing about the Startup Command file is that the Operating System looks for this file whenever the Controller is powered up or reset.

There are two major results of this feature. First, it allows the initial setup and configuration of the 1722A to be preprogrammed; and second, it permits the keyboard to be disconnected from the Controller once the programs have been developed to the point that they run properly without it.

NOTE

While developing the Startup Command file, do not name it `STRTUP.CMD` until it has been tested as a Command file with some other name. If there is a problem, e.g., an unending loop is inadvertently created, it is much easier to correct the error if it only occurs when the file is intentionally run, rather than every time the Controller is turned on.

Linking to Other Command Files

Assume that a Startup Command file looks like this:

```
SET  
KB1: BR600, PB E, TO 30  
EXIT  
TEST1.CMD  
BASIC  
RUN "RS232.SEL"
```

This Command file would begin by running the Set RS-232 Utility program, establish the baud rate, parity bit, and time out parameters for port KB1:. Then it exits the Utility program and performs the keyboard commands contained in TEST1.CMD, another Command file. When TEST1 is complete (whatever it might be), control reverts to the Startup Command file, which loads the BASIC Interpreter and runs the program RS232.SEL.

Notice that the Command file can bring in another Command file. It is possible, for example, for TEST1.CMD to call still another Command file, say TEST2.CMD. Up to four of these branches are possible. If the fourth Command file calls still a fifth, the first is lost, and any subsequent commands that it contains will not be executed.

Assume that the program named RS232.SEL is a BASIC language program that presents test selections to the operator. By using the BASIC statement SET SHELL, a program can be designed that returns to RS232.SEL when the ABORT button is pressed. Otherwise, the system would return to FDOS, which provides no possibility for operator input other than RESTART, ABORT, or both (a cold start). None of these is of much value, since it means that the test must start again from the beginning, loading the Operating System and the Startup Command file.

ESTABLISHING THE ENVIRONMENT - THE BASIC SET SHELL STATEMENT

Part of the power of the 1722A Instrument Controller is the opportunity it affords the programmer to completely structure a programming environment. This capability is a result of the Fluke Enhanced BASIC language statement SET SHELL.

The SET SHELL statement is covered in detail in the BASIC Programming Manual, but deserves mention here because it is so intimately connected with programming the Controller.

Assume the Startup Command file has these lines:

```
BASIC  
SET SHELL"MF0:BASIC"  
RUN "PROG1"  
RUN "PROG2"
```

On power up, this Command file loads the BASIC Interpreter program, and sets the system to a BASIC Environment. Next, it loads and runs a BASIC language program called PROG1. No matter what happens during execution of PROG1, including a "fatal error", recovery can be made by pressing the ABORT button. The result is that PROG2 would be immediately executed. Upon completion, or when the ABORT button is again pressed, the SET SHELL statement returns control to the BASIC Interpreter program. This is what is meant by establishing the BASIC environment, and is in fact a variation of what the Getting Started disk does.

The Immediate mode BASIC statement SET SHELL (with no arguments) resets the shell to the Operating System. Notice, however, that when the BASIC Interpreter program executes this statement, it does not immediately return to the FDOS prompt, but to the BASIC Ready prompt. Now, the EXIT command can be used to return to the Operating System. When the shell is set to BASIC, any EXIT commands merely exit the current program, and return you to the BASIC shell, just like pressing RESTART.

Be careful not to use commands like "SET SHELL TIME". Doing so will set the environment to the Time and Date Utility program, which will continually ask you the time of day, rather than doing anything productive.

ALIAS FILE

An alias, as the name implies, is a way to call something by a different name. The purpose of an alias is to provide another programming shortcut to help simplify the creation of programs for the 1722A.

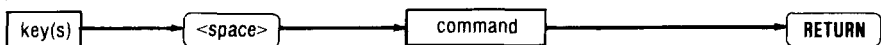
During programming, you may want to shorten repeatedly used commands (or command lines) by using an alias. Aliases are recorded on the System disk in a file called ALIAS.SYS. The standard aliases provided with the Controller can be seen easily by displaying this file. You can use the System Editor program to add your own aliases or to modify the standard ones.

Aliases provide another powerful feature of the Command Line Interpreter. By observing which commands are being entered repetitiously, a collection of shortened commands can be created and recorded in the file named ALIAS.SYS. The alias file is part of the system software, and its contents become a part of the vocabulary of the Command Line Interpreter during software loading. Since this is true, aliases can be used within the Startup Command file, which does not become active until after the software is loaded.

Aliases are operational whenever the FDOS) prompt is displayed. They can only be used from the FDOS Command Line Interpreter.

Creating Aliases

By adding to the system alias file (ALIAS.SYS), you will be able to abbreviate many commonly used commands into a single keystroke or a short sequence of keystrokes. Be certain to observe the correct syntax. Here is the required syntax for constructing an alias:



Automating System Functions

The Alias Files

The command may contain the following metacharacters:

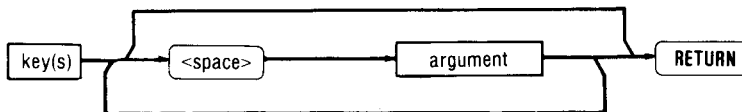
- Use the \$ character to pass multiple arguments.
- Use the ? character to pass a single argument line.

According to the required syntax, the alias

```
cp fup $2=$1
```

translates into: FUP pathname2 = pathname1 (a useful copy alias).

When the alias is used, the syntax is:



- If the alias takes arguments, then each argument must be separated by a space.

According to this syntax, to use the copy alias in the previous example, you would type:

```
cp FILE1 FILE2 <RETURN>
```

to copy the contents of FILE1 to FILE2.

- The alphabetic case of an alias is significant, allowing you to use, for example, D to delete files without using the individual switch, and d to delete them but asking for confirmation first.
- If the ? or \$ characters are used to pass arguments, they can accept any character as the argument.

Error Messages

During software loading, error messages indicate if the alias file is too long, or if an I/O error occurs during the time that the alias table is being built. In either case, the table is valid up to the point of the error. The error messages are:

```
?Alias file too long
?Unable to read alias file
```

Standard Aliases

If the file ALIAS.SYS is displayed, it will look like this:

```
f          fup ?
dir        fup ?/l
qdir      fup ?/q
edir      fup ?/e
protect   fup ?/+
unprotect fup ?/-
pack      fup ?/p
kill      fup ?/di
list      fup KBO:?
assign    fup ?/a
copy      fup %2=%1
?         fup alias.sys
b         basic
e         edit ?
s         set
t         time
```

Each short expressions on the left can be used instead of the longer expression on the right. These standard aliases shorten often-used File Utility program commands into brief, easily remembered keystroke sequences.

AUTOMATING UTILITY PROGRAMS

The Time and Date Utility

When a new 1722A arrives, one of the first things that is normally done is to use the Time and Date Utility program to set the internal clock. This clock can later be used by programs to perform an activity at a specified time, or to report the time when a condition was met or when a piece of data was gathered.

The Time and Date Utility is a machine-language program supplied on the System Disk with the file name TIME.FD2. When TIME.FD2 is loaded into memory, it requests the user to set the time and date of the internal time clock. (See section 3, Software Configuration, for details about how to set the time and date.) When called from an active command file, the Time and Date Utility program does not request input unless status shows that the clock has lost power since the last time it was set.

Using the Time and Date Clock

The command language of the Controller permits Command files to use the Time and Date Utility program. The TIME command can be modified by the arguments -p and -f.

TIME -p Prints the current setting of the clock.

TIME -f Forces the clock to display the current settings and wait for input, just as if the clock had not been previously set.

To automatically date and time stamp a piece of information or a program, a Command file can use either command shown above. However, if the -f argument is used, be sure that the keyboard is connected to accept operator input.

Notice that these arguments are the only place in the Controller's Utility programs where lower-case letters are required, rather than optional.

Programming Language Commands

Each programming language available for use with the Controller provides commands that can be used to read out the time and date. The table below is a synopsis of these commands. For more information, refer to the individual programming manuals.

BASIC

- TIMES** Returns the actual time of day.
- STIMES** Same as **TIMES**, but includes seconds.
- TIME** Indicates in scientific notation the number of milliseconds since the previous midnight.
- DATES** Returns the actual date.

FORTRAN

- TIME** Returns the number of milliseconds since the previous midnight as a long integer (**INTEGER *4**).
- DATE** Returns the date as an integer in a 16-bit format.
- ATIME** The current time as an ASCII string in 24 hour format (hh:mm:ss).
- ADATE** Current date as a 10-byte ASCII string (dd-Mmm-yy).
- ITIME** Returns the current time as an array of three integers in 24 hour format. (hh:mm:ss).
- IDATE** Returns the current date as an array of three integers (dd mm yy).

Set Utility Program

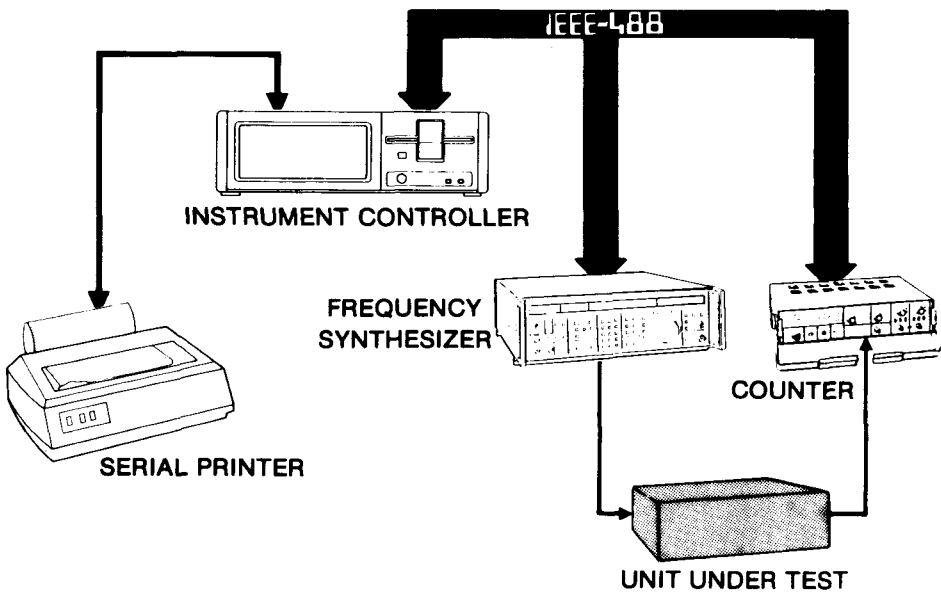
There are no programming language commands to access the Set Utility program. Therefore, if it is necessary to change any of the port parameters for a given connection, use a Command file. The BASIC language statement SET SHELL will return to the program after executing the Utility program commands. This can usually be accomplished as part of the Startup Command file, but some installations may require changing parameters in mid-program. An example of this case would be a program that communicates by way of a modem and data switch arrangement to two different front-end processors.

File Utility Program

Like the Set Utility program, there are no commands in the programming languages for the File Utility program. And also similarly, Command files can be used, as can the BASIC language SET SHELL statement. If it is necessary to work with the File Utility program from within an active program, be sure to provide a return to the shell you wish to work in. Otherwise, the only way out of the program is to press RESTART.

SAMPLE INSTRUMENTATION SYSTEM

In this section, the sample instrumentation system first introduced in sections 2 and 5 is used once again. In section 2, the sample system was used to introduce how a system would be physically configured and tested. Section 5 used it to demonstrate programming techniques using both RS-232 and IEEE-488 communications. In this section, the sample system is used to demonstrate how a complete program for an instrumentation system would be developed.



RS-232 Port:
1776B Serial Impact Printer

IEEE-488 Instrumentation Bus:
1722A Instrument Controller
6071A Frequency Synthesizer
1953B Frequency Counter

The Unit Under Test is the undefined subject instrument. It doesn't matter what the UUT is; by its connection we can assume that it will respond to a varying input frequency by varying its output frequency. The Frequency Synthesizer is going to send a signal at some frequency, and the Frequency Counter will read the result, sending it back to the Controller.

One other instrument is connected in the sample system: the 1776B Serial Impact printer. In this example, the printer will be used to give a hardcopy of the test results. The printer, of course, is not necessary for system operation, but is included to fill out the example program we will be developing.

Controlling The Sample System

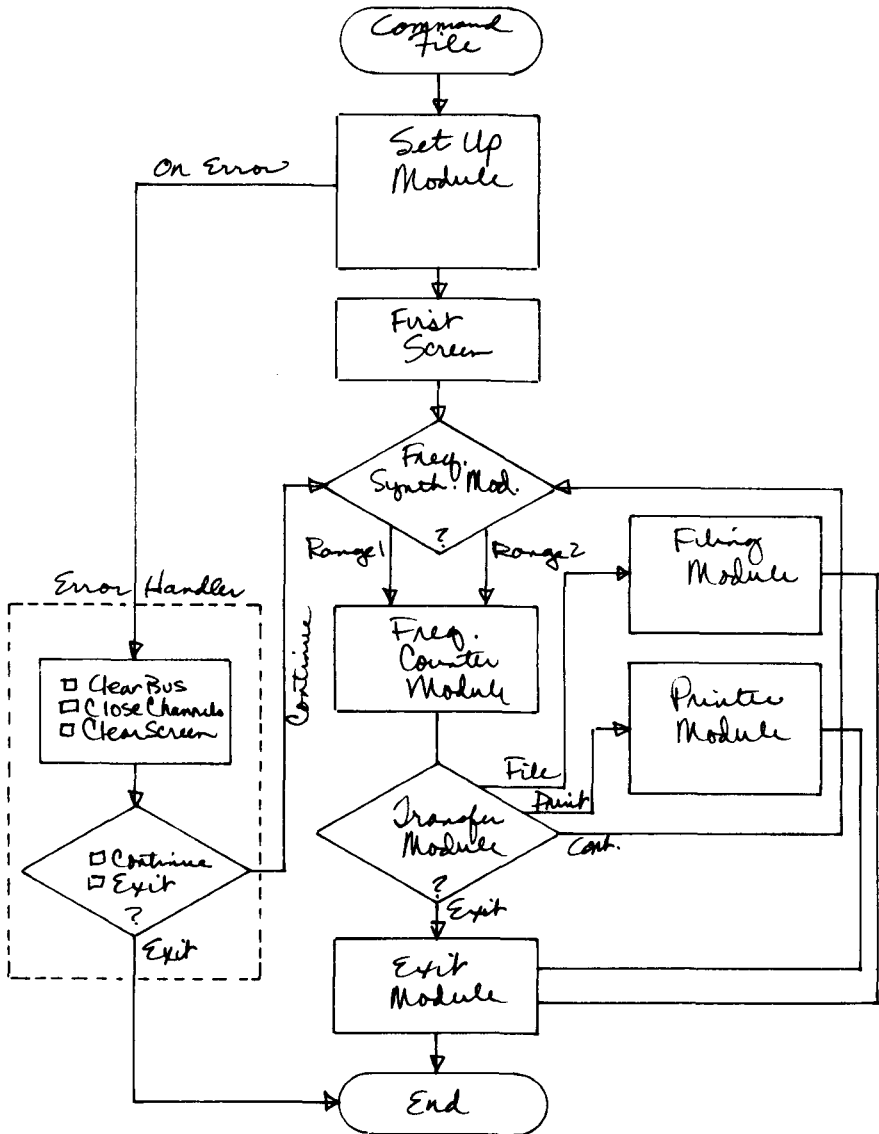
Step 1: Start With a Flowchart

Developing a flowchart is a necessary part of developing software; unfortunately, it is often not done because it sounds like an easy task to string together a few lines of code and get some kind of meaningful result. However, there are several good reasons to write a flowchart before writing a program:

- First, with a flowchart to guide your efforts, you will write more efficient programs, and be less likely to get sidetracked.
- Second, program debugging can be greatly simplified if a flowchart is available that shows what the program is supposed to do.
- Third, the flowchart provides a valuable piece of documentation if you want to modify or use parts of the program later.
- Fourth, the flowchart will help others understand and/or modify your program.

The flowchart is a graphical representation of how the program will proceed. It translates an algorithm into a visual aid, so that the interactions among the various parts of the program can easily be seen. It also provides a valuable first step in the programming task, because it breaks the job down into manageable modules, each of which can be written in order, and then linked together.

The flowchart for the sample instrumentation system might look something like this:



Automating System Functions

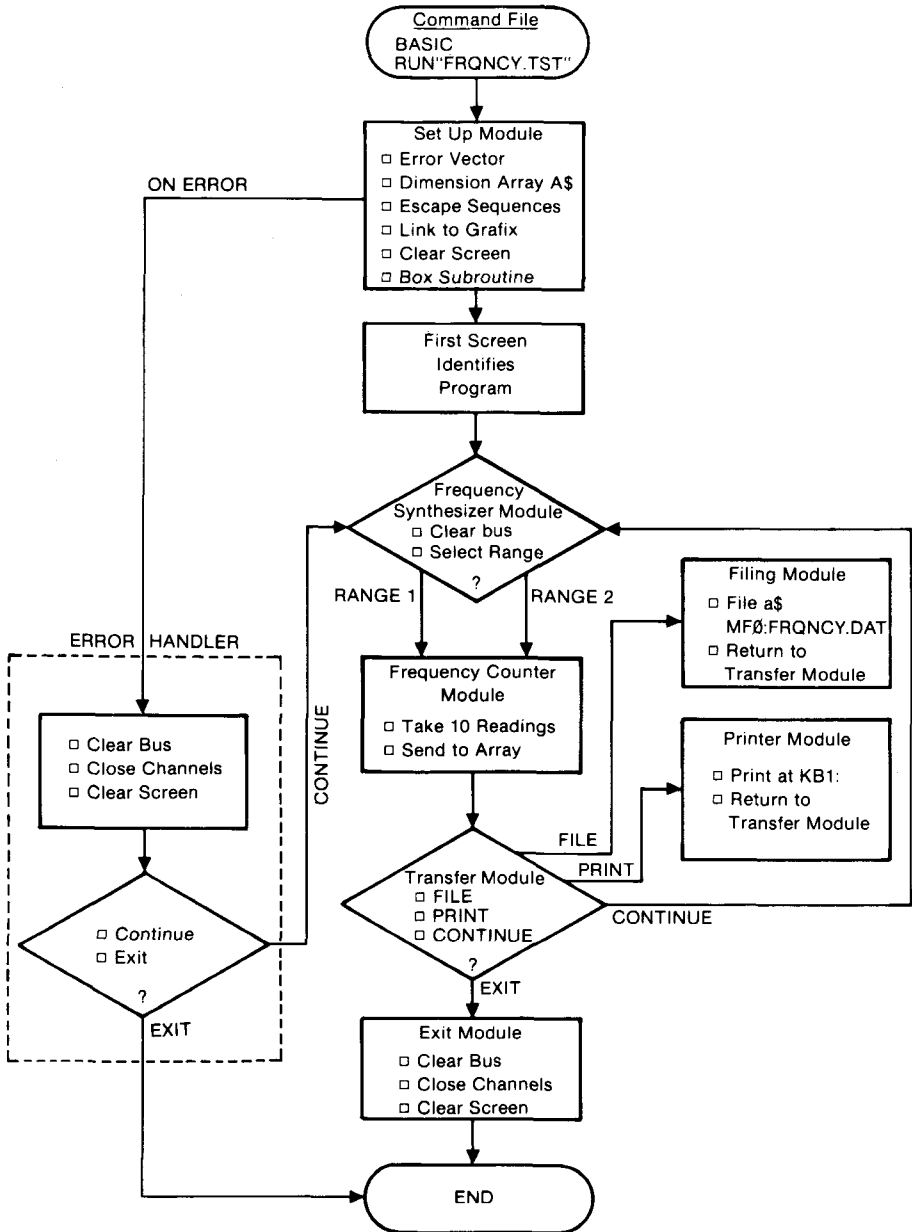
First a Flowchart

As program development progresses, update the flowchart to incorporate new ideas and program capabilities. While the example program was being written, four flowcharts were drawn, each one showing slightly more refinement and detail.

When the program was complete, a final flowchart was drawn to show how the actual program worked. The first flowchart can be thought of simply as a guide for program writing, and the final flowchart as a document that shows how the program operates.

The final flowchart for the sample is shown on the next page.

Automating System Functions First, a Flowchart



Automating System Functions

First a Flowchart,

Then Begin Programming

Step 2: Establish Bus Addresses

The next step in developing a program for this system will be to establish the addresses of all the IEEE-488 instruments. All Fluke instruments are set by rear-panel switches, and usually conform to an easily-remembered scheme. In both the Synthesizer and Counter of this example, the address switches are binary-weighted; the manual provided with the instrument gives complete details on how to set its address.

In the sample system, bus addresses are set up as follows:

- 01 Frequency Synthesizer
- 02 Frequency Counter

Step 3: Program the Modules

Programming even this simple system can be too complex without proper planning. Be judicious; program by parts, then link the parts together. In this example, follow the flowchart to program the various modules.

Setup Module

The Setup Module starts the program by establishing variables and strings that will be used later. This module is sometimes thought of as "housekeeping". Here are some of the things that such a module can be used for:

- Establish the location of the error handler routine.
- Assign the name of the array that will hold the test data.
- Assign escape sequences as variables to saving typing later in the program.
- Link to an object file, so that there is no need to access the disk later when the file is used.
- Define subroutines that will be used throughout the program. This program will use such a subroutine to draw the operator selection boxes using the graphics plane.

First Screen

For most programs, it is a good practice to incorporate an introductory screen to identify the program to the operator, and to ask for the screen to be touched when the test setup is ready. This insures that the correct disk is loaded, and gives the operator confidence that everything is under control.

Frequency Synthesizer Module

This module is the first selection screen, and will do these things:

- Present the range selections available.
- Provide an exit selection in case the operator notices that the wrong program has been loaded, or for some other reason wants to quit testing when this screen is displayed.
- Accept the selection, and use it to: 1) Address the Synthesizer as a listener, 2) put it into remote mode so it can be set by command rather than its front panel switches, and 3) program the desired output frequency.
- Ask the operator to wait while the synthesizer is being programmed.

Frequency Counter Module

When the synthesizer has been programmed, the counter will be told to begin reading the frequency output by the UUT, and report the resulting measurement data back to the Controller. This portion of the program will:

- Indicate that the test is in progress.
- Address the Counter as a talker.
- Put the Counter into remote mode so it will be set by Controller commands rather than by its front panel switches.
- Trigger the readings.
- Collect the resultant data.

Transfer Module

The Transfer Module is included so the operator can select where to transfer the measurement data. It can be filed and/or printed, or discarded by continuing the test or exiting. This module will:

- Display the test results.
- Display selections for the Operator and accept the selection to branch to the File or Print modules, to continue the program at the Frequency Synthesizer Module, or to exit with no further testing.

Filing Module

If the operator elects to file the data, a channel is opened to the floppy disk, and the data is recorded there. When filing is complete, the program returns to the Transfer Module. Notice that in this sample system, the data can only be filed once. In a real application, a virtual array would probably be used in order to increase the amount of test data that could be filed.

Printer Module

If the operator wishes to print the data, the program branches to the Printer Module, and returns to the Transfer Module. In a real application, this module would probably send an entire data file to the printer, rather than just the array that contains the single set of test data.

Error Handler

This module insures that if an error occurs while the program is running, the program itself can handle it, rather than halting. It displays a message to the operator that an error has occurred, some information about the error, and requests a decision whether to continue or exit. If Continue is selected, the program returns to the Frequency Synthesizer Module. If Exit is selected, it goes immediately to the exit module.

Exit Module

The Exit Module can be as short as one line: END. In this program, however, two lines are used that include six separate commands, five of which are "housekeeping". The housekeeping commands clear the bus, close all channels, and erase the display.

Step 4: Concatenate

Now that each portion of the program has been written and found to operate properly, they are linked together, or concatenated. During the writing phase, the line numbers in each of the modules were given the same first digit, and they were assigned in the range that the eventual program would use them. For example, the Setup Module was assigned numbers in the 100 to 199 range; the frequency counter module 200 to 399, and so on.

Each module was recorded to a filename that recalled its place in the order of things: Setup module to NEW1.BAS, First Screen module to NEW2.BAS, Frequency Synthesizer module to NEW3.BAS, and so forth. It is a simple matter to use the File Utility program to merge the modules. Then, when the program is loaded using the BASIC Interpreter program, the line numbers can be renumbered using the REN statement.

Step 5: Debugging

Many programmers write all the code, then start debugging. While this approach may seem to be more efficient, in the long run it only leads to trouble. Fix the little problems as they arise so they are less likely to have larger effects later on.

For example, the program might seem to work, but have you tried asking the Synthesizer to output it's maximum frequency? Minimum? Before a program for this system is really up and running, we have to be sure that it will accept any parameters. Perhaps the operator can be instructed not to choose the highest range of the Synthesizer, because the program still needs a little work. It is probably a better idea, though, to eliminate those selections if that part of the program is still being tested.

Automating System Functions
Debug the Program
and Document Your Work

Unfortunately, debugging is something of an arcane art. The techniques used are not easily taught or learned, so most programmers develop techniques of their own through experience. The BASIC Programming Manual includes a section on debugging, and discusses many proven techniques.

One technique is to “comment out” the program lines that cannot be used until the actual system is set up. All that is involved is to put an exclamation point immediately after the line number that you don’t want as part of the program. During the development of the Frequency Test program, for example, all the lines containing IEEE-488 commands were commented out because they would cause errors until the IEEE instruments were connected. This technique leaves the program relatively intact, and it is a simple matter to re-include any dropped lines later.

Another technique is to insert GOTO statements to route program execution around known areas. This could be used, for example, to not include the First Screen module to save time. Another frequently used technique is to put a RETURN statement at the first line of an unfinished subroutine.

Step 6: Document the Program

Be sure to adequately document your work. This is one of the last steps, but one which you can work on as the program evolves. No program should be undocumented. This means you! Someday, you will no longer be with the Bitty Widget Corporation, but will have moved on to the Mighty Widget Programming Consortium. What happens to program maintenance when the Author leaves, but his programs don’t give a hint as to how they work? As technology advances, all your efforts will be thrown out if someone else is not able to look at the code and see what you had in mind.

Not every line needs a comment, but leave some clues at least. Every programmer, at some time, has needed to re-invent a routine simply because it was more work to figure out what his predecessor had done than it was to start from scratch.

Automating System Functions
Sample Program Listing

```

10  !   * * *   F R E Q U E N C Y   T E S T   P R O G R A M   * * *
20  !
30  !
40  ! <your name>
50  ! <date written>
60  ! <identification> [test disk: filename francy.tst]
70  !
80  ! This program performs a frequency test in two ranges for the
90  ! 6070/1A frequency synthesizer and a 1953A frequency counter.
100 ! Notes:
110 ! - The 1953 Counter must have option C installed for Range 2.
120 ! - Range 1 is 20 MHz output, range 2 is 200 MHz.
130 ! - The synthesizer is IEEE-488 address 01, the counter is 02.
140 !
150 ! The program takes ten measurements and stores them in an array.
160 ! Then the results are displayed, and the operator decides whether
170 ! to file or print the array, continue testing, or exit.
180 !
190 ! All operator selections are made by touching the screen.
200 !
210 !           - Setup Module -
220 !   Error vector, array for data, escape sequences, link to "graph"
230 !
240 ON ERROR GOTO 1510
250 DIM A(11Z)           ! main memory array to rcv data
260 BP% = CHR$(7)       ! beep
270 ES% = CHR$(27) + "[2J" ! erase screen
280 PRINT ES%;CHR$(27)+"[?81"; ! clear the screen, disable cursor
290 LINK "GRAPH.OBJ"   ! link to graphics object file
300 GRPOFF \ ERAGRP (0Z) ! graphics plane off, then erase
310 GOTO 470           ! display first screen
320 !
330 !   Selection Box Subroutine
340 !   Draws a box around TSO keys
350 !
360 MOVE (XGZ,YGZ)     ! current position is defined
370 MOVE (XGZ,YGZ)     ! current position is defined
380 PLOTR (80Z, 0Z, 1Z) ! prior to the gosub commands
390 PLOTR (0Z, -50Z, 1Z)
400 PLOTR (-80Z, 0Z, 1Z) ! box is 80 x 50 pixels
410 PLOTR (0Z, 50Z, 1Z)
420 GRPON
430 RETURN
440 !
450 !           - First Screen -
460 !
470 PRINT BP%; ES%; CPOS (6,34);"FREQUENCY TEST";
480 PRINT CPOS (8,20);"Check all connections, and apply power to the";
490 PRINT CPOS (9,20);"test instruments. Touch the screen when ready.";
500 KRZ = KEY \ WAIT FOR KEY \ KRZ = KEY ! reset tso \ wait \ set key
510 !
520 !           - Frequency Synthesizer Module -
530 !
540 PRINT ES%; \ GRPOFF \ ERAGRP (0Z)
550 XGZ = 360Z \ YGZ = 150Z \ GOSUB 360
560 XGZ = 360Z \ YGZ = 100Z \ GOSUB 360           ! draw three boxes
570 XGZ = 360Z \ YGZ = 50Z \ GOSUB 360
580 PRINT CPOS(2,20);"PLEASE SELECT FREQUENCY SYNTHESIZER RANGE";
590 PRINT CPOS (7,25); "RANGE 1:  20 MHz";

```

Automating System Functions
Sample Program Listing

```

600 PRINT CPOS (11,25);"RANGE 2: 200 MHZ";
610 PRINT CPOS (15,37); "EXIT";
620 KRZ = KEY \ WAIT FOR KEY \ KRZ = KEY           ! set response
630 IF KRZ = 17% OR KRZ = 27% THEN 680           ! range 1 selected
640 IF KRZ = 37% OR KRZ = 47% THEN 710           ! range 2 selected
650 IF KRZ = 56% OR KRZ = 57% OR KRZ = 58% THEN 1470 ! exit
660 PRINT BP%; E$                                ! invalid - repeat
670 WAIT 666 \ PRINT BP%; \ GOTO 550
680 RZ = 1                                         ! range 1 program data:
690 PD$ = "FR20MZ,AP1V"                           ! 20 MHZ @ 1.0 v
700 GOTO 710
710 RZ = 2                                         ! range 2 program data:
720 PD$ = "FR200MZ,AP1V"                          ! 200 MHZ @ 1.0 v
730 !
740 ! Selection made, so program instruments
750 !
760 GRPOFF \ ERAGRP (0X)
770 PRINT E$; CPOS (4,32); " - PLEASE WAIT - ";
780 PRINT CPOS (6,23);"Programming Synthesizer for Range ";RZ
790 INIT PORT 0                                   ! initialize the bus
800 CLEAR @1                                       ! clear synthesizer
810 REMOTE @ 1 @ 2                                 ! both to remote
820 PRINT @1, PD$                                  ! send program data
830 WAIT 666
840 !
850 !           - Frequency Counter Module -
860 !
870 PRINT CPOS (6,15);"                               Measurement In Progress           ";
880 CLEAR @2
890 FOR IX = 1 TO 10
900   PRINT @2, "FOR2A0S0M1H1T" ! chnnl A, 10ms, ac couple, one sample
910   !                               ! sep. output, SRQ, trisser
920   PRINT CPOS(16,40);IX;      ! displays which count is being done
930   WAIT 500                   ! takes a reading every half second
940   INPUT @2, A(IX)            ! puts the measurements into array
950 NEXT IX
960 !
970 !           - Transfer Module -
980 !
990 ERAGRP (0X) \ GRPOFF
1000 PRINT BP%; E$; CPOS (2,1);"TEST RESULTS:";    ! format for display:
1010 PRINT CPOS (4,0)                               ! 2 rows, 5 columns
1020 PRINT USING "###.####^", A(1..5),             ! array elements 1-5
1030 PRINT USING "###.####^", A(6..10),            ! array elements 6-10
1040 !
1050 XGZ = 76% \ YGZ = 90% \ GOSUB 360
1060 XGZ = 225% \ YGZ = 90% \ GOSUB 360
1070 XGZ = 376% \ YGZ = 90% \ GOSUB 360           ! draw the boxes
1080 XGZ = 530% \ YGZ = 90% \ GOSUB 360
1090 PRINT CPOS (12,14); "FILE";CPOS(12,32);"PRINT";CPOS(12,49);"CONTINUE"
1100 PRINT CPOS (12,70); "EXIT"
1110 PRINT CPOS (16,33); "Please Touch Selection";
1120 KRZ = KEY \ WAIT FOR KEY \ KRZ = KEY
1130 IF KRZ = 41% OR KRZ = 42% THEN 1210           ! file A in "FRQNCY.DAT"
1140 IF KRZ = 44% OR KRZ = 45% THEN 1320           ! print the array
1150 IF KRZ = 47% OR KRZ = 48% THEN 540           ! back to test
1160 IF KRZ = 49% OR KRZ = 50% THEN 1460           ! exit
1170 PRINT E$; BP%; \ WAIT 666 \ GOTO 1000         ! invalid - repeat
1180 !

```

Automating System Functions
Sample Program Listing

```

1190 !           - Filings Module -
1200 !
1210 PRINT ES$; CPOS (4,30); "One moment, filings";
1220 WAIT 2000
1230 CLOSE 1
1240 OPEN "AFO:FRANCY.DAT" AS NEW FILE 1           ! filename "francy.dat"
1250 PRINT #1, USING "##.###^", A(1..10)         ! store array elements 1-10
1260 PRINT ES$; CPOS (4,20); "Data has been filed - returns to menu";
1270 !
1280 WAIT 750 \ GOTO 990                           ! return to transfer module
1290 !
1300 !           - Printer Module -
1310 !
1320 GRPOFF
1330 PRINT ES$, CPOS (4,30); "One moment, printing";
1340 !
1350 CLOSE 1                                         ! - - - note! - - - !
1360 OPEN 'KB1:' AS NEW FILE 1                       ! be sure to check port parameters !
1370 PRINT #1, CHR$(12X)                             ! before making this selection. !
1380 PRINT #1, "TEST RESULTS"
1390 PRINT #1, USING "##.###^", A(1..10)
1400 PRINT ES$; CPOS(4,20); "Data has been printed - returns to menu";
1410 CLOSE 1
1420 WAIT 750 \ GOTO 990
1430 !
1440 !           - Exit Module -
1450 !
1460 CLEAR #1 \ CLOSE ALL
1470 PRINT ES$; CHR$(27)+"[?8h" \ GRPOFF \ ERAGRP (0X) \ END
1480 !
1490 !           - Error Handler Module -
1500 !
1510 GRPOFF \ ERAGRP (0X) \ PRINT ES$
1520 XGZ = 300X \ YGZ = 130X \ GOSUB 360             ! draw the boxes
1530 XGZ = 300X \ YGZ = 60X \ GOSUB 360
1540 PRINT CPOS (3,5); "System Error -";
1550 PRINT CPOS (4,5); "Check instruments and connections";
1560 PRINT CPOS (5,5); "before continuing.";
1570 PRINT BP$; CPOS (10,40); "CONTINUE";
1580 PRINT CPOS (15,42); "EXIT";
1590 KRZ = KEY \ WAIT FOR KEY \ KRZ = KEY
1600 IF KRZ = 26X OR KRZ = 36X THEN 1610 ELSE 1620   ! continue
1610 GRPOFF \ ERAGRP (0X) \ PRINT ES$ \ RESUME 990
1620 IF KRZ = 46X OR KRZ = 56X THEN RESUME 1470     ! exit
1630 !
1640 PRINT ES$; BP$; \ WAIT 666 \ GOTO 1550         ! invalid - repeat
1650 !

```

The Startup Command File

One final thing is needed to make the resulting program truly stand-alone: the Startup Command file that will make all the rest happen from power up. In this sample programming session, the Command file will be the last thing written. It is a relatively minor portion of the entire task; but without it, it would be necessary to leave the keyboard attached to get the program operating. With it, the keyboard can be detached entirely, and the program will run on its own whenever the disk is loaded and power applied.

To complete the automation of this program, the Startup command file must do two things:

- Load the BASIC Interpreter program.
- Run the Frequency Test program, FRQTST.BAS

Here is what the file STRTUP.CMD should look like:

```
BASIC  
RUN "FRQTST"
```

CONCLUSION

This section has given guidelines on Automating the 1722A Instrument Controller. It has used a sample instrumentation system to show how to write and develop programs that will be useful for a system of this sort. Larger systems are of course possible; in fact up to 15 instruments can be connected onto the same IEEE-488 bus. If another Controller is one of them, 15 more are possible, and so on. No matter how big the final system is to be, the guidelines given here should make the programming task much easier.

Start with a flowchart. It will be a valuable guide once you're down inside all those GOSUBs and FOR-NEXTs. Program in small amounts, then concatenate. Test each module; test each parameter; test each selection. Make sure the program works as you designed it to do. Finally, document your efforts. If you stay with the same company, your task will be much easier if you don't have to relearn the program before you can update it. If you leave the company, your successor will have a lot less trouble figuring out how the program was supposed to operate.

Section 8 Display

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INTRODUCTION

The 1722A Instrument Controller features a display that can provide a great deal of visual information to the operator. Dot-addressable graphics, coupled with the state-of-the-art Touch Sensitive Display, makes it possible to design displays that are meaningful and interesting, and that provide a high degree of interaction between the operator and the Controller.

The 1722A supports all of the features incorporated in the 1720A, but expands the display capabilities by using more of the ANSI Standard controls, and by incorporating a set of graphics routines contained in the Object file "GRAPH.OBJ" on the System disk.

The 1722A includes 256 displayable characters in two character sets. The 128 characters in the standard set are the full ASCII set, and the alternate character set can be customized for characters in languages other than English, or for custom applications such as logos or other special symbols.

THE CHARACTER PLANE

Display information is stored in two separate sections of memory, the character plane and the graphics plane. Each display memory is independent; that is, they can be enabled or disabled separately. When both are enabled, displayed characters can be made either opaque or transparent to the graphics portion of the display.

A pad of 50 Programming Worksheets is provided with the Controller. The grids printed on the sheets are helpful in the design of displays that use the Touch-Sensitive Display. Columns and rows are indicated for both normal- and double-size characters, and each of the 60 touch-sense key locations is clearly marked.

Character Sets

The character set EPROM contains two character sets. The primary character set is ASCII, with some Greek characters and commonly used symbols. The table in appendix F shows the display responses for the primary character set.

Custom Character Sets

Depending on the revision level of the Video-Graphics-Keyboard module, the alternate character set may be a duplicate of the primary set, or may be a selection of non-English characters and additional symbols.























The character EPROM is a readily available 2732 type, which can be programmed with very little effort to display any character set desired. Appendix E of this manual explains how to design a custom character set, and includes a short BASIC program that displays all the characters in both character sets. When the program is run, the primary set is displayed in double size characters. When you touch the screen, the alternate set is displayed. The program toggles between displaying first one set then the other, to allow you to compare them.

Character Graphics

Besides individual characters, straight horizontal and vertical lines can also be included in displays on the character plane. An example of this usage is the program "MASTER.BAS" on the Getting Started disk. This program uses only the character plane. The graphics plane could easily display this grid, but is only needed for displays where diagonal lines or motion simulation are used, as in the program called "WOW" on the Getting Started Disk. In fact, the program titled "TOUCH" on the Getting Started Disk displays all 60 touch sense locations using the Graphics plane. The Graphics plane is discussed in more detail later in the section.

The table on the next page shows the graphics characters that are contained in the character set EPROM. With character graphics enabled, the characters 0 through 9 and the colon (:) result in the display of these symbols.

1722A DISPLAY RESPONSE

CHARACTER	NORMAL SIZE	DOUBLE SIZE	FUNCTION
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 or ESC [?3h
2. To disable Graphics Mode, send the display ESC [2p or ESC [?3l
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.

Programming a Character Graphics Display

Two sample Interpreted BASIC programs are used here to illustrate how to create a display using the 1722A Character Graphics capability. The first program displays all of the graphics characters, first in normal size, then in double size. The second program uses the characters to display an area the size of approximately one touch-sensitive key. Both of the programs make use of escape sequences to clear the screen and put it into character graphics mode. The first program also uses an escape sequence to make use of double-size character mode. These control sequences are described in more detail later in the section.

Program to Display Graphics Characters

```
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 20  
50 PRINT " 0 1 2 3 4 5 6 7 8 9 : "  
60 PRINT \ PRINT \ PRINT " Please Touch the Screen";  
70 WAIT FOR KEY \ KZ = KEY \ RETURN
```

In the first program, the first line establishes an escape sequence variable E\$ as ASCII 27 + the left bracket character. This sequence saves typing the entire escape sequence later in the program. The second part of line 10 establishes a variable CL\$ (clear) as the escape sequence just defined (<ESC>) + "[2J". This sequence will be used later in the program to clear the screen before each of the displays.

Line 20 clears the screen, then enables the graphics display (3p). The line ends by sending the program to the subroutine at line 50, which now prints the characters 0 through 9 and the colon (:), resulting in a display of the 10 graphics characters.

When the subroutine is stopped by touching the screen, the program returns to line 30, where the screen is again cleared, and the escape sequence given the parameters to go to double size, and to once again enable the graphics display (1;3p).

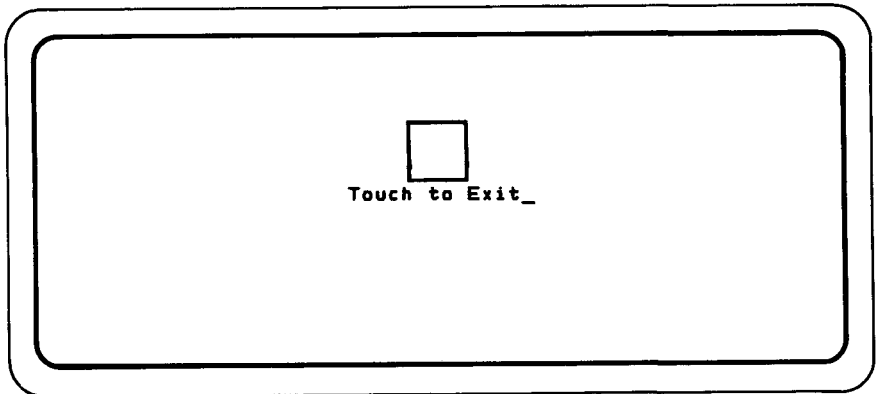
The display toggles between normal- and double-size characters for comparison. The program stops when <CTRL>/C is pressed.

Program to Display One Touch-Sense Keypad

This second sample program uses the graphics characters to draw a box the size of one touch-sense keypad. Notice that the program begins by assigning the escape sequences.

```
10 E$ = CHR$(27) = "[" \ CL$ = E$ + 2J
20 PRINT CL$; E$ + "3p";
30 PRINT CPOS(4,40); "1888880"
40 PRINT CPOS(5,40); "9 9"
50 PRINT CPOS(6,40); "3888882"
60 PRINT CPOS(8,37); "Touch to exit"
70 WAIT FOR KEY
80 PRINT E$ + "2p"
90 PRINT CPOS(8,37); " Thank you. "
100 WAIT 2000 \ PRINT CL$ \ END
```

The display resulting from this sample program looks like this:



INTRODUCTION TO ANSI STANDARDS

The American National Standards Institute publishes ANSI Standard X3.4, which describes the American Standard Code for Information Interchange, or ASCII. Since its initial publication in 1968, ANSI X3.4 has become the industry accepted standard for defining a 7-bit character code.

Another ANSI standard, X3.41, describes recommended code extension techniques for use with ASCII. In essence, the standard specifies how to represent ASCII in an 8-bit environment.

The 1722A Instrument Controller implements both ANSI standard X3.4 and applicable code extension techniques from ANSI standard X3.41. This compliance assures the upward compatibility of Fluke products as well as the ability of the Controller to communicate effectively with the products of other manufactures.

Special Display Control Characters

Eleven of the ASCII characters are interpreted by the Video-Graphics-Keyboard module (VGK) as display control characters. In addition to these eleven control characters, two others (ASCII 24 and 26, CANCEL and SUBSTITUTE) are used by the system's microprocessor to cancel a display control. These codes are not sent on to the VGK module.

The display control characters as summarized in the next table, must be preceded by an escape sequence.

ASCII DISPLAY CONTROL CHARACTERS

<CTRL>	ASCII	MNEMONIC	RESULT
	0	NUL	Null; no action.
G	7	BEL	Sounds a tone.
H	8	BS	Moves the cursor left one column, if it is not already positioned at the leftmost column.
I	9	HT	Moves the cursor to the next tab stop, (every 8 columns).
J	10	LF	All of these commands move the cursor to the next line down in the same column. The display scrolls up if the cursor is on the bottom line.
K	11	VT	
L	12	FF	
M	13	CR	Moves the cursor to the beginning of the current line.
N	14	SO	Selects alternate character set.
O	15	SI	Selects the standard character set.
	24	CAN	Cancel a display control.
	26	SUB	Substitutes a character sequence if sent as part of the sequence.
	27	ESC	Starts a display control character sequence.

Escape Sequences

Besides display control characters, the ANSI Standard also specifies a set of Code Extension Techniques (Escape Sequences) which can be used in controlling the display. These techniques use commands in the form:

`<ESC> [{parameter 1} ; {parameter 2} ; {parameter n} {terminator}`

- The `<ESC> [` is called the Control Sequence Identifier. All control sequences except scrolling commands begin with this identifier.
- The parameters may be either numeric or selective. If the sequence uses numeric parameters, and no number is given, zero is normally assumed. Cursor controls assume 1 if no number is given.
- The terminator is always an alphabetic character.

Any number of commands can be specified within a given command set as long as each is separated by a semicolon (;). Ill-formed parameters are ignored.

Numerically-Defined Display Control Sequences

The 1722A uses the same display controls as those used for the 1720A, and some additional ones. Many of the sequences shown in the table on the next page are equivalent to ANSI Standard Selective Parameter Sequences, which are discussed later in this section.

The default conditions are indicated by an asterisk (*).

DISPLAY CONTROL SEQUENCES

FUNCTION	CONTROL SEQUENCE	COMMENTS
Cursor Controls		
Up n lines	⟨ESC⟩[nA	The cursor stops at the edge if the number given as an argument results in movement past the edge of the screen.
Down n lines	⟨ESC⟩[nB	
Right n columns	⟨ESC⟩[nC	
Left n columns	⟨ESC⟩[nD	
Direct to line, column	⟨ESC⟩[l; c H	
Scroll down one line	⟨ESC⟩D	
Scroll up one line	⟨ESC⟩M	
Scroll to start new line	⟨ESC⟩E	
Erasing		
To end of display	⟨ESC⟩[J or ⟨ESC⟩[0J	
To start of display	⟨ESC⟩[1J	
All of display	⟨ESC⟩[2J	
To end of line	⟨ESC⟩[K or ⟨ESC⟩[0K	
To start of line	⟨ESC⟩[1K	
All of line	⟨ESC⟩[2K	
Attributes		
Attributes Off*	⟨ESC⟩[m or ⟨ESC⟩[0m	
High Intensity	⟨ESC⟩[1m	
Underline	⟨ESC⟩[4m	
Blinking	⟨ESC⟩[5m	
Reverse Image	⟨ESC⟩[7m	
Cursor Status		
Request cursor position	⟨ESC⟩[6n	For a program to make use of the report, a logical input channel must exist between the program and KBO:
Cursor position report	⟨ESC⟩[l, c R	
Size of Characters		
Normal	⟨ESC⟩[p or ⟨ESC⟩[0p	These commands affect the entire display.
Double	⟨ESC⟩[lp	
Character Graphics		
Disabled*	⟨ESC⟩[2p	These commands also affect the graphics plane.
Enabled	⟨ESC⟩[3p	

DISPLAY CONTROL SEQUENCES (cont)

FUNCTION	CONTROL SEQUENCE	COMMENTS
Keyboard Enabled* Disabled	(ESC) [4p (ESC) [5p	Even when disabled, the keyboard can respond to control codes. To exit a locked condition, use (CTRL)/T to unlock the keyboard, reset the screen to normal-size characters, home the cursor (upper left), and disable the graphics plane.
Cursor Type Blinking Underscore* Steady Underscore Blinking Block Steady Block	(ESC) [0x (ESC) [1x (ESC) [2x (ESC) [3x	

*Indicates the default conditions.

Selective Parameters

Selective parameters are defined with a number followed by a letter . These parameters are always a string with the first character a question mark (?), and the second a numeric character between 1 and 8. The terminator is either the lower case letter 'h' (RESET or high), or the lower-case letter 'l' (SET or low). As with numerically defined parameters, selective parameters are always started with the "Control Sequence Identifier", <ESC>[.

- To SET a mode, the terminator is the lower case letter 'h'.
- To RESET a mode, terminate with a lower case letter 'l'.

The table below summarizes the ANSI Standard Selective parameters. The defaults are indicated by an asterisk (*).

SUMMARY OF MODE SELECTIONS

MODE	RESET (l)	SET (h)
?1	Field Attributes*	Character Attributes
?2	Single Size*	Double Size
?3	Disable Character Graphics*	Enable Character Graphics
?4	Keyboard Unlocked*	Keyboard Locked
?5	Opaque to Graphics*	Transparent to Graphics
?6	Disable Character Display	Enable Character Display*
?7	Disable Graphics Display	Enable Graphics Display*
?8	Disable Cursor Display	Enable Cursor Display*

*Indicates the default conditions.

Field Attributes

The field attributes are identical to the non-transparent field attributes used on the 1720A. When this mode is RESET, all attributes, such as blinking or inverse video, are defined for a field on the display before the characters themselves are placed there. Both Field and Character attributes use the numeric parameter escape sequences.

NOTE:

The refresh scanning rate exceeds the rate that characters are written to the screen. Therefore, in the field attribute mode, the underlining and reverse image commands will cause the entire remaining display to momentarily exhibit the attribute until the attributes-off command (ESC)[m or (ESC)[0m] is received.

To avoid the "flashing" associated with this phenomenon, first position the cursor to the location for the attributes-off command, then return it to the location for the attributes and the message to be displayed.

The entire display is either in field or character attribute mode; field mode is the default.

Character Attributes

In the character attribute mode, attributes are associated with individual characters rather than with an area of the display. These attributes do not use a display position, so it is possible to highlight a single character within a word, for example.

If the ANSI Standard Mode "?1" is SET (h), then 1720A-type field attributes are disabled, and character attributes are enabled.

In the character attribute mode, displays need not include the leading and trailing spaces on the display associated with field attributes. Additionally, new enhancements can be added without resetting previously set ones. (They are "sticky".) As new enhancements are sent to the display, they are added to an already existing list until they are reset by the reset enhancements command (ESC) [0m. When the set mode command is first received, the screen is cleared, and the cursor is homed.

As shown in the next table, many of the selective parameters have equivalent numerically defined parameter control sequences. The default conditions are indicated by an asterisk (*).

The Display
ANSI Standards

SELECTIVE PARAMETER DISPLAY CONTROLS

FUNCTION	MODE SELECTION	EQUIVALENT NUMERIC SEQUENCE
Attribute Mode		No equivalent.
Field*	⟨ESC⟩[?1l	
Character	⟨ESC⟩[?1h	
Character Size		
Normal*	⟨ESC⟩[?2l	⟨ESC⟩[0p
Double size	⟨ESC⟩[?2h	⟨ESC⟩[1p
Character Graphics		Similar to ⟨ESC⟩[2p and ⟨ESC⟩[3p, except that these commands do not affect the graphics plane.
Disable*	⟨ESC⟩[?3l	
Enable	⟨ESC⟩[?3h	
Keyboard		
Unlocked*	⟨ESC⟩[?4l	⟨ESC⟩[4p
Locked	⟨ESC⟩[?4h	⟨ESC⟩[5p
Opaque to Graphics*	⟨ESC⟩[?5l	When this command is received, any graphics displays that cross display character cells are hidden behind the character cell, an area 8 pixels wide and 14 high. This mode is used to make characters stand out from surrounding graphics displays. There is no equivalent capability for the 1720A Controller.
Transparent to Graphics	⟨ESC⟩[?5h	This mode causes displayed characters to be transparent to the graphics display. Any graphics displays that cross a character cell are not obstructed by the cell. Select this mode to blend characters into the graphics display.
Character Display		No equivalents.
Disable	⟨ESC⟩[?6l	
Enable*	⟨ESC⟩[?6h	
Graphics Plane		No equivalents.
Disable*	⟨ESC⟩[?7l	
Enable	⟨ESC⟩[?7h	
Cursor Display		No equivalents.
Disable	⟨ESC⟩[?8l	
Enable*	⟨ESC⟩[?8h	

*Indicates the default conditions.

Non-Destructive Display Character

Sometimes you may want to call attention to a word or phrase on the display by switching between two sets of attributes. An example would be using highlighting and normal attributes to give the appearance of blinking without having the word actually go away. In character attribute mode, a “non-destructive” character is used. It takes the form:

⟨ESC⟩=

This character is called non-destructive because it can be specified for the same location as the character which it will be modifying. When it is received, the character attributes of the current character position are replaced with the most recent attribute specification.

THE GRAPHICS PLANE

Information to be displayed is held in two separate portions of memory: the character plane and the graphics plane. Both of them can be turned on and off using the ANSI Standard Control Sequences just described. Additionally, the graphics plane can be turned on and off using two of the routines in the Object File named "GRAPH.OBJ".

To use the Graphics Routines described in this section, your program must link to them. For example, using the BASIC Interpreter line

LINK "GRAPH"

early in the program will link the graphics routines and enable them to be used throughout the program.

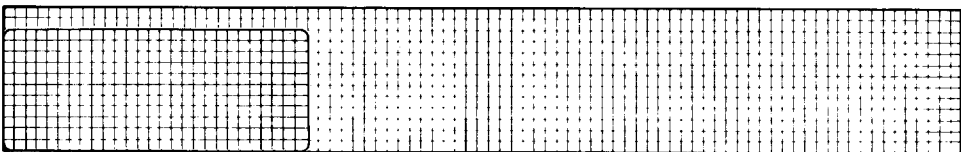
If you will be compiling the program with the BASIC Compiler, do not include the LINK "GRAPH" statement in the program. Instead, use the Linking Loader (LL) to link your program's object file with the graphics routines as shown here:

```
LL) I {program name}, B$LOAD, GRAPH  
LL) O {program name}  
LL) G
```

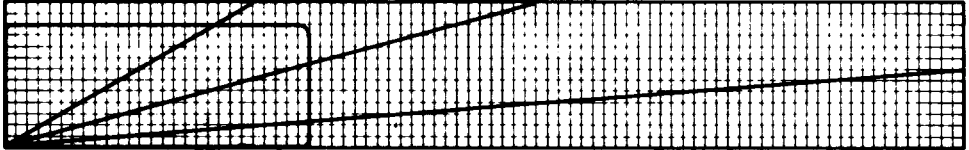
Introduction to the Graphics Routines

The display memory is divided into a character plane, and a graphics plane. Either plane can be enabled or disabled independently.

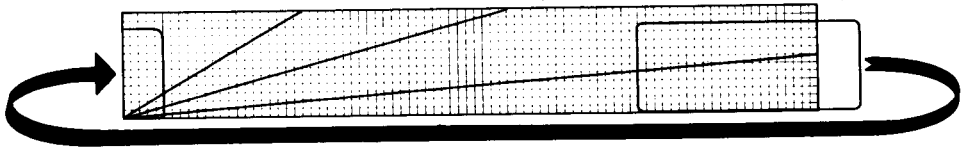
The graphics workspace is an array of dots called pixels, a contraction of the words picture elements. In the horizontal direction, there are 2048 pixels, and in the vertical direction, there are 256. The display screen provides a window into the graphics workspace that is 640 dots wide and 224 dots high. The window can be positioned anywhere over the graphics plane. Here is where it starts out:



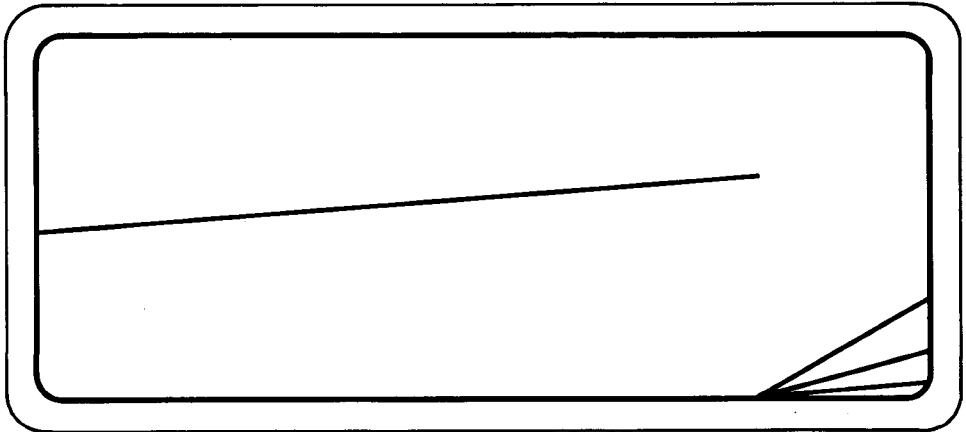
If the window position is moved beyond the edges of the graphics plane, the display wraps around to the opposite edge. For example, assume that these lines have been drawn in the graphics area:



This is what happens when you move the window to overlap the right hand boundary of the workspace:

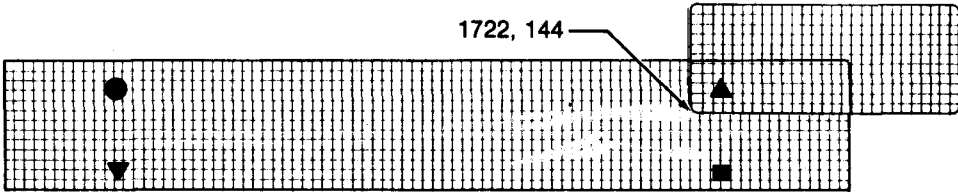


Because of the wraparound effect, the resulting display will be:

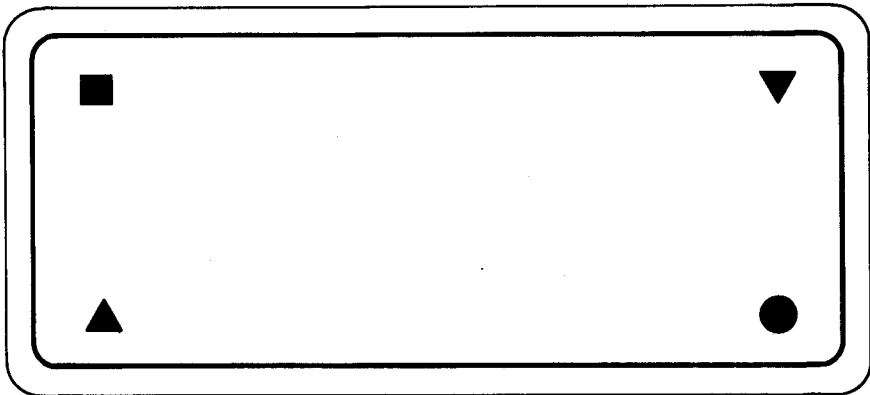


The Display
The Graphics Plane

The next drawing illustrates what would happen if the window is positioned so that it overlaps both a vertical and horizontal edge of the graphics workspace. First, assume that these symbols have been placed in the four corners of the display, and the window positioned as shown:



The resulting display would be:



This result may be either useful or surprising, depending on what you had in mind as you designed the display. Note that the effect does not hold true for the lower left reference corner of the window, which cannot be moved outside the graphics workspace.

Addressing the Pixel Positions

Dot positions are addressed by their X,Y coordinates. In the first drawing, the display window was positioned so that its lower left corner was at position 0,0 (the default starting position); the lower right is at 639,0; upper left is at 0, 223, and the upper right corner is at 639,223. In the last drawing, the current position has been moved so the lower left corner of the display is at 1722, 144.

Pixels can be turned on or off anywhere within the window. The rest of this section describes the set of routines that control turning the pixels on and off, and moving the current position.

Graphics Routines

All the graphics routines are recorded on the System disk in a file named GRAPH.OBJ, and in a library file named GRAPH.LIB.

Some of the routines turn the display on or off, and others move the "current position". Though the current pixel position is not displayed (as a cursor shows the current position in the character plane), the initial current position is always 0,0. As you can see by the drawings, position 0,0 is the lower left corner of the display. The upper right corner of the display window is position 639, 223. The upper right corner of the entire graphics plane is at location 2047, 255.

As a program moves the pixel position, or pans the window around the workspace, the routines keep track of the changing current position.

All the routines can be linked to programs generated by the BASIC Interpreter and the BASIC and FORTRAN Compiler programs.

Summary of Commmands

The table that follows describes each of the graphics routines. Note that all the arguments must be integers; this means that in a BASIC language program, for example, the arguments must be followed by the % symbol. In FORTRAN, variable types are determined by the first character in the variable name (Integers I though N), or by using the TYPE statement. See the particular progamming language manual for full details.

SUMMARY OF GRAPHICS ROUTINES

COMMAND	PURPOSE
DOT (X, Y, {type})	Draws a single dot at X, Y, returns to the current position.
DRAW (X1, Y1, X2, Y2, {type})	Draws a line from X1, Y1 to X2, Y2.
ERAGRP ({type})	Erases the entire graphics plane.
GRPOFF	Disables the graphics plane.
GRPON	Enables the graphics plane.
MOVE (X, Y)	Moves to absolute position X, Y.
MOVER (Xoffset, Yoffset)	Moves relative to amount specified by the offset.
PAN (X, Y)	Sets display window position to X, Y.
PLOT (X, Y, {type})	Plots from current position to X, Y.
PLOTR (Xoffset, Yoffset, {type})	Plots relative to amount specified by the offset.

*Type: -1 = INVERSE
 0 = BLACK
 1 = WHITE

- The values of the X and Y arguments may not exceed 2047, and may only be negative in the relative commands MOVER and PLOTR.
- The X argument is the number of pixels in the horizontal direction. Since the screen is 640 pixels wide, the center is 320 pixels from the left edge.
- The Y argument is the number of pixels in the vertical direction. The screen is 224 pixels high, so the center is 112 pixels from the bottom edge.
- The 'Type' argument determines whether the routine paints white on black (1), black onto white (0), or the inverse of the color already at that position (-1).

In the pages that follow, each of the routines is described in detail, and some suggestions are given about the kinds of things that each of them can be used for. Some of the descriptions include program examples. The example listings are all shown as they would appear in programs written for the BASIC Interpreter.

DOT

Usage: DOT(X, Y, {type})

Description:

This routine places a single dot at the specified coordinates, then returns to the current pixel, position. Because this routine returns to the former pixel position it is useful in the construction of detailed charts or graphs that require pixel resolution and are generated by a mathematical formula that calculates each point from the same position.

Example:

This BASIC program uses DOT to draw a sine wave. It first asks for "Amplitude", and then for "Period". The amplitude is the peak-to-peak pixel amplitude of the sine wave that will be drawn. The period is used for frequency and sampling rate. Notice that the program does not allow a period of less than 1. Selecting periods less than five result in waveforms whose resolution is too coarse for the wave to be observable.

```
10 LINK "GRAPH"
20 ERASEP (0X) \ ORPON
30 PRINT CHR$(27) + "[2J"
40 PRINT CPOS (14,0); "Amplitude";
50 INPUT A
60 PRINT CPOS (15,0); "Period";
70 INPUT P
80 IF P = 0 THEN 60
90 PRINT CHR$(27) + "[2J"
100 FOR X% = 1 TO 640
110   Y = A * SIN (X% / P)
120   Y% = 0.5 * (Y) + 112
130   DOT (X%, Y%, 1X)
140 NEXT X%
140 GOTO 40
```

```
! link to graphics
! erase, turn on graphics
! clear character plane
! input amplitude
! amplitude: dots peak-to-peak
! input period (sampling rate)
! period: no. of dots/cycle
! P = 0 is illegal
! clear character plane
! x across display
! calculate y
! integerize and offset y
! dot at calc'ed position
! continue calculation
! next value
```

DRAW

Usage: DRAW(X1, Y1, X2, Y2, {type})

Description:

This routine draws a line from absolute position X1, Y1 to another absolute location, X2, Y2. If the final position is beyond the edge of the graphics plane, the line will end at the edge. The current pixel position is updated to X2,Y2 or the edge of the plane.

Example:

Current position is 0,0. To draw a white diagonal line across the display, use:

```
DRAW(0%, 0%, 639%, 223%, 1%)
```

ERAGRP

Usage: ERAGRP {type}

Description:

This routine erases the entire graphics plane to the color indicated by {type}, either white, black, or the reverse of the color before erasing. Any data within the plane will be deleted. The character plane is unaffected.

Example:

At the beginning of a program, use ERAGRP to prepare the Graphics plane for the display.

GRPOFF, GRPON

Description:

These routines turn the graphics portion of a display off and on. The memory is left intact; the routines only determine if the graphics plane is displayed or not. The character plane is unaffected.

Example:

A selection display has just been presented to the operator. When the selection has been made, a new display is presented that contains new graphics. Rather than using ERAGRP to erase the graphics plane, however, it is desired to leave the contents alone because the test results update the display for the next selection. In this case, use GRPOFF to turn off the graphics display. When the display is updated, the program uses GRPON to display the change.

MOVE

Usage: MOVE(X, Y)

Description:

This routine moves the current pixel location without drawing. If either X or Y are outside of the graphics plane, the move stops at the corresponding edge.

Example:

A program has just drawn a diagonal line from the bottom left to the upper right corner of the screen. Now, to "lift the pencil" to get back to 0,0, use the MOVE routine:

```
MOVE (0x, 0x)
```

MOVER

Usage: `MOVER(Xoffset, Yoffset)`

Description:

This is the relative move routine. It moves the current pixel position to a relative position within the graphics plane. The move is done without drawing; if the new position is outside the graphics plane, the move stops at the corresponding edge.

Example:

A program is being designed that draws two figures that may appear any place on the display. The second figure must appear immediately to the right of the first. After the first figure is drawn, use the relative move routine to move the current position relative to the ending location of the first figure.

PAN

Usage: PAN(X, Y)

Description:

The PAN routine moves the window around the graphics workspace. The reference is the lower left corner of the display window. Positive arguments move the reference corner to the right and up. Negative arguments move the reference corner left and down. PAN does not affect the current pixel position.

Example:

During a measurement session, data has been collected by a program, and has become part of a data file. The operator then elects to view the results of the day. The program inserts the raw data into a subroutine that creates and draws a chart that cannot fit in one window. Use the PAN routine to permit viewing the entire chart. Left and right arrow keys can be made part of the display, to allow positioning the window at any area of interest.

PLOT

Usage: PLOT(X, Y, {type})

Description:

This routine draws a line from the current position to the location indicated by the X and Y arguments. (Also see DRAW.) PLOT uses the current position as the starting place to begin drawing, rather than defining the starting position, as DRAW does. The current pixel position is updated to X,Y.

Example:

Use PLOT rather than DRAW in those instances where the starting position will be unknown, but a line is desired from one place to some other position. This routine can be used in constructing some types of graphs, like pie-charts. As the program collects data, the value of the data would be inserted into a Relative Move statement, and the PLOT statement would draw the line from the starting point to the calculated position (which then becomes the new current position).

PLOTR

Usage: PLOTR(Xoffset, Yoffset, {type})

Description:

The relative plot routine draws a line from the current position to the location indicated by the Xoffset and Yoffset arguments; it is similar to DRAW, except that as it returns to the starting position, continues drawing; it doesn't "lift the pencil".

Example:

A triangular figure is to be drawn, and it may appear anywhere within the graphics plane. Use the Plot Relative routine to draw the figure relative to any starting position. This example draws a triangle that will be black if the field is white, and white if the surroundings are black:

```
PLOTR(60%, 60%, -1%)  
PLOTR(60%, -60%, -1%)  
PLOTR(-120%, 0%, -1%)
```

CONCLUSION

This section has described the many features of the 1722A display. The display is specifically designed for ease of use by both the programmer and the operator. While maintaining compatibility with the display capabilities of its predecessor, the 1720A Controller, the 1722A incorporates a greatly expanded set of graphics and display-control features.

Taken as a whole, the 1722A boasts one of the most comprehensive display packages in the instrumentation industry. When the possibilities of the software are combined with the unique touch-sensitive screen, the result is a powerful set of tools for the programmer and operator alike.

Section 9 Appendices

CONTENTS

A	Specifications	A-1
B	Options and Accessories	B-1
C	IEEE-488 Reference	C-1
D	Glossary	D-1
E	Custom Character Sets	E-1
F	Primary Character Set	F-1

Appendix A

Specifications

CRT DISPLAY

Scanning Method	Non-interlaced raster scan.
Refresh Rate	50 or 60 Hz, selectable.
Character Memory	1280 bytes of dedicated display memory. 16 lines of 80 characters.
CRT Screen	High-contrast green phosphor, low profile, rectangular. 8.6 cm x 20.3 cm (3.4 in x 8.0 in).
Character Capacity	16 x 80 cells, or 8 x 40 cells.
Standard Character Set	96 Standard ASCII characters, graphics characters, match, and other useful symbols.
Character Cell	7 x 9 dots in an 8 x 14 dot matrix.
Character Enhancements	Reverse video, blinking, underlining, and highlighting.
Cursor	Blinking, underline, block, or suppressed.
Raster Size	7.6 cm x 19 cm (3.0 in x 7.5 in).
Graphics Screen Capacity	650 x 224 pixels.
Graphics Memory Capacity	64K bytes (2048 x 256 pixels). Independent of main memory.

ENVIRONMENTAL

Operating

WITH DISK MEDIA	10°C to 40°C (50°F to 104°F).
WITHOUT DISK MEDIA	0°C to 40°C (32°F to 104°F).
HUMIDITY	20% to 80% (non-condensing).

Storage

WITH DISK MEDIA	10°C to 52°C (50°F to 126°F); 8% to 90% humidity (non-condensing).
WITHOUT DISK MEDIA	-20°C to 60°C (-5°F to 140°F); 5% to 85% humidity (non-condensing).

EMI and RFI Emissions	Tested to FCC Part 15, Subpart J, Class B; VDE 0871, Class B; CISPR 11-1975.
------------------------------------	--

GENERAL

Dimensions	13 cm H x 43 cm W x 55 cm L (plus feet) (5.25 in H x 17.0 in W x 21.5 in L). See Outline Dimensions.
-------------------------	--

Specifications

Weight

CONTROLLER 15.5 kg (34 lbs).
 KEYBOARD 1.4 kg (3 lbs).

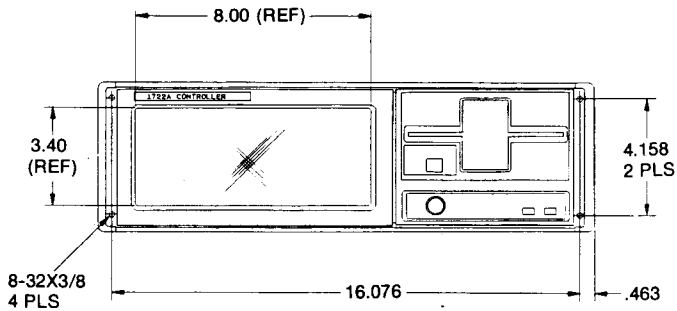
Power 175W max.

VOLTAGE 120V ac 50-60 Hz use 1½ amp AGC fuse
 240V ac 50-60 Hz use ¾ amp AGC fuse

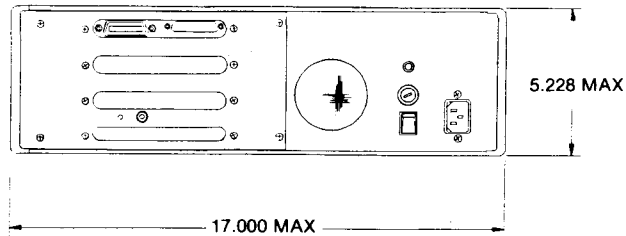
POWER DISSIPATION 175W max.

1  THESE HOLES USED FOR MOUNTING OF FEET. CAN BE USED FOR NON STRUCTUAL INSTRUMENT MOUNTING.

2 ALLOW 2' MINIMUM AT REAR AND CRT SIDE OF INSTRUMENT FOR AIRFLOW.

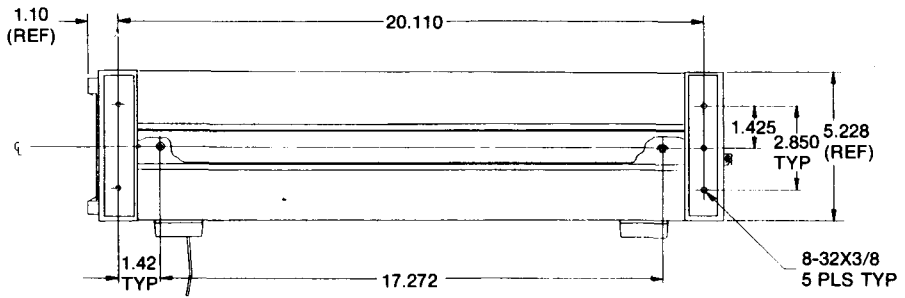


FRONT

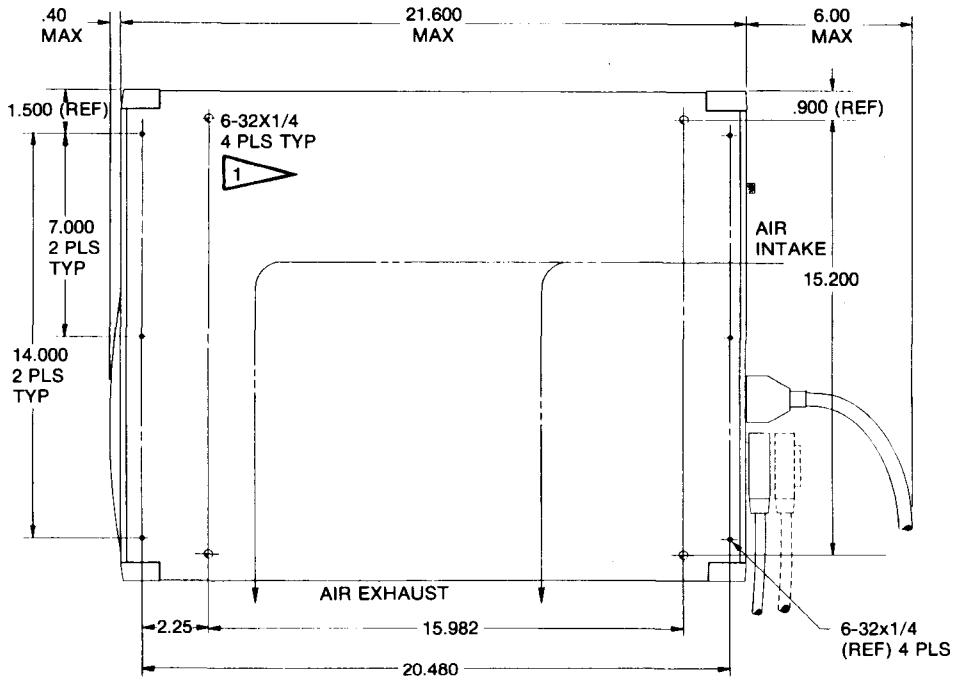


BACK

Specifications



SIDE



BOTTOM

Appendix B

Options and Accessories

These items are not included in the shipment unless ordered at the same time as the Controller. If specified on the order, options will be installed at the factory. Otherwise, they may be packaged separately.

This list was complete at the time this manual was printed; however, because of Fluke's ongoing program of hardware and software development, other options or accessories may become available between reprintings of the manual. Contact your local Fluke representative for the latest information about available options.

OPTIONS

All options are listed by their dash number, the unique three-digit identifier appended to the model number to yield a part number. For example, to order the -004 option, 256K Byte Bubble Memory Expansion Module, you would use P/N 1722A-004.

Memory Expansion

Memory Expansion options greatly increase the available on-line storage capabilities of the Controller. Memory Expansion Modules can be placed in any of the five unused options slots in the card cage. The maximum dynamic RAM configuration increases the total on-line system memory to about 2.6 Megabytes; Bubble Memory can provide up to approximately 1.3 Megabytes. Combinations are possible; please consult the configuration guide for complete details.

- 004 256K byte Bubble Memory
- 005 512K byte Bubble Memory
- 006 256K byte RAM Expansion
- 007 512K byte RAM Expansion

Options and Accessories

Interface Additions

Optional Interface options expand the Input/Output possibilities of the Controller. They may only be used in card cage slots 1, 3, and 5.

- 002 Parallel Interface
- 008 IEEE-488/RS-232C Interface
- 009 Dual Serial Interface

Note

When it is shipped from the factory, the 1722A Instrument Controller meets or exceeds the requirements of FCC part 15-J and VDE 0871. To ensure continued compliance with these standards, any cables connected must be shielded and incorporate 360° metal connector bodies. These are available from John Fluke Mfg. Co. Inc. using these part numbers:

IEEE-488

- 1 meter: 658526*
- 2 meter: 682401*
- 4 meter: 682419*

RS-232

- 2 meter: 706688*
- 10 meter: 706846*

Software

For increased flexibility, these software options are available to allow programming the Controller in languages other than Interpreted BASIC, which is supplied as the standard programming language. Each language option is supplied as a floppy disk with an accompanying Programming manual.

- 201 Assembly Language Software Development System
- 202 FORTRAN Software Development System
- 203 Compiled BASIC Software Development System

Option Configuration Table

OPTIONS							SLOTS
IEEE-488/RS-232C Interface	Dual Serial Interface	Parallel Interface	512K byte RAM Expansion	256K byte RAM Expansion	512K byte Bubble Memory	256K byte Bubble Memory	
•			•	•	•	•	1
Reserved for Video/Graphics/Keyboard Interface							2
•			•	•	•	•	3
					•	•	4
•	•		•	•	•	•	5
					•	•	6
Reserved for Single Board Computer							7

• = Allowable Slot for Option

ACCESSORIES

Y1700 Keyboard

Y1706 Ten-pack of Blank Unformatted floppy disks (Certified)

P/N 533547

Pad of 50 Programmers Worksheets

Y1711 Reinforced Shipping Case

IEEE-488 Cables

Y8021 Shielded, 1 meter

Y8022 Shielded, 2 meters

Y8023 Shielded, 4 meters

RS-232C Interface Cables

Standard (For DCE devices)

Y1707 2 meter

Y1708 10 meter

Null Modem (For other DTE devices)

Y1703 4 meter

Y1705 0.3 meter

Printer Cable

For connecting a Fluke model 1776A Serial Printer.

Y1709 2 meter

Parallel Interface Cable

Y1717 2 meter

Rack Mount Kits

Y1790 Rack Mount Kit with 24-inch slides

Y1791 Rack Mount Kit for 1780A without slides

M00-260-610 18-inch rack slides

M00-280-610 24-inch rack slides

PERIPHERALS

All the peripherals listed here are separate products, and can be ordered by the model numbers shown.

1760A Disk Drive System, 400K Byte

1761A Dual Disk Drive System, 800K Byte

1771A Intelligent Digital Plotter

1775B Serial Impact Printer (IEEE-488 Interface)

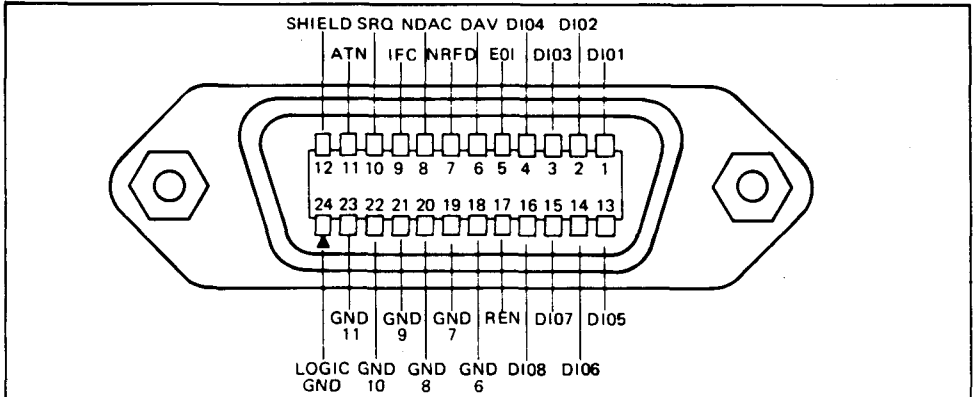
1776B Serial Impact Printer (RS-232C Interface)

1780A InfoTouch Display

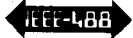
Appendix C

IEEE-488 References

IEEE-488-1978 Instrument Ports (Port 0 and Port 1)



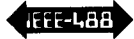
BUS	PIN	SIGNAL	DEFINITION
DATA BUS	1	DIO1	Data input and output lines, bidirectional and active-low. DIO8 is most significant. Data transfers are 8-bit parallel and byte serial.
	2	DIO2	
	3	DIO3	
	4	DIO4	
	13	DIO5	
	14	DIO6	
	15	DIO7	
MANAGEMENT BUS	11	ATN	Attention. Activated by the 1722A when peripheral devices are being assigned as listeners and talkers. The 1722A assumes it is the only source of this signal.
	23	ATN Return	
	10	SRQ	Service request. Any peripheral device on the Instrument Bus can request the attention of the 1722A Controller by setting SRQ active low.
	22	SRQ Return	
9	IFC	Interface clear. Set by the 1722A to place all instruments on the bus in a predetermined reset state. The 1722A assumes that it is the only source of this signal.	
21	IFC Return		
	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.



ASCII and IEEE-488 Mnemonic Abbreviations

ACK	Acknowledge	MSA	My Secondary Address
ASCII	American Standard Code for Information Interchange	MTA	My Talk Address
		NAK	Negative Acknowledge
ATN	Attention	NDAC	Not Data Accepted
BEL	Bell	NRFD	Not Ready For Data
BS	Backspace	NUL	Null
CAN	Cancel	OSA	Other Secondary Address
CR	Carriage Return	OTA	Other Talk Address
DCL	Device Clear	PCG	Primary Command Group
DCn	Device Control 1, 2, 3, or 4	PPC	Parallel Poll Configure
DEL	Delete	PPD	Parallel Poll Disable
DIO _n	Data Input/Output 1 through 8	PPE	Parallel Poll Enable
DLE	Data Link Escape	PPR _n	Parallel Poll Response 1 through 8
ENQ	Enquiry	PPU	Parallel Poll Unconfigure
EOF	End of File	REN	Remote Enable
EOI	End or Identify	RS	Record Separator
EOT	End of Transmission	SDC	Selected Device Clear
ESC	Escape	SI	Shift In
ETB	End of Transmission Block	SO	Shift Out
ETX	End of Text	SOH	Start of Heading
FF	Form Feed	SP	Space
GET	Group Execute Trigger	SPD	Serial Poll Disable
GND	Ground	SPE	Serial Poll Enable
GTL	Go To Local	SRQ	Service Request
HT	Horizontal Tab	STB	Status Byte
IEEE	Institute of Electrical and Electronic Engineers	STX	Start of Text
		TCT	Take Control
IFC	Interface Clear	UNL	Unlisten
LF	Line Feed	UNT	Untalk
LLO	Local Lockout	US	Unit Separator
MLA	My Listen Address		

IEEE-488 References



ASCII/IEEE-488-1978 Bus Codes

ASCII	DECIMAL	OCTAL	HEX	BINARY		MESSAGE (ATN)	DEV. NO.	ASCII	DECIMAL	OCTAL	HEX	BINARY		MESSAGE (ATN)	DEV. NO.	
				7654	3210							7654	3210			
NUL	0	000	00	0000	0000	ADDRESSED COMMANDS		@	64	100	40	0100	0000	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	
ENO	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		
DC1	16	020	10	0001	0000	UNIVERSAL COMMANDS	---	P	80	120	50	0101	0000	MTA	16	
DC2	17	021	11	0001	0001		LLO	O	81	121	51	0101	0001	MTA	17	
DC3	18	022	12	0001	0010		---	R	82	122	52	0101	0010	MTA	18	
DC4	19	023	13	0001	0011		---	S	83	123	53	0101	0011	MTA	19	
NAK	20	024	14	0001	0100		DCL	T	84	124	54	0101	0100	MTA	20	
SYN	21	025	15	0001	0101		PPU	U	85	125	55	0101	0101	MTA	21	
ETB	22	026	16	0001	0110		---	V	86	126	56	0101	0110	MTA	22	
---	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	30		
SP	32	040	20	0010	0000	LISTEN ADDRESSES	MLA	0	a	96	140	60	0110	0000	MSA	0
!	33	041	21	0010	0001		MLA	1	b	97	141	61	0110	0001	MSA	1
"	34	042	22	0010	0010		MLA	2	c	98	142	62	0110	0010	MSA	2
#	35	043	23	0010	0011		MLA	3	d	99	143	63	0110	0011	MSA	3
\$	36	044	24	0010	0100		MLA	4	e	100	144	64	0110	0100	MSA	4
%	37	045	25	0010	0101		MLA	5	f	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	0110	1000	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	15	
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	0111	1000	MLA	28	]	124	174	7C	0111	1100	MSA	28
=	61	075	3D	0111	1001	MLA	29	^	125	175	7D	0111	1101	MSA	29	
>	62	076	3E	0111	1010	MLA	30	_	126	176	7E	0111	1110	MSA	30	
?	63	077	3F	0111	1111	UNI	DEL	127	177	7F	0111	1111	MSA	30		

Appendix D

Glossary

ABORT

Front panel push switch that causes the Controller to terminate the current program and return to the shell without clearing memory or performing the power-up self-test. When pressed simultaneously with RESTART, causes the system to perform a cold start.

address

A coded number representing the location of an item. Examples include bus address and program address.

Address command

A bus command from a controller commanding an instrument at a designated address to talk or listen.

Addressed command

A bus command from a controller intended for all instruments that have been addressed as talker or listener.

alias

A shortened or more familiar form of a command. In the 1722A, all aliases must be recorded on a file named ALIAS.SYS.

application program

A user written program designed to perform specified functions in a working environment.

array

A collection of data items, organized as a row x column matrix.

array element Identifier

The subscript of an array variable that identifies the row and column of the desired array element. In the expression: $AS(3,5)$, (3,5) is the array element identifier, referring to row 3, column 5.

ASCII

Acronym for American Standard Code for Information Interchange. ASCII is a standardized code set of 128 characters, including full alphabetic (upper and lowercase), numerics, and a set of control characters.

Glossary

asynchronous data

Information transmitted at random times, normally one character at a time, and at predefined, self-clocking baud rates. See synchronous data.

BASIC

Beginner's All-purpose Symbolic Instruction Code, a general purpose, high-level language that has been widely accepted because of its versatility and the ease with which it can be learned. Fluke BASIC has added commands for instrument control.

baud rate

The serial transfer rate in bits per second including all framing bits used to identify the start and end of characters or messages.

binary

A number system based on zero (0) and one (1) representations. It is often used to represent data or instruction codes. There are only two numbers, so digital computers can use binary for their operations because each number can be represented as the state (on or off) of a transistor.

bit

A contraction of binary digit. A bit is either a one or a zero and represents the smallest single unit of computer information. Bits are often used in groups of eight to represent ASCII characters.

block

Memory size equal to 512 bytes.

bootstrap

A short program permanently recorded in ROM whose only function is to read an operating system program from bulk storage into system memory and transfer control to it.

buffer

A temporary storage area in main memory used to store data.

bulk storage

A device attached to a computer that can store much more program or data information than the computer's main memory can hold. The Instrument Controller incorporates two types of bulk storage: floppy disk and hard disk. Also called mass storage.

bus

The IEEE-488-1978 standardized interconnection system used for connecting instruments. Also, bus can refer to any set of parallel connections that have the same meaning for each unit connected to them.

Bus address

A 7-bit code placed on the IEEE-488 bus in command mode to designate an instrument as a talker or listener.

byte

A grouping of eight bits of information into a coded representation of all or part of a number or instruction. Often a 7-bit ASCII character is referred to as a byte, with the eighth bit available for parity if needed. Bytes are commonly considered as 8-bit storage areas to represent ASCII characters.

chaining

A method of operating a program that is larger than available main memory. The technique is to break the program into smaller elements, and call in the next element from bulk storage as each succeeding element is completed. Requires highly modular programming to be effective. See structured programming.

channel

A communication path opened between an application program and a file or a system device.

character plane

The portion of the display memory that is used for displaying the normal- and double-sized characters. The character set includes the upper- and lower- case alphabet, the ten numerals, and punctuation. See graphics plane.

character string

A grouping of ASCII characters.

cold start

The power-up activities of the Controller. These include clearing all memory including E-Disk, performing a self-test, and loading the operating system. A cold-start occurs when the system is powered up, or when RESTART and ABORT are pressed simultaneously.

Command file

A file that, when designated active by FDOS, is used as a substitute for keyboard inputs. In Fluke Instrument Controllers, a command file with the name STRTUP.COMD is processed each time the Controller is initialized by a cold start or power-on.

Command mode

An IEEE-488 term indicating that a controller has set the ATN (attention) line. In this mode, instruments on the bus are addressed or unaddressed as talkers and listeners.

constants

Fixed values which may be floating-point, integer, or string data types.

control character

Used to produce specific actions such as terminating program execution, exiting from the Editor, halting and restarting scrolling.

controller

A device connected to a bus capable of designating instruments as talkers or listeners by using bus message sequences. A device does not need to be programmable to act as a controller. However, only a controller can examine the data or status of instruments to determine appropriate conditions for designation changes. There can be only one active controller on a bus at one time.

CPU

Central processing unit, the controlling instruction and data processor in any computer system. In the Fluke Instrument Controller, the CPU is the microprocessor and its supporting components' located on the Single Board Computer module.

CRT

Cathode Ray Tube, the display screen on the Instrument Controller front panel.

current position

The pixel location defined by X,Y coordinates in the graphics plane that is the starting position for turning the beam on or off to paint a line, or to move to another location. On power up, the current location is X0, Y0.

cursor

The visible pointer on the CRT display that allows the user to recognize the position being pointed to by the system software.

data

Numerical information that has been collected for interpretation by a program.

data base

A stored and defined collection of data that is made available for report generation or further calculations by a program.

Data Base Management System (DBMS)

Any systematic approach to storing, updating, and retrieving information as a common data base for many users.

data file

A file holding either random or sequential access information. Contrasted to a program file.

Data lines

Eight of the sixteen bus lines which carry either data or multiline bus messages (Universal, Addressed and Address commands).

Data mode

The default mode of the bus when the controller has left the ATN (attention) line false. All transfers of data or instructions are between instruments.

Glossary

data processing

The ability to perform calculations on collected data and formatting it into readable reports.

debugging

Any method of detecting and correcting syntax and structure errors in a program.

default

That option which system software selects when the user does not specify an option.

device

A hardware resource that can act as a source or destination of data. In this manual, device is used in two different ways: 1. To represent the internal devices recognized by the Operating System. In this usage, the Controller's devices are identified by two letters, a number, and a colon. For example, MF0: identifies the mini-floppy drive. 2. The symbol "@" followed by a number from 0 to 30 represents external devices, such as instruments connected to the IEEE-488 bus. The BASIC language statement "PRINT @ 2" followed by program data would address instrument 2 as a listener device, and send it program data.

Device Address

A number used by a program to designate an external device for data transfer.

Display control

An ANSI-standard character sequence of ASCII characters which produces a desired display effect such as cursor position or reverse image.

E-Disk

Fluke Trade Mark for the Electronic disk, a memory configuration that makes use of memory as if it were a file-structured device. See Electronic Disk.

editor

A system software program that enables a user to generate and update an application program.

EIA

Electronic Industries Association, publishers of standard RS-232-C for serial data ports.

Electronic Disk

A portion of the memory designated as a file-structured device. Part of the system's dynamic RAM memory is configured so that it functionally emulates a floppy disk. The electronic disk is about 100 times faster than the floppy disk and has no moving parts to wear or cause noise.

EPROM

Erasable Programmable Read Only Memory. A ROM that can be erased and reprogrammed by an equipment manufacturer using specialized equipment.

Escape sequence

A string of characters including an escape (ESC) character, a numeric parameter and a function code which is recognized as a Display control.

expression

A combination of data-names, numeric literals, and named constants, joined by one or more arithmetic operators in such a way that the expression as a whole can be reduced to a single numeric value.

Extended Listener

A listener instrument that requires a two-byte address. See secondary commands.

Extended Talker

A talker instrument that requires a two-byte address. See secondary commands.

FDOS

Floppy Disk Operating System program. FDOS is the executive monitor program of the 1722A Instrument Controller, and is supplied as a file on the System Disk with the filename FDOS2.SYS. Usually called "the Operating System", FDOS is the Controller's central program. When any other program is exited, FDOS takes control (unless the BASIC statement SET SHELL has been used to change the environment). The purpose of FDOS is to load other programs.

file

A collection of related information designated by name as a unit.

file-structured device

Any bulk memory device where programs and data may be stored and retrieved via a system directory.

File Utility Program (FUP)

The file management program provided with the standard Fluke Instrument Controller software package. Provided on the system disk as a file with the name FUP.FD2, this utility program permits directory listing, transferring, deleting, and renaming files, and formatting, packing, and zeroing the Controller's devices.

firmware

Computer programs and data that are recorded in permanent memory. See ROM.

flag

A symbol that indicates a status condition. System flags can be used to indicate the presence of command files or to indicate a state of system readiness.

floating-point variable

A representation of a general-purpose number. They are characterized by wide range (up to 308 places from decimal) and high resolution (up to 15 places). When displayed without modification, up to seven of the digits are displayed, with the last one rounded if necessary. If the decimal is out of range of the display, an exponent of ten is included to bring it to just left of the first number. For example, .00123456789 is displayed as 0.1234567e-02, and 1234567.89 is displayed as 1234568. Note that the inexactness of floating-point representation occasionally must be considered. For example, $IF 7*(1.7)=1$ will evaluate false. See integer.

floppy disk

A bulk storage recording device that uses a flexible mylar disk similar to recording tape to record programs and data. The location of information on the disk is identified by track (distance from center) and sector (pie-shaped radial subdivision).

flowchart

A pictorial, symbolic representation of a program. Various shapes represent commands, computations, or decisions. A flowchart is the recommended step between an algorithm specification and program writing. It facilitates understanding and debugging because it breaks the program down into logical, sequential modules.

FUP

See File Utility Program

graphics plane

The portion of the display memory where the lines and patterns displayed by the graphics routines are stored. The area is measured in pixels, rather than bytes. One pixel is the smallest amount of graphics information that can be stored or displayed. The graphics plane is 2048 pixels long and 256 high. The display provides a moveable window looking into the graphics plane. The window is 640 by 224 pixels. See character plane.

handshaking

Refers to the 3-wire hardware protocol used to exchange data on the bus. The three bus lines (DAV, NRFD, and NDAC) indicate a remote instrument's readiness to send or receive data.

hexadecimal

A number system based on 16 digits. Sometimes called hex, the system uses A, B, C, D, E, and F, to represent the numbers above 9.

high-level language

Any programming language that requires conversion through a compiler or interpreter into machine code instructions. Examples of high-level languages are BASIC and FORTRAN.

IEEE

Institute of Electrical and Electronic Engineers, Inc., 345 East 47th Street, New York, NY, 10017. The IEEE is the publisher of Standard 488-1978 used for interconnecting instruments to the Fluke Instrument Controller through the bus.

IEEE-488-1978

A bus standard agreed upon by participating instrument manufacturers for the interconnections of instruments into a functional system. Also known as the GPIB (General Purpose Instrumentation Bus). The standard is published and maintained by the IEEE.

Immediate mode

A method to use BASIC directly as each line is typed in rather than storing a sequence of lines as a program for later execution. In Immediate Mode, line numbers are not used and each line is executed as soon as the RETURN key is pressed.

Instrument Controller

In an IEEE-488 system, designates the piece of equipment that asserts control over the bus, and which establishes the roles of other connected equipment as listeners or talkers.

Integer variable

A representation of an exact number. They are characterized by limited range (-32768 to 32767) and numeric resolution. Integers are normally used for event counting, and for comparisons where exactness is required. See also floating-point.

interface

A hardware and software connection of a device to a system. For example, in the Fluke Instrument Controller, the DMA/Floppy Interface is needed for the system to gain access to the floppy disk.

interpreter

A system software program that interprets the statements of a high-level language program (such as BASIC), producing and executing machine code.

lexical file

An intermediate form of an application program that occupies less space and eliminates some processing steps for the Fluke BASIC Interpreter. Line numbers are represented in binary format and all commands and operators are reduced to binary form. Lexical files always have ".BAL" extensions.

listener

A bus device designated by a controller to receive data or instructions from a designated talker or controller. There can be more than one listener on a bus at the same time.

loader

A program which places another program into main memory for execution.

logical expression

An expression containing variables, constants, function references, etc., separated by logical operators and parentheses.

logic operator

A functions that performs comparisons, selections, matching, etc. In BASIC, the logical operators are AND, OR, NOT, and XOR. These are used for either Boolean operation or for bit-manipulation.

machine code

The coded bit-patterns of directly executable machine-dependent computer instructions, represented by numbers or binary patterns.

machine-dependent program

A program that operates on a particular model of computer.

machine-independent program

A program that operates on any computer system that has the necessary hardware and supporting software.

main memory

The RAM memory from which the microcomputer directly executes all instructions and which is used for fast, intermediate storage of data or programs.

main memory array

An array that is stored in main memory.

management lines

Five of the sixteen lines on an IEEE-488 bus. The lines are ATN (Attention), IFC (Interface Clear), REN (Remote Enable), EOI (End Or Identify), and SRQ (Service Request), and call for an immediate and specific action, or flag a condition existing on the bus.

Operating System

A computer program that manages the resources of computer through task scheduling, I/O handling, and file management. See FDOS.

operator

A term for symbols within an application program (such as + or <) that identify operations to be performed.

Operator's Keyboard

The Touch-Sensitive Display.

parallel poll

A method of simultaneously checking the status of up to eight instruments on a bus by assigning each instrument a data line to transmit a service request.

parity

A method of error detection that uses one extra bit for each unit of information (such as a byte). The parity bit is set to one or zero so that the total number of one-bits in the byte is even or odd.

pathname

The full designation of a file. The three parts are the device name, file name and extension. The first two are separated by a colon, and the last two by a period.

pixel

Acronym for picture element; the smallest amount of visual information that the display is able to resolve; one dot.

port

A connection point used for data transfer. See interface.

Primary command

An ASCII character typically used as a bus command.

program

Any meaningful sequence of computer instructions that cause a system to accomplish a desired task.

PROM

Programmable Read Only Memory, a memory IC that can be recorded by an equipment manufacturer using specialized equipment.

protection state

Files prepared on the Controller are assigned a value, either + or - to indicate the intent of the author either to prevent or allow alteration. A file with the + state is protected and will not be written over. A - state indicates that the file may be altered if desired. All newly created files are assigned the - state. All files supplied on the System disk with the Controller are protected. The File Utility Program includes commands for changing the protection state of files.

protocol

A set of rules for exchange of information between a system and a device or between two systems.

RAM

Random Access Memory. Through common usage, the term has come to mean the high-speed volatile semiconductor memory that is normally used for system and user memory.

random access

A method of obtaining information out of memory; each word of a file can be accessed via its own discrete address. See also sequential access.

raster

The scanning pattern of an electron beam on a CRT display. A raster display uses the same scan pattern all the time, forming images by turning the beam on and off at appropriate times.

RESTART

Front panel switch that resets the system. When pressed alone, RESTART causes a warm start. When pressed at the same time as ABORT, causes the system to perform a cold start.

ROM

Read Only Memory, used for permanently recorded computer programs and data.

RS-232-C

A digital communications standard agreed upon by participating manufacturers of data communication equipment for the transfer of serial digital data between data communication equipment (DCE) and data terminal equipment (DTE). The 1722A is a DTE device. The standard is published and maintained by the Electronic Industries Association.

scientific notation

A system for describing real or integer numbers via a shorthand form of floating-point notation.

Secondary command

IEEE-488 bus commands used to increase the address length of extended talkers and listeners to two bytes.

serial data

Information transmitted one bit at a time over a single wire at a predefined baud rate.

sequential access

A method of accessing data in a file by looking at each piece of data, in order, until a match is found. See also random access.

serial poll

A method of sequentially determining which instrument on a bus has requested service. One instrument at a time is checked via the eight data lines.

serial port

An external connector that conforms to the industry standard RS-232-C. Normally, asynchronous ASCII codes are used unless otherwise desired.

SET Utility Program

The program that changes the parameters of the 1722A's serial communications ports. Supplied on the System Disk with the filename SET.FD2, this program permits configuring the Controller so it is able to communicate with other devices that implement the RS-232 Serial Data Communications standard. Parameters that can be changed include baud rate, parity bit, number of bits per character, stall input and output characters, and time out value.

shell

The Controller's environment, either defaulted to FDOS or changed by the BASIC language SET SHELL statement. When RESTART is pressed, the Controller returns to the program named by the SET SHELL statement, rather than to the bootstrap loader PROM.

simple variable

Fluke BASIC program variable that is either an integer or floating-point value (not a character string) and contains only one value (not dimensional).

Glossary

soft-sectored

In floppy disks, the beginning of every sector on a disk is determined by checking certain data patterns. Hard-sectored disks have predetermined sector beginnings designated by a physical marker, such as a hole.

software

Computer programs and data recorded and used on a medium that can be erased and rewritten by program command.

source

This term has two meanings: 1. The pathname where information presently resides when using a File Utility Program command that moves a file from one place to another; the input side of the channel. 2. An instrument connected to the bus and transmitting either command mode or data mode information.

string variable

An expression that represents collections of characters that may or may not be numeric.

structured programming

A method of programming which require an initial design process to lay out the program structure in a modular form. Structured programming minimizes 'spaghetti code' programs by keeping GOTO statements to a minimum and by using subroutines to structure the program into discrete, easily readable modules.

subroutine

A section of a program that performs a specific function on request of the main program or another subroutine. Subroutines are used in BASIC via the GOSUB statement.

synchronous data

Digital information transmitted in predetermined message block sizes with a clock signal to synchronize the receiver. See asynchronous data.

syntax

The proper grammar required for an interpreter to recognize and execute a program statement.

syntax diagram

A pictorial representation of the grammar required for the execution of a program statement.

system

Any interconnection of instruments or other devices that cooperate to accomplish a task. A controller is an essential part of a system whenever the designations of talkers and listeners needs to be changed during the task. A controller is a necessary part of any system that requires data processing or a centralized control point.

System Device

The designated file-structured device on the Controller that acts as the primary file storage module. The floppy disk or electronic disk may be designated as the system device by the File Utility program's Assign option. The floppy disk drive (MF0:) is the default system device.

system directory

The listing of program and data files on a bulk storage, file structured device.

system memory

Those portions of the Random Access Memory allocated for use by the operating system and utilities or BASIC Interpreter.

system software

The collection of programs used to handle file management procedures on a system.

Talker

An IEEE-488 connected instrument that has been designated by the controller on the bus to send data to listeners.

Time and Date Utility Program

The program that sets the time and date of the Controller's real time clock. Supplied on the System Disk with the filename TIME.FD2, this program accepts the time and date by keyboard inputs, and transmits the information to the real-time clock. With battery back-up, the clock maintains the correct time and takes into account leap years. The clock can be used to time and date stamp programs or data collected by programs, or to perform an operation at a specified time.

Touch-Sensitive Display

The combination of the display screen and the touch-sensitive panel which acts as the operator's keyboard.

warm start

The activities the Controller performs when the RESTART switch is pressed: ceases the current operation and returns to the shell. See cold start.

Universal command

A message sent across the data lines of a bus that affects all connected instruments whether or not they are designated as listeners.

user memory

Area reserved in main memory for storage and execution of user-written application programs and data.

variable

A representation of a quantity, or the quantity itself, which can assume any of a given set of values. A variable may be integer, string, or floating point value designators.

virtual array

A matrix stored on a file-structured storage medium as a random access file. Virtual arrays can be integer, string, or floating-point arrays with one or two dimensions. Once a virtual array file has been opened and the virtual array has been dimensioned, the array elements are handled by the programmer exactly as they are in main memory array.

yank buffer

A temporary memory location where the System Editor program can store data "yanked" from a file.

Appendix E

Custom Character Sets

This appendix describes the relationships among data in the Character EPROM (U32), ASCII codes received as input, and the images displayed on the 1722A screen. This information and an EPROM programmer allow you to create custom character sets for your 1722A.

Character cell dot patterns are stored in a 2732A type EPROM. The standard character set capacity is 128 characters. The alternate character set capability provides an additional 128 characters for a total of 256 characters. Each character uses 16 of the PROM's locations (0 through F). In both the standard and the alternate character set modes, 115 characters can be displayed directly. Eleven of the remaining characters are displayed through the Character Graphics Mode.

Depending on the revision level of the Video-Graphics-Keyboard module, the character sets may be identical, or the alternate font may contain a selection of symbols and non-English characters. Each character is contained in a cell 8 dots wide by 14 dots high. Since every dot in each character cell can be displayed, all character codes are available for graphics.

CAUTION

Leave character position 32 (decimal) blank. ASCII character 32 is the space character. Erase operations write this character on the screen, so position 32 must be left blank.

The rules by which standard ASCII display characters are defined follow. This information is provided for reference as you design any characters you wish.

- Standard ASCII characters are 9 dots high and up to 7 dots wide.
- The topmost row is left blank to provide the spacing between the lines.
- The leftmost column is left blank for spacing between characters.
- Row D is reserved for underlines.

Upper-case characters, numerals, and symbols like the percent and dollar signs, brackets and braces, conform to these rules:

1. They start on row 1.
 2. They extend to row 9.
- Lower-case letters with ascenders (like the letter 'h') start at row 2.
 - Lower-case letters with descenders (like 'g') extend down to row D.
 - Other characters (like 'a' or the symbol '@') start on row 4.

Sixteen bytes are reserved in the EPROM for each character cell. The first byte corresponds to the top row of dots in the cell. The fourteenth byte corresponds to the bottom row. The last two bytes are not used, because the hardware does not address these locations.

The hexadecimal EPROM address of each byte is its ASCII code in hexadecimal followed by its byte number within the cell. For example, 412 is the EPROM address of the third row of ASCII character number 41 (A). A 1-bit corresponds to a displayed dot.

EXAMPLE

This example shows how the capital letter H (ASCII 48) is encoded.

ADDRESS IN ROM	1722A DISPLAY								CODE BYTE
	8	4	2	1	8	4	2	1	
480	00
481	.	1	.	.	.	.	.	1	41
482	.	1	.	.	.	.	.	1	41
483	.	1	.	.	.	.	.	1	41
484	.	1	.	.	.	.	.	1	41
485	.	1	1	1	1	1	1	1	7F
486	.	1	.	.	.	.	.	1	41
487	.	1	.	.	.	.	.	1	41
488	.	1	.	.	.	.	.	1	41
489	.	1	.	.	.	.	.	1	41
48A	00
48B	00
48C	00
48D	00
48E	00
48F	00

THINGS TO KEEP IN MIND

Before starting, program the first 128 locations in the new EPROM with the standard Character set. Set aside the EPROM that is presently in the Controller. Now program the new character set into the last 128 locations of the copy. Taking these measures will ensure that if an error is made, you will still be able to use the original EPROM in the 1722A. Not only is the display needed in order to perform diagnostics, but the original EPROM must be in place if you ever need to send the module in for exchange.

Thirteen character codes in each character set are interpreted as control codes. Eleven of the characters in these locations can be displayed in the Character Graphics Mode. To select this mode, send the sequence ESC [2p.

In the Character Graphics Mode, character patterns are selected for display from the EPROM start addresses listed in the table below.

CHARACTER GRAPHICS MODE EPROM START ADDRESSES

CHARACTER RECEIVED	EPROM PATTERN START ADDRESS (HEXADECIMAL)	
	STANDARD	ALTERNATE
0	000	800
1	070	870
2	080	880
3	090	890
4	0A0	8A0
5	0B0	8B0
6	0C0	8C0
7	0D0	8D0
8	0E0	8E0
9	0F0	8F0
:	110	910

NOTE

The alternate character set contains the double-size graphics characters, so it is necessary to send the escape sequence for double size when addressing these locations.

EPROM INSTALLATION PROCEDURE

CAUTION

You may violate your warranty if you damage the 1722A during the following procedure. To be sure that your warranty stays intact, any Fluke Service Center will be pleased to install the new EPROM.

Once the PROM has been programmed, use this procedure to install it:

1. Set the 1722A Power switch to OFF and disconnect line power.
2. Remove the card cage cover (Phillips head screws) and slide out the Display Module from slot number 2.
3. Use a proper IC removal tool to remove the standard character set EPROM (U32).

NOTE

Save the standard EPROM. If the 1722A should need repair, it must have the standard character set EPROM installed. The Fluke Service Center will need it for proper diagnostic displays. If you return a 1722A for repair without a standard character set EPROM, you'll probably be charged for a new one.

4. Use an IC installation tool to install the custom character set EPROM.
5. Reinstall the Display Module and the rear cover.
6. Connect line power and turn on the power.
7. Test the new PROM by using the sample BASIC language program on the next page to display both character sets. The program works by displaying the primary character set when you command "RUN", and the second when you touch the screen. Both fonts are displayed in double-size to let you see the characters more clearly, and the program toggles between the two character sets for comparison.

Custom Character Sets

```
10 ON CTRL/C GOTO 200
20 E$ =CHR$(27) + "I" \ BL$ = " " \ FLX = 0
30 PRINT E$ + "ip";
40 IF FLX = 1 THEN 70
50 PRINT CPOS(1,0); "Standard - Touch Screen for Alternate"
60 GOTO 80
70 PRINT CPOS(1,0); "Alternate - Touch Screen for Standard"
80 PRINT CPOS(2,4);
90 FOR I = 1 TO 6 \ PRINT CHR$( I); \ NEXT I
100 FOR I = 7 TO 13 \ PRINT BL$; \ NEXT I
110 FOR I = 14 TO 26 \ PRINT CHR$( I); \ NEXT I \ PRINT BL$;
120 FOR I = 28 TO 31 \ PRINT CHR$( I); \ NEXT I
130 PRINT CPOS(4,4); FOR I = 32 TO 63 \ PRINT CHR$( I); \ NEXT I
140 PRINT CPOS(6,4); FOR I = 64 TO 95 \ PRINT CHR$( I); \ NEXT I
150 PRINT CPOS(8,4); FOR I = 96 TO 127 \ PRINT CHR$( I); \ NEXT I
160 WAIT FOR KEY \ ON KEY GOTO 170
170 KX = KEY \ IF FL$ = 0 THEN 180 ELSE 190
180 PRINT CHR$(14); FLX = 1 \ GOTO 40
190 PRINT CHR$(15); FLX = 0 \ GOTO 40
200 PRINT CHR$(27) + "CP" \ END
```

EPROM Programming Worksheet

This page can be photocopied for aiding in the design of custom character sets.

Address	8	4	2	1	8	4	2	1	Data
-- 0									--
-- 1									--
-- 2									--
-- 3									--
-- 4									--
-- 5									--
-- 6									--
-- 7									--
-- 8									--
-- 9									--
-- A									--
-- B									--
-- C									--
-- D									--
E									
F									

Address	8	4	2	1	8	4	2	1	Data
-- 0									--
-- 1									--
-- 2									--
-- 3									--
-- 4									--
-- 5									--
-- 6									--
-- 7									--
-- 8									--
-- 9									--
-- A									--
-- B									--
-- C									--
-- D									--
E									
F									

-- 0									--
-- 1									--
-- 2									--
-- 3									--
-- 4									--
-- 5									--
-- 6									--
-- 7									--
-- 8									--
-- 9									--
-- A									--
-- B									--
-- C									--
-- D									--
E									
F									

-- 0									--
-- 1									--
-- 2									--
-- 3									--
-- 4									--
-- 5									--
-- 6									--
-- 7									--
-- 8									--
-- 9									--
-- A									--
-- B									--
-- C									--
-- D									--
E									
F									

Appendix F Primary Character Set

FLUKE		ASCII & ←IEEE-LBB→ BUS CODES																							
B ⁷ B ⁶ B ⁵ B ⁴ BITS		0 0 0 0				0 0 0 1				0 1 0 1				0 1 0 0				0 1 1 0				0 1 1 1			
B ³ B ² B ¹ B ⁰		CONTROL				NUMBERS SYMBOLS				UPPER CASE				LOWER CASE											
0 0 0 0		0 NUL 16 ρ 10				32 SP 20 0 30				64 @ 40 P 50				96 ' 60 112 p 70											
		NUL DLE				SPACE MLA0 0 MLA16				@ MTA0 P MTA16				MSA0 P MSA16											
0 0 0 1		1 β 17 ↓ 11				33 ! 21 49 1 31				65 A 41 Q 51				97 a 61 113 q 71											
		SOH GTL DC1				! MLA 1 1 MLA17				A MTA1 Q MTA17				a MSA1 q MSA17											
0 0 1 0		2 γ 2 18 τ 12				34 " 22 50 2 32				66 B 42 R 52				98 b 62 114 r 72											
		STX DC2				" MLA2 2 MLA18				B MTA2 R MTA18				b MSA2 r MSA18											
0 0 1 1		3 δ 3 19 υ 13				35 # 23 51 3 33				67 C 43 S 53				99 c 63 115 s 73											
		ETX DC3				# MLA3 3 MLA19				C MTA3 S MTA19				c MSA3 s MSA19											
0 1 0 0		4 ε 4 20 φ 14				36 \$ 24 52 34				68 D 44 T 54				100 64 116 74											
		EOT SDC DC4				\$ MLA4 4 MLA20				D MTA4 T MTA20				d MSA4 t MSA20											
0 1 0 1		5 ζ 5 21 χ 15				37 % 25 53 35				69 E 45 U 55				101 65 117 75											
		ENG PPC NAK PPU				% MLA5 5 MLA21				E MTA5 U MTA21				e MSA5 u MSA21											
0 1 1 0		6 η 6 22 ψ 16				38 & 26 54 36				70 F 46 V 56				102 f 66 118 76											
		ACK SYN				& MLA6 6 MLA22				F MTA6 V MTA22				f MSA6 v MSA22											
0 1 1 1		7 BEL 7 23 ω 17				39 ' 27 55 37				71 G 47 W 57				103 g 67 119 77											
		BEL ETB				' MLA7 7 MLA23				G MTA7 W MTA23				g MSA7 w MSA23											
1 0 0 0		8 BS 8 24 Ω 18				40 (28 56 38				72 H 48 X 58				104 h 68 120 78											
		BS GET CAN SPE				(MLA8 8 MLA24				H MTA8 X MTA24				h MSA8 x MSA24											
1 0 0 1		9 HT 9 25 √ 19				41) 29 57 39				73 I 49 Y 59				105 i 69 121 79											
		HT TCT EM				) MLA9 9 MLA25				I MTA9 Y MTA25				i MSA9 x MSA25							
1 0 1 0		10 A 26 1A				42 * 2A 58 3A				74 J 4A Z 5A				106 6A 122 7A											
		LF A				* MLA10 10 MLA26				J MTA10 Z MTA26				j MSA10 z MSA26											
1 0 1 1		11 B 27 18				43 + 2B 59 3B				75 K 4B [5B				107 6B 123 7B											
		VT ESC				+ MLA11 11 MLA27				K MTA11 [MTA27				k MSA11 { MSA27											
1 1 0 0		12 C 28 10				44 , 2C 60 3C				76 L 4C \ 5C				108 6C 124 7C											
		FF FS				, MLA12 12 MLA28				L MTA12 \ MTA28				l MSA12 ; MSA28											
1 1 0 1		13 D 29 10				45 - 2D 61 3D				77 M 4D] 5D				109 6D 125 7D											
		CR GS				- MLA13 13 MLA29				M MTA13] MTA29				m MSA13 } MSA29											
1 1 1 0		14 E 30 2E				46 . 2E 62 3E				78 N 4E ^ 5E				110 6E 126 7E											
		SO Σ				. MLA14 14 MLA30				N MTA14 ^ MTA30				n MSA14 ~ MSA30											
1 1 1 1		15 F 31 1F				47 / 2F 63 3F				79 O 4F 95 5F				111 6F 127 7F											
		SI US				/ MLA15 15 UNL				O MTA15 - UUT				o MSA15 RUBOUT											
2 ³ 2 ² 2 ¹ 2 ⁰		ADDRESSED UNIVERSAL COMMANDS COMMANDS				LISTEN ADDRESSES				TALK ADDRESSES				SECONDARY ADDRESSES OR COMMANDS											

KEY decimal hex
38 & 26 1722A DISPLAY
 ASCII & MLA6 ←IEEE-LBB→

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FLUKE