1752A
DATA ACQUISITION SYSTEM

Data Acquisition and Control

FLUKE®

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1752A

DATA ACQUISITION SYSTEM

Data Acquisition and Control

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1752A Data Acquistion System

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Section 1
How To Use This Manual

CONTENTS

INTRODUCTION

This manual presents the user with complete operating and programming instructions for the measurement and control modules used with the 1752A Data Acquisition System.

This manual assumes that you are familiar with the BASIC language. To learn about BASIC, consult the BASIC manual supplied with your 1752A.

ORGANIZATION

This manual is organized as follows:

Section 1 How to Use This Manual

Presents an overview of this manual.

Section 2 Data Acquisition and Control: An Overview

Gives an introduction to the 1752A measurement and control modules and their use.

Section 3 Analog Measurement

Provides complete information about installing and using the 1752A-010 Analog Measurement Processor.

Section 4 Analog Control

Provides complete information about installing and using the 1752A-011 Analog Output.

Section 5 Frequency Measurement

Provides complete information about installing and using the 1752A-012 Counter/Totalizer.

Section 6 Bit-Parallel I/O

Briefly introduces the 17XXA-002 Parallel Interface module. Complete installation and programming instructions for this module are given in the 17XXA-002 Parallel Interface manual, which is supplied with the module.

Appendices

The appendices contain a list of Fluke Sales and Service Centers and a Programmer's Quick Reference Card. This card summarizes useful information for programming the 1752A measurement and control modules.

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USAGE GUIDE

The following guide is intended to help you quickly find the information you need.

Evaluators

If you are evaluating the 1752A Data Acquisition System for a particular application, refer to Sections 3 through 6 for a description of each I/O module, including specifications.

Beginning System Designers

For those with little or no experience in designing a data acquisition and control system, the 1752A Getting Started manual is a good place to begin. This handy, stand-alone volume and accompanying disk will familiarize you with the basic operation of the 1752A and the 1752A-010 Analog Measurement Processor. You can then use the 1752A Data Acquisition and Control manual to learn more about all of the measurement and control modules.

If you need to learn more about a particular programming language (Interpreted BASIC, Compiled BASIC, Extended BASIC, etc.), refer to the manual set for that language.

Programmers

If you already have some experience in programming, this manual is a good place to start. Refer to Section 2 for an overview, or refer directly to the later sections, which describe the measurement and control modules in detail.

Operators

Operators will find it useful to refer to the Operator's Quick Reference Guide, which is included in the 1752A System Guide. The Guide shows the location and operation of all controls, how to care for the floppy disk, and what to do if things don't go as expected.

Section 2
Data Acquisition and Control: An Overview

CONTENTS

Data Acquisition and Control: An Overview

INTRODUCTION

This section presents an overview of the 1752A measurement and control modules and explains in general terms how to program them. Detailed set-up and programming instructions for each of the modules can be found in Sections 3 through 6.

THE MEASUREMENT AND CONTROL MODULES

The measurement and control modules provide the 1752A with a variety of interfaces to the real world for making measurements and controlling processes. The modules presently available for the 1752A are described in the following paragraphs.

1752A-010 Analog Measurement Processor

The 1752A-010 Analog Measurement Processor converts voltages or currents to digital readings via 32 individually addressable input channels. The input channels may be configured as 32 single-ended channels, 16 differential input channels, or a combination of the two. Measurements are made in two voltage ranges (1V and 10V) and two current ranges (65 mA and 4 to 20 mA).

1752A-011 Analog Output

The 1752A-011 Analog Output provides efficient conversion of user-programmable voltage or current outputs to external control points. The outputs are user-configured on four fully isolated, addressable channels. Output voltage is programmable over -10.2375V to +10.2375V range. Output current is programmable over a 0 to 20.475 mA range.

1752A-012 Counter/Totalizer

The 1752A-012 Counter/Totalizer performs frequency, time, and totalizing measurements. Frequency measurements are performed on TTL or analog inputs at four different programmable gate times. Time measurements are performed on TTL, analog, or gate inputs. Pulse widths or periods can be measured by programming the slope of the signal that starts and stops measurement. Totalizing can be performed on two pairs of inputs. Inputs can be gated and an initial value can be programmed.

17XXA-002 Parallel Interface

The 17XXA-002 Parallel Interface is a versatile option that provides channel lines for bidirectional data transmission between the 1752A and compatible external devices.

OVERVIEW OF SOFTWARE CONTROL

The measurement and control modules are controlled by a special set of BASIC subroutines which are supplied on the 1752A System Disk. To control a module you write a program in BASIC that calls these subroutines. You can also call the subroutines directly, using Interpreted BASIC in the Immediate mode.

The subroutines are supplied on the 1752A System Disk in two forms. One form is for use with Interpreted BASIC. The other form is for use with Compiled BASIC and Extended BASIC.

Programming in Interpreted BASIC

For Interpreted BASIC, the measurement and control subroutines are supplied in the following libraries:

LIBRARY	DESCRIPTION
AIOLIB	AIOLIB is the analog I/O library. It contains the subroutines that control the 1752A-010 Analog Measurement Processor and the 1752A-011 Analog Output module.
DIOLIB	DIOLIB is the digital I/O library. It contains the subroutines that control the 1752A-013 Counter/Totalizer.
PIBLIB	PIBLIB is the parallel interface library. It contains the subroutines that control the 17XXA-002 Parallel Interface.

NOTE

The Parallel Interface subroutines can be controlled from languages other than BASIC. See the 17XXA-002 Parallel Interface manual for details.

Since these libraries are object files, each has the ".OBJ" extension in its filename. For example, the filename for the AIOLIB is AIOLIB.OBJ.

Programming in Compiled and Extended BASIC

For Compiled BASIC and Extended Basic, the measurement and control subroutines are supplied in a single file on the 1752A System Disk called BASIC.LIB.

USING THE MEASUREMENT AND CONTROL SUBROUTINES

The measurement and control subroutines are used in a program by first linking to the associated library and then calling the desired subroutines. Linking loads the subroutines into program memory for execution.

How you link to a library depends upon the programming language you are using.

Linking in Interpreted Basic

In Interpreted BASIC, libraries are linked with the LINK statement. For example, to use the Analog Measurement Processor, you need to link the AIOLIB library. In this case, the LINK statement would read:

```
LINK "AIOLIB"
```

If you are using Interpreted BASIC in the Immediate Mode, the LINK statement must be entered before the subroutines can be called. If you are writing a program, the LINK statement should be made early in the program.

Linking in Compiled BASIC and Extended BASIC

The measurement and control subroutines can also be used with Compiled BASIC and Extended BASIC. For these languages, the measurement and control subroutines are contained in the library file BASIC.LIB, which is supplied on the 1752A System Disk. For instructions on linking this library, refer to the manual supplied with Compiled BASIC or Extended BASIC.

Calling Subroutines

Once a library has been linked, its subroutines can be called using the CALL statement. For example,

```
CALL ADSYNC(1%,0%)
```

calls the subroutine ADSYNC, which sets the Analog Measurement Processor with board address 1 to the unsynchronous mode.

The subroutine name must be followed by any parameters or arguments that are required. ADSYNC requires two parameters: the board address (1%) and the synchronization mode (0%, for unsynchronous).

The word "CALL" can usually be omitted from a CALL statement, since the word is optional when the subroutine name does not duplicate a BASIC keyword. For instance, the previous example could be written simply as:

```
ADSYNC(1%,0%)
```

Unlinking Libraries

When a library is no longer needed in a program, it can be removed from program memory by using the UNLINK statement. For example, to unlink the AIOLIB library, the statement would simply read:

```
UNLINK "AIOLIB"
```

EXAMPLE PROGRAM

The following example program is written in Interpreted BASIC. The program uses the 1752A-010 Analog Measurement Processor to take a voltage reading on analog input channel 4. The program assumes that you have set the address switch on the Analog Measurement Processor to board address 0. It also assumes you have set jumpers on the Analog Measurement Processor to configure channel 4 for voltage readings.

```
100  LINK "AIOLIB"
110  VI=0
120  AISET(4%, 1%, 1%, 2%, 1%)
130  ADSYNC(0%, 0%)
140  AIREAD(4%, VI)
150  PRINT VI
160  END
```

The LINK statement in program line 100 causes the 1752A to load the AIOLIB Library from the System Disk into memory. This makes the library available for use in the program.

In line 110, we initialize the variable VI. Variables must be initialized before they are used in a subroutine. This variable will be used in line 140 to store the reading returned by the subroutine AIREAD. We have chosen the name VI arbitrarily.

Line 120 calls AISET, a subroutine that sets up all the parameters for an analog input channel. Following AISET, the first parameter (4%) specifies which channel is affected (channel 4). The next parameters configure channel 4 as follows: single-ended input mode; read enabled; 1V range; no filter. The percent signs are necessary because the subroutine requires that these parameters be integers.

In line 130, the subroutine ADSYNC sets the Analog Measurement Processor with board address 0 to the unsynchronous mode.

In line 140 we cause the 1752A to read the voltage on channel 4. AIREAD stores the reading in the variable VI. The reading is displayed to us after the program executes the PRINT statement in line 150.

Section 3
Analog Measurement

CONTENTS

INTRODUCTION

This section contains installation and programming instructions for the Analog Measurement Processor (Option 1752A-010). The section includes a description of the option and its accessories, operating notes, hardware set-up instructions, introductory programming notes, sample applications, and a complete description of the subroutines that are used to control the module.

A calibration procedure is provided at the end of this section. For additional service information, refer to the 1752A Service Manual.

GENERAL DESCRIPTION

The Analog Measurement Processor allows the 1752A to interface with the real world of dc analog signals. The Processor measures dc voltages and currents and digitizes the readings for manipulation by the 1752A. The Processor is controlled by BASIC subroutines that are provided on the 1752A System Disk.

Physically, the Analog Measurement Processor is a printed circuit assembly which mounts in the 1752A chassis. At its heart are an analog-to-digital converter and a 32-channel scanner. Two external connectors provide 32 individually-addressable input channels.

Features of the Analog Measurement Processor include:

- 32 addressable input channels
- Two voltage ranges
- Two current ranges
- Single-ended and differential input modes
- Selectable filtering
- Synchronous and asynchronous scanning modes

These features are explained under the heading “Operating Notes.”

SPECIFICATIONS

Number of Channels	32 single-ended or 16 differential (single-ended and differential channels may be mixed). Maximum of four Analog Measurement Processors per 1752A.
Synchronization Modes	Internally Synchronized: 50, 60, or 400 Hz Externally Synchronized: 45 to 65 Hz, or 360 to 520 Hz Asynchronous
Ranges (full scale, each channel)	± 1V ± 10V ± 65 mA 4 to 20 mA, displayed as 0 to 100% of scale
Reading Rate	Synchronized Modes: 400 readings/sec @ 50 Hz 480 readings/sec @ 60 Hz 400 readings/sec @ 400 Hz Asynchronous Mode: 1000 readings/sec
Accuracy (90 days, 10°C to 40°C)	10V Range: ±(0.02% of reading + 1 count) 1V Range: ±(0.02% of reading + 2 counts) 65 mA Range: ±(0.05% of reading + 2 counts)
Resolution (14 bits)	10V Range: 1.24 mV per count (±8192 counts) 1V Range: 124 μV per count (±8192 counts) 65 mA Range: 8.267 μA per count (±8192 counts) (15Ω, 0.04%, 20 ppm TC sense resistor)
Filtering	Software filter, 1 to 128 readings, software selectable in powers of two.
Common Mode Voltage	± 10.5V
Common Mode Rejection	dc: 77 dB @ 10°C-40°C 50/60 Hz: 60 dB @ 10°C-40°C

Normal Mode Rejection	Internally Synchronized mode: 20 dB (50/60 Hz ±0.3 Hz) Externally Synchronized mode: 50 dB (45 Hz to 65 Hz) 45 dB (360 Hz to 520 Hz) Asynchronous Mode: 0 dB
Input Protection	50V rms without side effects Fuse-resistor protected to 240V rms (400V peak)
Automatic Self-Calibration	Performed approximately every 17 seconds. Requires 10 msec. May be disabled by user software.

ACCESSORIES

The following accessories can be used to connect input voltages and currents to the Analog Measurement Processor.

- Termination Block With Cable

  The Y1750 Termination Block With Cable consists of one ribbon cable and one screw terminal connector block. The connector block can be installed on any of four types of commercially available DIN standard rails, which are available from a wide range of sources. Two Y1750 blocks are required to connect all channels of one Analog Measurement Processor.

- Signal Conditioning Cable Set

  The Y1751 Signal Conditioning Set provides a pair of 1-meter ribbon cables to allow the Analog Measurement Processor to connect to compatible connectors.

- Line Frequency Sync Transformer

  The Y1752 Line Frequency Sync Transformer allows external synchronization of the Analog Measurement Processor to power-line frequency. The unit is plugged into the line and then connected to the Analog Measurement Processor.

OPERATING NOTES

The following paragraphs describe important features of the Analog Measurement Processor. Understanding these features will help you get the best performance from your system.

Three of these features are controlled by setting switches or jumpers on the Analog Measurement Processor: board address; voltage/current selection; and external sync frequency range. Procedures for making these adjustments are provided later in this section, under "Hardware Set-Up."

Board and Channel Addressing

The 1752A can have up to four Analog Measurement Processors. Since each Analog Measurement Processor has 32 addressable inputs channels, the 1752A can have up to 128 addressable analog input channels.

Input channels are labeled consecutively from 0 to 127 by assigning a board address to each Analog Measurement Processor. The board address is assigned by setting switches on the Analog Measurement Processor. (The address selection procedure is given later under "Hardware Set-Up.")

Channel numbers are allocated to each board address in blocks of 32 channels, as shown in the following table. The Analog Measurement Processor shipped with the 1752A is set at address 0, corresponding to input channels 0 through 31.

BOARD ADDRESS	CHANNEL NUMBERS
0	0 to 31
1	32 to 63
2	64 to 95
3	96 to 127

Self-Calibration

The Analog Measurement Processor has a self-calibration feature, by which the board automatically calibrates itself when scanning is initiated and at approximately 17-second intervals thereafter. During self-calibration, scanning is momentarily suspended.

If you are taking a time-critical series of readings, the self-calibration feature can be disabled so that self-calibration does not occur. Self-calibration is disabled and reenabled with the subroutine ADCAL.

Self-calibration should not be confused with external calibration. External calibration is a separate procedure, given near the end of this section, which calibrates the Analog Measurement Processor to external reference standards.

Self-calibration is required for the Analog Measurement Processor to meet its specifications.

Range Selection

The Analog Measurement Processor has two voltage ranges and two current ranges:

Voltage Ranges: 1V (–1.0158V to +1.0158V)
10V (–10.158V to +10.158V)

Current Ranges: 4 to 20 mA
65 mA (–67.72 mA to +67.72 mA)

The ranges are selected using the subroutines AIRNGE or AISET. (Remember: Each input channel is set to measure current or voltage by setting a jumper on the board. To reconfigure a channel, see "Hardware Set-Up," later in this section.) You can tell what range is selected using the subroutine AISTAT.

The range determines the units in which readings are returned. Both voltage ranges return readings in volts. The 65 mA range returns readings in amps.

The 4 to 20 mA current range returns readings in percentages rather than mA. The readings range from 0% to 100%, with 0% corresponding to 4 mA and 100% corresponding to 20 mA. Polarity is ignored. Currents between 0 to 4 mA return a negative percentage. Any current over 20 mA will return a percentage greater than 100%.

If a reading exceeds the selected range, the Analog Measurement Processor normally returns the value 1*10**10 (1 times 10 to the 10th). The only exception is that out-of-range readings returned by the subroutine AISCNI have the value +32767.

NOTE

The subroutine AISCNI always returns readings in integer format. These readings must be converted to volts or amps using special scale factors. For further explanation, see the heading, "Reading Multiple Channels," later in this section.

Whenever a channel is programmed to a current range, the channel is automatically configured for a differential reading. This is because, in the 1752A, current readings are always differential.

Single-Ended and Differential Readings

Measurements may be taken on an analog input channel in either single-ended or differential mode. The modes are selected using the AISET or AIMODE subroutines. External wiring is connected to the analog input channels differently for each mode.

In single-ended mode, a reading is made of the voltage between the channel input and common. Since current measurements can only be taken in differential mode, whenever a channel is programmed to the single-ended mode, the channel is automatically set to a voltage range.

In differential mode, a reading returns the voltage difference between two consecutive channel inputs (when measuring voltage), or the current flowing in one channel and out the other (when measuring current). Since current measurements can only be taken in differential mode, whenever a channel is programmed to a current range that channel is automatically programmed to differential mode.

If an even-numbered channel is programmed to be a differential input, the next higher-numbered (odd) channel comprises the negative half of the differential pair. For example, if channel 0 is programmed to be differential, then the inputs from channels 0 and 1 make up the differential pair. A single-ended measurement or a differential measurement may still be taken on channel 1, but readings taken on channel 0 are always differential in this case.

If an odd-numbered analog input channel is set up to be differential, then the next lower-numbered (even) channel comprises the negative half of the differential pair. For example, if channel 3 is programmed to be differential, then the inputs of channels 2 and 3 make up the differential pair. A single-ended or differential measurement may be made on channel 2, but all measurements taken on channel 3 are always differential in this case.

Synchronous and Asynchronous Scanning

When reading inputs, the Analog Measurement Processor scans the input channels starting from the lowest channel on the board (channel 0 for board 0, channel 32 for board 2, channel 64 for board 3, etc.) and continuing on to higher channels until all the channels have been read.

There are two modes of scanning: asynchronous and synchronous. Each is described below. The scanning mode and rate are set using the ADSYNC subroutine.

Asynchronous Mode

In the asynchronous mode, the Analog Measurement Processor reads only those channels which are enabled. (A channel is enabled or disabled using the AISET or AIENBL subroutines.) If a channel is disabled, no reading is made on that channel. By reading only the channels of interest, the Analog Measurement Processor can read the enabled channels at 1000 readings per second.

Synchronous Mode

In the synchronous mode, all 32 channels are always read. The term synchronous refers to the fact that two readings are made on each channel at times synchronized to the power-line frequency. The two readings are taken 180 degrees apart on the power-line waveform and averaged to eliminate, to a large degree, line-frequency noise from the measurement.

Reading timing may be controlled by an internal clock (internal synchronous mode) or by an external reference signal (external synchronous mode). In the internal synchronous mode, reading timing may be selected to correspond to 50, 60, or 400 Hz power.

In the external synchronous mode, an external reference input may be provided to synchronize readings to non-standard or poorly controlled power-line frequencies in the 45-65 Hz or 360-520 Hz range. (A procedure for selecting the external sync frequency range is provided later under "Hardware Set-Up.") For the lower sync frequency range, the reading rate is eight times the synchronizing frequency (e.g., 400 averaged readings per second for 50 Hz; 480 averaged readings per second at 60 Hz). For the upper sync frequency range, readings are taken at the synchronizing rate.

Filtering

The Analog Measurement Processor features software-controlled filtering. Filtering averages several readings on the same channel. Filtering can improve accuracy when measuring noisy signals with slowly changing average values.

Filtering is selected using the subroutines AIFLTR or AISET. The number of readings averaged can be varied from 1 to 128, in increments of powers of 2 (1, 2, 4, 8, 16, etc.) The default is one reading (no filtering). (Note: The number of readings is also the filter coefficient.)

For larger filter values, you may notice a delay when initiating filtering. The delay occurs while the first batch of readings is being taken. After this initial delay, new readings become available at the same rate for both filtered and unfiltered channels. The delay disappears because new readings are averaged with previous readings.

This method of filtering gives a response similar to that of an RC filter, with a time constant approximately equal to the time required to take the number of readings being averaged. (The approximation becomes closer the larger the number of readings being averaged.) For example, in the asynchronous mode, the Analog Measurement Processor takes approximately 1000 readings per second. If 12 channels are being read (i.e., if 20 channels are being skipped), then each channel is read 1000/12 or 80 times per second. If a filter coefficient of 16 is used, then the filter time constant will be 16/80, or 0.2 seconds.

For readings taken in the synchronous mode, the filter coefficient is divided in half, since each new pre-filtered measurement is the average of two readings. For example, if in 50 Hz synchronous scan mode, the Analog Measurement Processor takes 400 readings per second. Since all channels are always scanned in synchronous mode, the Analog Measurement Processor takes 12.5 readings per second on each channel. If a filter coefficient of 64 is used, the filter time constant will be 64/(2X12.5) or 2.56 seconds.

Default Configurations

The Analog Measurement Processor is reset to the default configuration when the 1752A is powered-up or when the RESTART and ABORT buttons are pushed simultaneously (cold start). (Pushing RESTART or ABORT alone does not reset the Analog Measurement Processor.)

The default configuration is:

- Self-calibration enabled
- Asynchronous scan mode
- All channels enabled
- 10V range
- Filter value of 1 (no filtering)
- Single-ended mode

HARDWARE SET-UP

The 1752A arrives from the factory with one Analog Measurement Processor already installed in the chassis. Additional Analog Measurement Processors are shipped separately and must be installed in the 1752A chassis.

There are four user-adjustable hardware settings on the Analog Measurement Processor: voltage/current selection (each channel is configured to take voltage or current readings); the board address; external calibration write-enable/disable; and external sync signal frequency range. The settings are configured at the factory as follows:

- All channels are configured for voltage measurement.
- The board address is zero.
- Calibration is write-disabled.
- External sync frequency range is 45-65 Hz.

To change or check the settings on a board that is already installed in the 1752A, remove the board as described under the next heading. To change or check the settings on a board that is not yet installed, proceed to "Setting the Board Address," below.

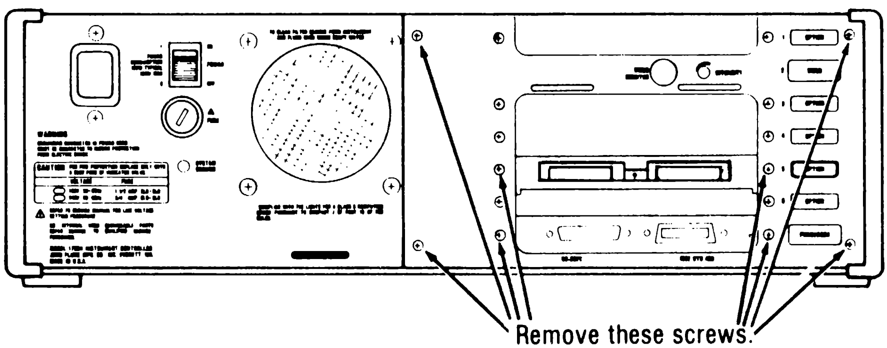
The procedure for moving the calibration jumper is provided in the external calibration procedure, at the end of this section.

Removing the Analog Measurement Processor

Follow these steps to remove an Analog Measurement Processor from the chassis:

1. Power down the 1752A and remove the line cord.

2. Remove the rear card cage cover. (See illustration.) The number of screws you will need to remove depends on the number of options already installed.



CAUTION

Handle the board by its edges to avoid contaminating it with oil from the hands. The use of gloves is recommended.

3. Carefully slide the Analog Measurement Processor board out of the slot in the card cage.

Setting the Board Address

Each Analog Measurement Processor has a board address, which is set by Address Switch S1. The board address assigns channel numbers to the board's 32 analog input channels.

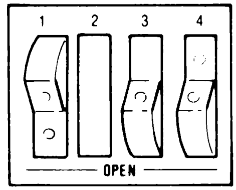
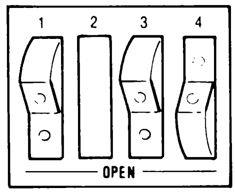
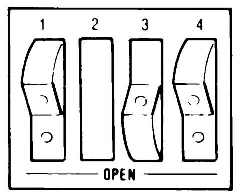
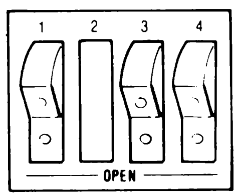
Since a 1752A system can have up to four Analog Measurement Processors, input channels are labeled consecutively from 0 to 127, corresponding to the 128 input channels in a system with four Analog Measurement Processors. The channels are assigned numbers in blocks of 32.

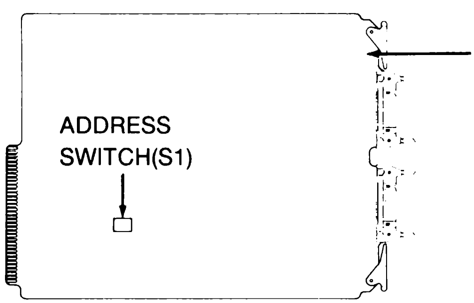
Before installing an Analog Measurement Processor, check the board address on the Address Switch. The accompanying illustration shows the location of the Address Switch on the board. The address is set by switch segments 3 and 4, as the illustration shows.

The first Analog Measurement Processor in your system should have board address 0. If you have a additional Analog Measurement Processors in your system, the second board should have address 1, the third board should have address 2, and the fourth board should have address 3.

If necessary, set switch segments 3 and 4 for the correct address.

BOARD ADDRESS SELECTION

BOARD ADDRESS	CHANNEL ALLOCATION	ADDRESS SWITCH SETTING
0	CHANNELS 0-31	
1	CHANNELS 32-63	
2	CHANNELS 64-95	
3	CHANNELS 96-127	



ANALOG MEASUREMENT
PROCESSOR
(component side)

Note: Switch segment 1 is used for calibration, and should normally be OPEN.
Switch segment 2 is not used.

Configuring for Voltage or Current Readings

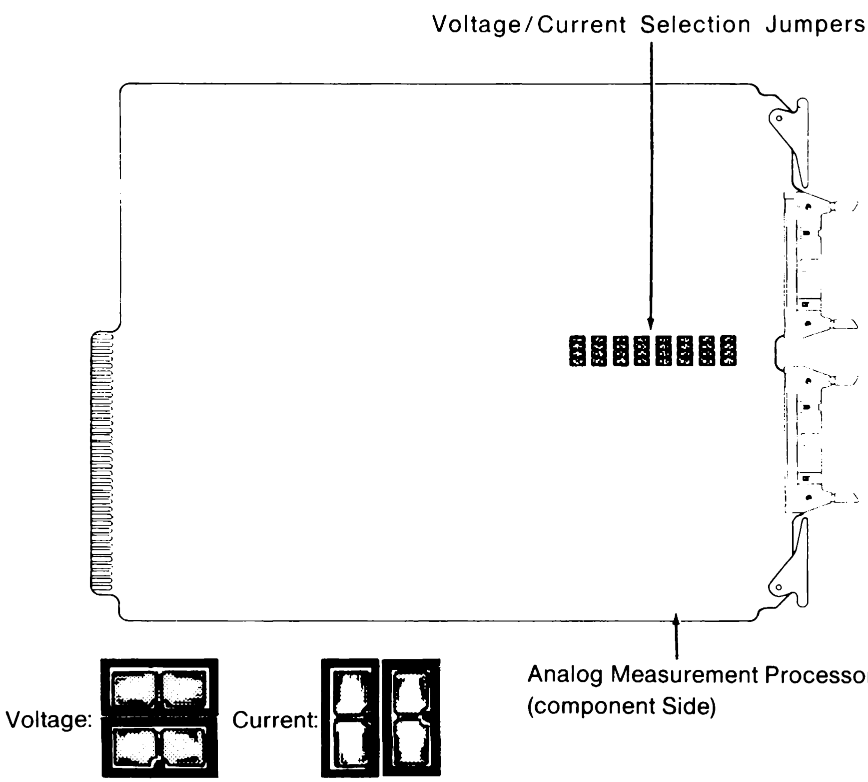
Each analog input channel is configured with a jumper as either a voltage or a current input. The Analog Measurement Processor is shipped from the factory with all channels configured as voltage inputs.

Since current readings are differential, they require that two consecutive channels be configured as current inputs.

To change a pair of channels from voltage to current, move the two jumpers for each channel from the horizontal position to the vertical position, covering the same four pins. (See illustration.) Channel numbers and jumper-direction identifiers are silk-screened on the circuit board.

To change a channel back to voltage, simply reverse this procedure.

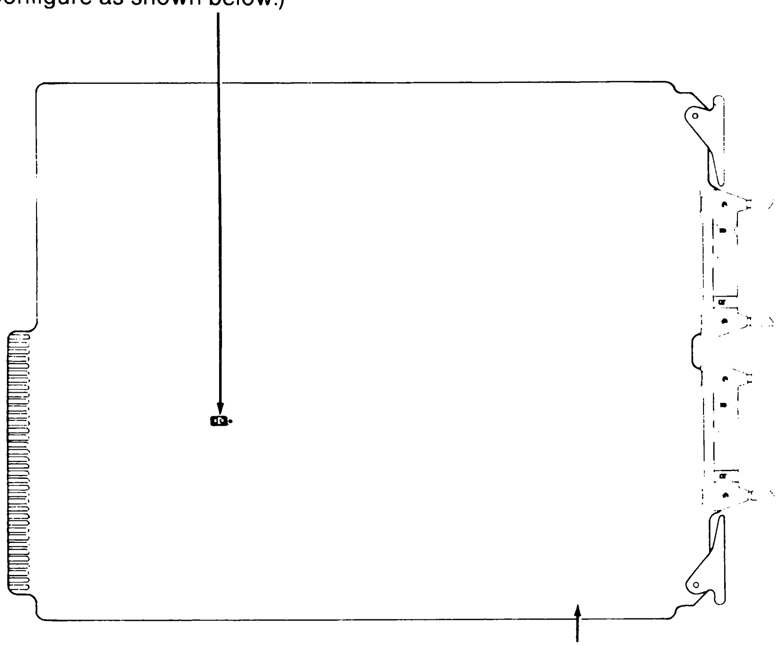
VOLTAGE/CURRENT SELECTION



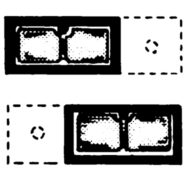
Selecting External Sync Frequency Range

Jumper 2, located between components U24 and U25 on the circuit board, selects the acceptable frequency range for externally synchronized input scanning. To select the 45 to 65 Hz range, place the jumper over the center and left-most pins. To select the 360 to 520 Hz range, place the shorting block over the center and right-most pins. (See illustration.)

EXTERNAL SYNC FREQUENCY RANGE SELECTION



45 - 65 Hz:
360 - 520 Hz:



Installing the Module

Once all hardware adjustments discussed in the previous paragraphs have been made or verified, the Analog Measurement Processor may be installed in the chassis. The Analog Measurement Processor mounts in option slots 1, 3, 4, or 5 in the 1752A chassis. (See illustration.)

OPTIONS

SLOTS	Counter/Totalizer -012	Analog Output -011	Analog Measurement Processor -010	Dual Serial Interface -009	IEEE-488/RS-232C Interface -008	512K byte RAM Expansion -007	256K byte RAM Expansion -006	512K byte Bubble Memory -004	256K byte Bubble Memory -003	Parallel Interface -002
1	●	●	●	●	●	●	●	●	●	●
2	Reserved for Video/Graphics/Keyboard Interface									
3			●	●		●	●	●	●	●
4	● *	● *	●	●	● †	● †	●	●	●	●
5	● *	● *	●	●	● †	● †	●	●	●	●
6							●	●	●	
7	Reserved for Single Board Computer									

● = Allowable Slot for Option
† Non I/O must be used in slot above
* Takes up two slots. No board in slot above

Use the following procedure to install the Analog Measurement Processor:

1. Power down the 1752A and remove the line cord.

2. Remove the rear card cage cover, if it has not been removed already. (See the illustration under the heading, "Removing the Analog Measurement Processor," earlier in this section.) The number of screws you will need to remove depends on the number of options already installed.

CAUTION

Handle the board by its edges to avoid contaminating it with oil from the hands. The use of gloves is recommended.

3. Carefully slide the Analog Measurement Processor into slot 1, 3, 4, or 5 in the card cage. Make sure the board is fully seated so that it makes solid contact with the card-edge connector.

4. Remove the cover plate from the corresponding slot on the card cage cover by removing the two screws.

5. Reinstall the card cage cover.

6. Thread the screws removed in step 4 through the card cage cover and into the threaded stand-offs mounted on the Analog Measurement Processor.

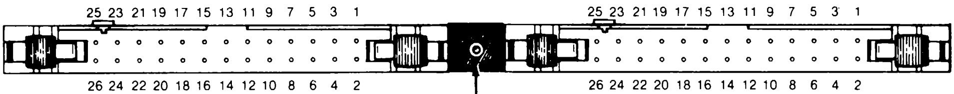
SYSTEM DIAGNOSTICS

Once installation is complete, the Analog Measurement Processor can be tested by running the System Diagnostic as described in Appendix G of the 1752A System Guide. This program verifies that the board is installed properly and functioning.

CONNECTOR DESCRIPTION

The Analog Measurement Processor has three rear-panel connectors: two 26-pin analog input connectors and one external sync input connector. Pinouts for the analog input connectors are shown on the next page. Channel numbers are shown for board address zero.

INPUT CONNECTORS



INPUT CONNECTOR PIN ASSIGNMENTS

PIN NUMBER (CONNECTOR J1)	CHANNEL NO.	PIN NUMBER (CONNECTOR J2)	CHANNEL NO.
1	0	1	16
2	1	2	17
3	(Signal Ground)	3	(Signal Ground)
4	2	4	18
5	3	5	19
6	(Signal Ground)	6	(Signal Ground)
7	4	7	20
8	5	8	21
9	(Signal Ground)	9	(Signal Ground)
10	6	10	22
11	7	11	23
12	(Signal Ground)	12	(Signal Ground)
13	8	13	24
14	9	14	25
15	(Signal Ground)	15	(Signal Ground)
16	10	16	26
17	11	17	27
18	(Signal Ground)	18	(Signal Ground)
19	12	19	28
20	13	20	29
21	(Signal Ground)	21	(Signal Ground)
22	14	22	30
23	15	23	31
24	(Signal Ground)	24	(Signal Ground)
25	(Not Used)	25	(Not Used)
26	(Power Ground)	26	(Power Ground)

Notes Signal grounds are connected together internally.
Channel numbers are shown for board address 0.

GETTING STARTED

The Analog Measurement Processor is controlled by BASIC subroutines that are supplied on the 1752A System Disk. You can call the subroutines from programs that you write in BASIC, or you can call the subroutines directly by using Interpreted BASIC in the Immediate mode.

The subroutines are supplied on the 1752A System Disk in two forms: in the AIOLIB library, for use with Interpreted BASIC, and in BASIC.LIB, for use with Compiled BASIC or Extended BASIC.

It is a simple matter to use the subroutines in a program. Here are a few things to keep in mind:

- You must first link to the library. In Interpreted BASIC, the line reads, LINK "AIOLIB". For Compiled BASIC or Extended BASIC, consult the programming manual for those languages.
- Most of the subroutines can be used simply by giving the program name followed by any parameters or arguments required.
- Parameters in which a value is returned from a subroutine must be initialized (assigned a value) before they can be used with the subroutines.

APPLICATIONS

Voltage Measurement

DC voltage measurement is the simplest use of the Analog Measurement Processor. There are many applications of dc voltage measurement. For example, many industrial sensors put out 0 to 5V to indicate 0% to 100% of the measured parameter.

To show you how to use the Analog Measurement Processor to measure dc voltage, you will be walked line-by-line through a sample BASIC program. You can then refer to the subroutine reference pages for more detailed programming information.

Required Components

Applications involving voltage measurement require the following option assemblies:

1752A-010	Analog Measurement Processor
Y1750	Termination Block With Cable

Sample Voltage Measurement Program

In this example we want to read the dc voltage from a fluid level sensor that we know outputs 0 to 5V. In a typical application we could write a program that watches for a certain fluid level and then sends an alarm message or takes an action when our fluid level is reached. In this example, however, we will deal only with setting up and taking the voltage reading from the sensor with the 1752A.

The following program reads the voltage of the sensor. The program assumes that the fluid level level sensor leads are hooked up to channel 3.

NOTE

Before running this program, the jumpers for channel 3 must be configured for voltage input. If channel 3 is configured to read current, the jumpers must be changed before proceeding. (See "Hardware Set-Up," earlier in this section.)

```
110  LINK "AIOLIB"
120  PR=0
130  AISET(3%, 1%, 1%, 1%, 1%)
140  AIREAD(3%, PR)
150  PRINT PR
160  END
```

The LINK statement in program line 110 causes the 1752A to load the AIOLIB Library from the System Disk into memory. This makes the library available for use in the program.

In line 120, we initialize the variable PR. Variables must be initialized before they are used in a subroutine. This variable will be used in line 140 to store the pressure transducer voltage reading returned by the subroutine AIREAD. We have chosen the name PR arbitrarily.

Line 130 calls AISET, the subroutine that sets up all the parameters for the analog input channel. Following AISET, the first parameter (3%) specifies which channel is affected (channel 3). The next parameters configure channel 3 as follows: single-ended input mode; read enabled; 10V range; no filter (i.e., only one reading is used for computing the running average). The percent signs are necessary because the subroutine requires that these parameters are integers.

In line 140 we cause the 1752A to get the present reading on channel 3. The reading is displayed to us after the program executes the PRINT statement in line 150.

See Also

For more information on voltage measurement, see the pages following the heading "Analog Input Subroutines." There are several more subroutines that can be used other than those used in the previous example. The reference page for each subroutine gives an example program showing how it is used.

Current Measurement

To show you how to use the Analog Measurement Processor to measure dc current, you will be walked line-by-line through a sample BASIC program. You can then refer to the subroutine reference pages for more detailed programming information.

Sensors are available that put out a current value proportional to the physical parameter being measured. This type of sensor usually sources a value of from 4 mA to 20 mA across its measurement range. One current range of the Analog Measurement Processor is optimized to measure current values within this range. The other current range allows you to measure values ranging from -65 mA to 65 mA, to accommodate non-standard sensors and other current measurement applications.

Required Components

Applications involving current measurement require the following option assemblies:

1752A-010	Analog Measurement Processor
Y1750	Termination Block With Cable

Sample Current Measurement Program

In this example we want to read the dc current from a pressure transducer, which we know puts out between 4 mA and 20 mA. In a typical application we could write a program that watches for a certain critical pressure, then sends an alarm message or takes other action when our pressure limit is reached. In this example, however, we will deal only with setting up and taking the current reading from the transducer with the 1752A.

The following program reads the current value from the pressure transducer. The program assumes that the high lead of the transducer is connected to the input of channel 6 and that low lead of the transducer is connected to the input of channel 7.

Note

Before running this program, the jumpers for channel 6 must be configured to measure current. If channel 6 is configured to measure voltage, the jumpers must be changed before proceeding. (See "Hardware Set-Up," earlier in this section.)

```
110  LINK "AIOLIB"
120  FL = 0
130  AISET(6%, 2%, 1%, 4%, 1%)
140  AIREAD(6%, FL)
150  PRINT FL
160  END
```

The LINK statement in program line 110 causes the 1752A to load the AIOLIB Library from the System Disk into memory. This makes the library available for use in the program.

In step 120, we initialize the variable FL. We have arbitrarily chosen FL as the variable in which the current value from the transducer is to be returned.

Step 130 calls AISET, the subroutine that sets up all the parameters for the analog input channel. The parameters following AISET configure the channel as follows: channel number 6; differential input mode (necessary for current measurement); read enabled; 4 to 20 mA range; no filter (i.e., only one reading is used for computing the running average). The percent signs are necessary because the subroutine requires that the parameters are integers. The 4 to 20 mA range returns the value as 0% to 100%. A negative percentage indicates a value between 0 and 4 mA.

In step 140 we cause the 1752A to get the present reading on channel 6. (The reading is differential, measured with respect to channel 7.) The reading is displayed when the program executes the PRINT statement in step 150.

See Also

For more information on current measurement, see the pages following the heading "Analog Measurement Subroutines." There are several more subroutines that can be used other than those used in the example. The reference page for each subroutine gives an example program showing how it is used.

Reading Multiple Channels

The AISCAN and AISCNI subroutines allow you to read multiple channels, or multiple sets of channels, with a single call. AISCAN and AISCNI are identical, except that AISCAN returns readings as scaled floating-point numbers, while AISCNI returns readings as unscaled integers. The readings returned by AISCAN and AISCNI are stored in a user-defined array.

Before calling AISCAN or AISCNI, you must use a DIM statement to declare a storage array variable. The variable must have a dimension greater than or equal to:

$$((\text{last} - \text{first} + 1) * \text{sets}) - 1 - (\text{sets} * \text{skipped})$$

where "first" and "last" are the channel numbers of the first and last channels to be read, "sets" is the number of sets of readings to be taken, and "skipped" is the number of channels skipped between first and last. If you are using AISCAN, the array must be a floating-point array; if you are using AISCNI, the array must be an integer array. You do not need to initialize the array, as the DIM statement automatically does that for you.

CAUTION

If the dimension of the array is less than required, memory may be overwritten, causing the program to fail.

Each set of readings consists of one scan from the first channel to the last channel, inclusive. Channels that are disabled (set to be skipped) are not read and no array element is used for these channnels. Each scan is stored in order in the array before the next set of readings is started. The first reading is put in array element 0; the second reading is put in element 1; the third reading is put in element 2; etc.

When using AISCNI, the integer returned must be multiplied by a scale factor to get the actual value. The scale factor for each range is as follows:

RANGE	REQUIRED SCALE FACTOR
10V	310 μV
1V	31.0 μV
65 mA	2.06667 μA
4 to 20 mA	2.06667 μA

Example programs can be found on the AISCAN and AISCNI reference pages, later in this section.

ANALOG MEASUREMENT PROCESSOR SUBROUTINES

The following pages present each of the subroutines in the AIOLIB library that control the Analog Measurement Processor. The subroutines are first summarized, arranged by function, and parameter conventions are described. The subroutines are then presented in reference page format, arranged alphabetically.

Error messages that might be returned from the subroutines are included in the corresponding reference pages. The error messages are collected together and explained in more detail following the reference pages.

Subroutine Summary

Every subroutine in the AIOLIB Library that applies to the Analog Measurement Processor is briefly described below. The subroutines are arranged here in three functional categories: Module Functions, Channel Functions, and Read Functions.

Module Functions

ADCAL	Enables or disables automatic self-calibration.
ADSTAT	Returns the status of the Analog Measurement Processor. Information returned includes the module's synchronization frequency and indicates whether the self-calibration feature is enabled or disabled.
ADSYNC	Sets the module's synchronization frequency and source.

Channel Functions

AIENBL	Selects whether an analog input channel is to be read or skipped.
AIFLTR	Selects the filter value for an analog input channel.
AIMODE	Sets up one analog input channel for single-ended or differential mode.
AIRNGE	Selects the range for an analog input channel.

AISET	Sets the following parameters for an analog input channel: single-ended or differential input mode, read enable or disable, range, and filter.
AISTAT	Gets the status of an analog input channel: single-ended or differential input mode; read enabled or disabled; range; and filter value.

Read Functions

AIREAD	AIREAD returns a reading for a specified analog input channel.
AISCAN	AISCAN returns a specified number of sets of readings in floating-point format.
AISCNI	AISCNI returns a specified number of sets of readings in integer format.

Parameter Conventions

The following conventions are used for parameters and variables:

- Parameters that are spelled out (such as board, channel, sync, and volt) can be either numeric values or variables in a program.

- Parameters that are two-character names (numbers or capital letters), and which are valid BASIC variables, are used to store values returned when a subroutine is called. These parameters must be variables.

- A percent sign following a parameter signifies an integer variable or constant. The lack of a percent sign signifies a floating-point variable or constant.

- A variable in which an AIOLIB subroutine returns a value (such as a reading or status information) must be initialized before the subroutine is called. A variable is initialized by being set equal to a value, such as 1.

Usage

BASIC: [CALL] ADCAL(board%,calibration%)

Description

This subroutine enables or disables the automatic self-calibration feature on the Analog Measurement Processor. Self-calibration is enabled on power-up or a cold start. When disabled, self-calibration is not performed so that time-critical measurements can be taken. Self-calibration must be enbled for the Analog Measurement Processor to meet its specifications.

Parameters

board	This parameter is the Analog Measurement Processor's board address. It must be between 0 and 3, inclusive.
calibration	This parameter enables or disables the automatic self-calibration feature. The value of calibration corresponds to the following states:

0	Self-calibration disabled
Nonzero	Self-calibration enabled

See Also

ADSTAT. Also see "Operating Notes" for a description of the self-calibration feature.

Example

The following BASIC program enables automatic self-calibration on the Analog Measurement Processor with board address 0.

```
100  LINK "AIOLIB"
110  ADCAL(0%, 1%)
120  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1503 The Analog Measurement Processor is not installed.
1504 Illegal Analog Measurement Processor board address.

ADSTAT
AIOLIB

Usage

BASIC: [CALL] ADSTAT(board%,SY%,CA%)

Description

This subroutine returns the Analog Measurement Processor synchronization mode and shows whether automatic self-calibration is enabled or disabled. ADSTAT returns the status as values which are stored in the corresponding variables (SY and CA). The variables must be initialized before ADSTAT is called.

Parameters

board This parameter is the Analog Measurement Processor's board address. It must be between 0 and 3, inclusive.

SY This variable is where the synchronization value is stored. The value of SY corresponds to the following synchronization modes:

0	Asynchronous mode
1	Synchronous to external signal (45-65 Hz)
2	Synchronous to external signal (360-520 Hz)
50	50 Hz synchronous (internal)
60	60 Hz synchronous (internal)
400	400 Hz synchronous (internal)

CA This variable is where the status of the self-calibration feature is stored. The value of CA corresponds to the following modes:

0	Self-calibration disabled
1	Self-calibration enabled

See Also

ADCAL and ADSYNC. Also see "Operating Notes" for a description of the self-calibration and synchronization features.

Example

The following BASIC program gets the status of the Analog Measurement Processor with board address 0 and prints the status on the screen.

```
100  LINK "AIOLIB"
110  SY% = 0 \ CA% = 0
120  ADSTAT(0%, SY%, CA%)
130  PRINT "Synchronization value = "; SY%; ",  Self-calibration status = "; CA%
140  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1503 The Analog Measurement Processor is not installed.
1504 Illegal Analog Measurement Processor board address.

Usage

BASIC: [CALL] ADSYNC(board%,sync%)

Description

This subroutine sets the synchronization mode of an Analog Measurement Processor. The Analog Measurement Processor defaults to the asynchronous mode on power-up or cold start. The external sync signal must be present to program the Analog Measurement Processor to the external sync mode.

Parameters

board This parameter is the Analog Measurement Processor's board address. It must be between 0 and 3, inclusive.

sync This parameter represents the synchronization mode of the Analog Measurement Processor as follows:

0	Asynchronous
1	Synchronous to external signal (45-60 Hz)
2	Synchronous to external signal (360-520 Hz)
50	50 Hz synchronous internal
60	60 Hz synchronous internal
400	400 Hz synchronous internal

See Also

ADSTAT. Also see "Operating Notes" for a discussion of synchronous and asynchronous readings.

Example

The following BASIC program step sets the Analog Measurement Processor with address 1 to synchronize readings internally at 50 Hz.

```
100  LINK "AIOLIB"
110  ADSYNC(1%,50%)
120  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1503 The Analog Measurement Processor is not installed.
1504 Illegal Analog Measurement Processor board address.
1508 Illegal parameter for the ADSYNC function.
1516 The external sync input is not present.

AIENBL
AIOLIB

Usage

BASIC: [CALL] AIENBL(channel%,enable%)

Description

This subroutine sets an analog input channel to be read or skipped. If the channel is set to be skipped, it is not read when using AISCAN or AISCNI. If AIREAD is used to read a channel that is set to be skipped, a warning is issued. When in the asynchronous mode, the channel will not be scanned by the Analog Measurement Processor if it is skipped. All channels are enabled on power-up or cold start.

Parameters

channel — This parameter represents the analog input channel number. The value of channel must be between 0 and 127, inclusive.

enable — This parameter sets the analog input channel to be read or skipped. The value of enable corresponds to the following states:

0	Skip
Nonzero	Read

See Also

AISCAN, AISCNI, AIREAD, AISET, AISTAT. Also see "Operating Notes" for a description of the synchronization modes and disabled channels.

Example

The following BASIC program sets analog input channel 17 to be read.

```
100  LINK "AIOLIB"
110  AI% = 17%
120  AIENBL(AI%, 1%)
130  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.

Usage

BASIC: [CALL] AIFLTR(channel%,filter%)

Description

This subroutine selects the degree of filtering for a specified analog input channel. The Analog Measurement Processor provides filtering by calculating a running average. The number of readings used for the running average is truncated to a power of two.

A slight delay occurs when a channel is programmed to a large filter value and then read immediately. The delay occurs because the Analog Measurement Processor must perform the (possibly large) number of readings specified for that filter value before the filtered reading is valid.

Parameters

channel — This parameter represents the analog input channel number. The value of channel must be between 0 and 127, inclusive.

filter — This parameter sets the degree of filtering by setting the number of readings used for computing the running average. Filter may be any integer between 0 and 255, inclusive. Zero and 1 are equivalent, giving a filter value of one reading. If the value is neither zero nor a power of two, a warning is issued saying the value has been truncated to a power of 2.

See Also

AISET, AISTAT. Also see "Operating Notes" for a description of the filter algorithm.

Example

The following BASIC program sets the number of readings used for the running average to 4 for analog input channel number 27.

```
100  LINK "AIOLIB"
110  FL% = 4%
120  AIFLTR(27%, FL%)
130  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1511 Illegal parameter for setting the filter of an analog input channel.
1515 (Warning) The filter value has been truncated to a power of two.

Usage

BASIC: [CALL] AIMODE(channel%,mode%)

Description

This subroutine selects either single-ended or differential input mode for an analog input channel. When you set a channel to the differential mode, the 1752A automatically selects an adjacent channel as the other side of the differential pair. Even-numbered channels use the next-higher channel as the low side of the differential pair. Odd-numbered channels use the next-lower channel as the low side of the differential pair.

When a channel is programmed from differential mode to single-ended mode and the range is set to one of the current ranges, the channel is automatically put in the 10V range.

Parameters

channel — This parameter represents the analog input channel number. The value of channel must be between 0 and 127, inclusive.

mode — This parameter sets the analog input channel to either single-ended or differential mode. The parameter value corresponds to the following modes:

1 Single-ended mode
2 Differential mode

See Also

AISET, AISTAT. Also see "Operating Notes" for a description of single-ended and differential modes.

Example

The following BASIC program sets up analog input channels 12 and 13 as a differential pair.

```
100  LINK "AIOLIB"
110  AIMODE(12%, 2%)
120  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1509 Illegal parameter for setting an analog input channel's input mode.
1524 (Warning) The analog input channel has been changed to the 10 volt range.

Usage

BASIC: [CALL] AIREAD(channel%,RE)

Description

This subroutine takes a reading from the specified analog input channel and returns the reading as a floating-point number in the variable RE. The variable must be initialized before the subroutine is called. The value returned is dependent on the range selected for that channel.

Parameters

channel — This parameter represents the analog input channel number. The value of channel must be between 0 and 127 inclusive.

RE — This is the variable where the reading is stored. It must be a floating-point variable. If a reading is out of range, a warning error message occurs, and the value 1 * 10**10 is stored in this variable.

See Also

AISCAN, AISCNI. Also see "Applications" for an explanation of voltage and current measurement.

Example

The following BASIC program prompts for a channel number on the display, reads that channel, and prints the reading on the screen.

```
100  LINK "AIOLIB"
110  FOR I% = 0% TO 31%
120  AISET(I%, 1%, 1%, 1%, 1%)
130  NEXT I%
140  PRINT "Enter channel to read (0-31)";
150  INPUT CH%
160  BR = 0
170  AIREAD(CH%, BR)
180  PRINT "Channel "; CH%; " = "; BR; "volts"
190  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1513 (Warning) The specified analog input channel has been disabled.
1514 (Warning) The input to an analog input channel is out of range.
1516 The external sync input is not present.
1520 Analog Measurement Processor has had an overspeed failure.
1521 Analog Measurement Processor configuration has be corrupted.
1522 Analog Measurement Processor has had a calibration error.
1523 Analog Measurement Processor has had a system error.
1525 Analog Measurement Processor does not respond.

Usage

BASIC: [CALL] AIRNGE(channel%,range%)

Description

This subroutine selects the voltage or current range of an analog input channel. If a channel is set to measure voltage, AIRNGE selects among the two voltage ranges. If a channel is set to measure current, AIRNGE selects among the two current ranges.

(Remember: Each input channel is set to measure current or voltage by setting a jumper on the board. To reconfigure a channel, see "Hardware Set-Up," earlier in this section. Also, when a channel is set to the current range, that channel is automatically put in the differential mode.)

Parameters

channel This parameter represents the analog input channel number. The value of channel must be between 0 and 127 inclusive.

range This parameter sets the range of an analog input channel.

1 10 volts
2 1 volt
3 65 mA
4 4 to 20 mA returned as 0 to 100%

See Also

AISET, AISTAT. Also see "Operating Notes" for a description of ranges.

Example

The following BASIC program sets the range of input channels 5 through 13 to the 10V range.

```
100  LINK "AIOLIB"
110  FOR I% = 5% TO 13%
120  AIRNGE(I%, 1%)
130  NEXT I%
140  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1507 (Warning) The analog input channel has been changed to differential mode.
1510 Illegal parameter for setting the range of an analog input channel.

Usage

BASIC: [CALL] AISCAN(first%,last%,set%,B1())

Description

This subroutine takes a specified number of sets of readings and stores them in an array. The array must be a BASIC floating-point array variable. The dimension of the array must be greater than or equal to:

$$((\text{last} - \text{first} + 1) * \text{sets}) - 1 - (\text{sets} * \text{skipped})$$

where "first" and "last" are the channel numbers of the first and last channels to be read, "sets" is the number of sets of readings to be taken, and "skipped" is the number of channels skipped between first and last.

CAUTION

If the dimension of the array is less than required, memory may be overwritten, causing the program to fail.

Each set of readings consists of one scan from the first channel to the last channel, inclusive. Channels that are disabled (set to be skipped) are not read. The first reading is put in array element 0; the second reading is put in element 1; the third reading is put in element 2; etc.

Parameters

first — This parameter sets the first analog input channel to be read. First must be between 0 and 127, inclusive, and must be less than or equal to the value for "last".

last — This parameter sets the last analog input channel to be read. Last must be between 0 and 127, inclusive, and greater than or equal to "first".

set — This parameter defines the number of sets of readings to be taken. The value of set must be greater than or equal to 0.

B1() — This is the array variable where the values of readings are stored. The array variable must be a floating-point array. Virtual arrays are not allowed. If a reading is out of range, a warning error message occurs, and the value 1 * 10**10 is stored in the array element for that reading.

See Also

AIREAD, AISCNI. Also see "Applications" for an explanation of voltage and current measurement.

Example

The following BASIC program takes three sets of readings from analog input channels 15 through 19 (skipping channel 17, which is disabled in line 130) and stores the readings in array elements B1(0) to B1(11). Then the values of the readings are printed in a table.

```
100  LINK "AIOLIB"
110  DIM B1(11)
120  FOR I% = 15% TO 19%
130  IF I% = 17% THEN AIENBL(I%,0%) ELSE AIENBL(I%,1%)
140  NEXT I%
150  AISCAN(15%,19%,3%,B1())
160  PRINT "Channel #", "1st Set", "2nd Set", "3rd Set"
170  PRINT "15", B1(0), B1(4), B1(8)
180  PRINT "16", B1(1), B1(5), B1(9)
190  PRINT "18", B1(2), B1(6), B1(10)
200  PRINT "19", B1(3), B1(7), B1(11)
210  END
```

The contents of the array after this example program runs is:

```
Channel   1st Set    2nd Set    3rd Set

15        B1(0)      B1(4)      B1(8)
16        B1(1)      B1(5)      B1(9)
18        B1(2)      B1(6)      B1(10)
19        B1(3)      B1(7)      B1(11)
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1512 Illegal parameter for the number of sets of readings to be taken.
1513 (Warning) The specified analog input channel has be disabled.
1514 (Warning) The input to an analog input channel is out of range.
1516 The external sync input is not present.
1519 First channel parameter is greater than last channel parameter.
1520 Analog Measurement Processor has had an overspeed failure.
1521 Analog Measurement Processor configuration has been corrupted.
1522 Analog Measurement Processor has had a calibration error.
1523 Analog Measurement Processor has had a system error.
1525 Analog Measurement Processor does not respond.

Usage

BASIC: [CALL] AISCNI(first%,last%,set%,AR%())

Description

This subroutine takes a specified number of sets of readings and stores them into a specified array. The array must be a BASIC integer array variable.

The readings returned are integers in the range of -32768 to 32767 and must be scaled by the user to give meaningful voltage or current values. The required scale factors are:

RANGE	REQUIRED SCALE FACTOR
10V	310 μV
1V	31.0 μV
65 mA	2.06667 μA
4 to 20 mA	2.06667 μA

The dimension of the integer array in which the readings are to be stored must greater than or equal to:

((last - first + 1) * sets) - 1 - (sets * skipped)

where "first" and "last" are the channel numbers of the first and last channels to be read, "sets" is the number of sets of readings to be taken, and "skipped" is the number of channels skipped between first and last.

CAUTION

If the dimension of the array is less than required, memory may be overwritten, causing the program to fail.

Each set of readings consists of one scan from the first channel to the last channel, inclusive. Channels that are disabled (set to be skipped) are not read. The first reading is put in array element 0; the second reading is put in element 1; the third reading is put in element 2; etc.

Parameters

first — This parameter sets the first analog input channel to be read. First must be between 0 and 127, inclusive, and must be less than or equal to the value for "last".

last — This parameter sets the last analog input channel to be read. Last must be between 0 and 127, inclusive, and greater than or equal to "first".

set This parameter defines the number of sets of readings to be taken. The value of set must be greater than or equal to 0.

AR() This is the array variable where the values of readings are stored. The array must be an integer array. Virtual arrays are not allowed. If an input is out of range, a warning error message occurs and the maximum value (32767) is stored in the array element for that reading.

See Also

AIREAD, AISCAN.

Example

The following BASIC program takes one set of readings from analog input channels 10 through 19 and the readings in array elements AR(0) through AR(9). The array elements are then scaled for the 10V range and printed.

```
100  LINK "AIOLIB"
110  DIM AR%(9)
120  FOR I% = 10% TO 19%
130  AIENBL(I%, 1%)
140  NEXT I%
150  AISCNI(10%, 19%, 1%, AR%())
160  FOR I% = 0% TO 9%
170  PRINT "Channel"; I%+10%; " = "; AR%(I%)*310E-6
180  NEXT I%
190  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1512 Illegal parameter for the number of sets of readings to be taken.
1513 (Warning) The specified analog input channel has been disabled.
1514 (Warning) The input to an analog input channel is out of range.
1516 The external sync input is not present.
1519 First channel parameter is greater than last channel parameter.
1520 Analog Measurement Processor has had an overspeed failure.
1521 Analog Measurement Processor configuration has been corrupted.
1522 Analog Measurement Processor has had a calibration error.
1523 Analog Measurement Processor has had a system error.
1525 Analog Measurement Processor does not respond.

Usage

BASIC: [CALL] AISET(channel%,mode%,enable%,range%,filter%)

Description

This subroutine sets all the parameters for the specified analog input channel. AISET sets all of the parameters that can be individually set by the subroutines AIMODE, AIENBL, AIRNGE, and AIFLTR.

The "range" parameter sets the channel's range. Either one of two voltage or current ranges may be selected. (Remember that each input channel is set to measure current or voltage by setting a jumper on the board. To reconfigure a channel, see "Hardware Set-Up," earlier in this section.) When a channel is programmed to one of the current ranges, that channel is automatically put in the differential mode.

The "mode" parameter sets the channel to either single-ended or differential input mode. When an even-numbered channel is set to the differential input mode, the next-higher channel becomes the low side of the differential pair. When an odd-numbered channel is set to the differential input mode, the next-lower channel becomes the low side of the differential pair.

When a channel is programmed from differential mode to single-ended mode and the range is set to one of the current ranges, the channel is automatically put in the 10V range.

The "enable" parameter sets a channel to be read or skipped. If a channel is set to be disabled (skipped), it is not read when using AISCAN or AISCNI. If AIREAD is used to read a disabled channel, a warning is issued. When the Analog Measurement Processor is in the asynchronous scanning mode, a channel that is set to be skipped is not scanned.

The "filter" parameter selects a filter value by setting the number of readings used in a running average. A slight delay occurs when a channel is programmed to a large filter value and then read immediately. The delay occurs because the Analog Measurement Processor must perform the (possibly large) number of readings specified for that filter value before the filtered reading is valid.

Parameters

channel This parameter represents the analog input channel number. The value of channel must be between 0 and 127, inclusive.

mode This parameter sets the analog input channel to either single-ended or differential mode. The parameter value corresponds to the modes as follows:

1 Single-ended mode
2 Differential mode

enable This parameter sets an analog input channel to be read or skipped. The value of enable corresponds to the following states:

0	Skip
Non zero	Read

range This parameter sets the range of an analog input channel. The value of range corresponds to the ranges as follows:

1 10 volts
2 1 volt
3 65 mA
4 4 to 20 mA, returned as 0 to 100%

filter This parameter sets the degree of filtering by setting the number of readings used for computing the running average. Filter may be any integer between 0 and 255, inclusive. Zero and 1 are equivalent, giving a filter value of one reading. If the value is neither zero nor a power of two, a warning is issued saying the value has been truncated to a power of two.

See Also

AIENBL, AIFLTR, AIMODE, AIRNGE, and AISTAT. Also see "Operating Notes" for a definition of ranges, filtering, single-ended and differential modes, and scanning.

Example

The following BASIC program sets up channel 7 as follows:

- Differential input mode (required for measuring current)
- Enabled (to be read, not skipped)
- 65 mA range
- Filter setting of 64 readings, which are used for computing the running average.

```
100  LINK "AIOLIB"
110  AISET(7%, 2%, 1%, 3%, 64%)
120  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.
1507 (Warning) The analog input channel has been changed to differential mode.
1509 Illegal parameter for setting the input mode of an analog input channel.
1510 Illegal parameter for setting the range of an analog input channel.
1511 Illegal parameter for setting the filter of an analog input channel.
1515 (Warning) The filter value has been truncated to a power of two.
1524 (Warning) The analog input channel has been changed to the 10 volt range.

Usage

BASIC: [CALL] AISTAT(channel%,MO%,EN%,RA%,FI%)

Description

This subroutine returns the current status of all parameters for a specified analog input channel. The subroutine returns the status by storing values in the corresponding variables (represented here as MO, EN, RA, and FI). These variables must be initialized before the subroutine is called.

Parameters

channel This parameter represents the analog input channel number. The value of channel must be between 0 and 127, inclusive.

MO This is the variable where the input mode will be stored. The value of MO identifies the channel as being in single-ended or differential mode as follows:

1 Single-ended
2 Differential

EN This variable is where the enable status is stored. Its value represents the skip or read status as follows:

0 Programmed to skip
1 Programmed to read

RA RA is the variable where the range is stored. The value of RA corresponds to the input ranges as follows:

1 10 volts
2 1 volt
3 65 mA
4 4 to 20 mA

FI This variable is where the number of readings used in the filter is stored. The value of FI is 1, 2, 4, 8, 16, 32, 64, or 128.

See Also

AIENBL, AIFLTR, AIMODE, AIRNGE, AISET. Also see "Operating Notes" for a definition of ranges, filtering, single-ended and differential modes, and scanning.

Example

This example gets the status of analog input channel number 7. The variables are initialized in line 110. The values of the variables are then used to print the configuration of the channel.

```
100   LINK "AIOLIB"
110   MO% = 0 \ EN% = 0 \ RA% = 0 \ FI% = 0
120   DIM A$(3)
130   A$(0) = "10 volt range"
140   A$(1) = "1 volt range"
150   A$(2) = "65 mA range"
160   A$(3) = "4 to 20 mA range"
170   AISTAT(7%, MO%, EN%, RA%, FI%)
180   PRINT "Channel 7: "
190   IF MO% = 1% THEN PRINT "single-ended", ELSE PRINT "differential",
200   IF EN% = 0% THEN PRINT "skipped", ELSE PRINT "enabled",
210   PRINT A$(RA% - 1%),
220   PRINT "filter = "; FI%
230   END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1505 The analog input channel is not installed.
1506 Illegal analog input channel number.

ERROR MESSAGE SUMMARY

This table provides an annotated list of all possible error messages that can be returned by the AIOLIB subroutines that control the Analog Measurement Processor. All of these errors are recoverable errors or warnings. See the Fluke BASIC Manual under "Errors and Error Handling" for a description of error types.

1500 AIOLIB software drivers have not been linked with FDOS.

Use the System Generation Utility program to link in the AIOLIB drivers.

1503 The Analog Measurement Processor is not installed.

The specified Analog Measurement Processor has not been assigned by the Address Switch on the module. See "Hardware Set-Up" to set the Address Switch.

1504 Illegal Analog Measurement Processor board address.

The value specified for the Analog Measurement Processor board address is not in the range of 0 to 3.

1505 The analog input channel is not installed.

The specified analog input channel is not within the range set by the Address Switch on the module. See "Hardware Set-Up" to set the Address Switch to the desired channel range.

1506 Illegal analog input channel number.

The value specified for the analog input channel is not in the range of 0 to 127.

1507 (Warning) The analog input channel has been changed to differential mode.

The analog input channel has been programmed to the current mode using AIRNGE or AISET and its mode was single-ended. Current ranges require the mode to be differential so the mode for that channel has been changed.

1508 Illegal parameter for the ADSYNC function.

The value passed to the ADSYNC function was not 0, 1, 2, 50, 60, or 400.

1509 Illegal parameter for setting the input mode of an analog input channel.

The value passed to the AIMODE or AISET functions was not a 1 or 2.

1510 Illegal parameter for setting the range of an analog input channel.

The value passed to the AIRNGE or AISET functions was not 1, 2, 3, or 4.

1511 Illegal parameter for setting the filter of an analog input channel.

The value passed to the AIFLTR or AISET functions was not between 0 and 255 inclusive.

1512 Illegal parameter for the number of sets of readings to be taken.

The value passed to the AISCAN or AISCNI functions specifying the number of sets of readings to be taken was less than zero. This parameter must be greater than or equal to zero.

1513 (Warning) The specified analog input channel has been disabled.

The analog input channel specified to be read has been programmed to be skipped. This error is given by AIREAD or by AISCAN and AISCNI when only one reading is requested.

1514 (Warning) The input to an analog input channel is out of range.

The voltage or current input to an analog input channel is outside the limits that the channel can measure. A value of 1 * 10E10 is stored in the variable for the out-of-range channel in AISCAN and AIREAD. The maximum integer value of 32767 is stored in the variable for the out-of-range channel in AISCNI.

1515 (Warning) The filter value has been truncated to power of two.

The filter value passed as a parameter to AIFLTR or AISET was not an even power of two (1, 2, 4, 8, 16, 32, 64, 128). The filter value has been truncated to the highest power of two that is less than the value of the parameter passed.

1516 The external sync input is not present.

The phase-locked loop on the Analog Measurement Processor cannot lock onto the external sync input signal. Check to ensure that the external sync input source is present and connected to the module.

1519 The first channel parameter is greater than the last channel parameter.

When reading multiple channels using the AISCAN and AISCNI functions, the first channel being read must be less than or equal to the last channel being read.

1520 Analog Measurement Processor has had an overspeed failure.

The Analog Measurement Processor has had a hardware or software failure. Power-down the system to reload the software drivers. If the failure persists, contact the local Fluke Technical Service Center for assistance.

1521 Analog Measurement Processor configuration has been corrupted.

The Analog Measurement Processor has had a hardware or software failure. Power-down the system to reload the software drivers. If the failure persists, contact the local Fluke Technical Service Center for assistance.

1522 Analog Measurement Processor has had a calibration error.

The Analog Measurement Processor has had a hardware or software failure. Power-down the system to reload the software drivers. If the failure persists, recalibrate the Analog Measurement Processor. If the Failure still persists, contact the local Fluke Technical Service Center for Assistance.

1523 Analog Measurement Processor has had a system error.

The Analog Measurement Processor has had a hardware or software failure. Power-down the system to reload the software drivers. If the failure persists, contact the local Fluke Technical Service Center for assistance.

1524 (Warning) The analog input channel has been changed to the 10 volt range.

The analog input channel has been programmed to single-ended using AISET or AIMODE when it was in a current range. Current measurements cannot be taken in the single-ended mode, so the range for that channel has been changed to voltage.

1525 Analog Measurement Processor does not respond.

The Analog Measurement Processor has had a hardware or software failure. Power down the system to reload the software drivers. If the failure persists, contact the local Fluke Technical Service Center for assistance.

CALIBRATION

The Analog Measurement Processor should be calibrated as described here every 90 days to ensure the board's accuracy. A calibration program shipped with the 1752A System Disk helps you complete this task.

The Analog Measurement Processor is calibrated by running the calibration program (CAL) on the 1752A System Disk. The program prompts you to measure two on-board reference voltages, which are nominally 6.95V and 0.695V, and enter the actual voltage readings via the 1752A keyboard. The calibration program stores these readings in nonvolatile memory. The Analog Measurement Processor uses the stored readings during its self-calibration cycles.

When you enter the voltage readings, the calibration program checks the values for validity. The program rejects the values if they are out of tolerance (an error message will appear). If you correctly enter the value of the reference and the error message still appears, the board is out of tolerance and needs to be repaired. In this case, refer to the 1752A Service Manual or contact the local Fluke Service Center (see the appendix for a list of Service Centers).

Before attempting to calibrate the Analog Measurement Processor, you must first enable writing to nonvolatile memory on the board. (The calibration procedure explains how.) Failure to enable writing to memory will cause an error message to appear on the screen when the calibration program is run.

Once the board is calibrated, you must remember to write-protect the nonvolatile memory. Failure to do so can alter firmware on the board, causing the board to malfunction.

Required Equipment

The following equipment is required to calibrate the Analog Measurement Processor:

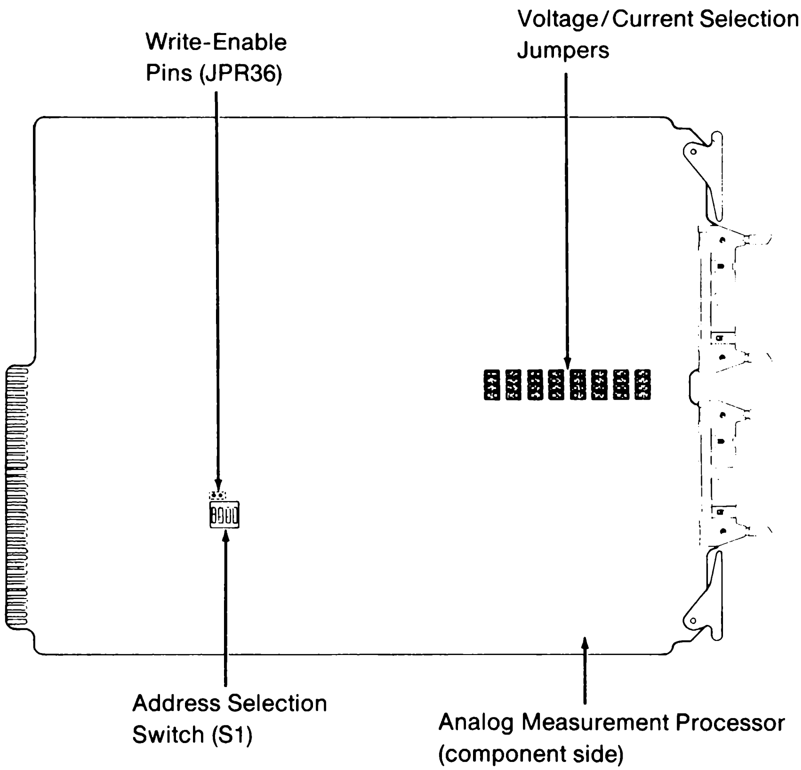
- 1752A Data Acquisition System
- 1752A System Disk
- Fluke 8840A Digital Multimeter or equivalent (with accuracy of $\pm 10\ \mu V$ or better)

Calibration Procedure

To calibrate the Analog Measurement Processor, proceed as follows:

1. Switch the 1752A power off.
2. Remove the Analog Measurement Processor from the 1752A (reverse the installation procedure presented earlier in this section).
3. Referring to the accompanying illustration, enable writing to the board's nonvolatile memory as follows:
   a. Close the write-enable switch (segment 1 of Address Selection Switch S1).
   b. Place any one of the voltage/current configuration jumpers over the write-enable pins (JPR36). JPR36 is located just above Switch S1.

CALIBRATION JUMPER LOCATION



4. Place the Analog Measurement Processor back into the 1752A.

5. Switch the Digital Multimeter (DMM) power on. Set up the DMM to measure voltage in the 20V range.

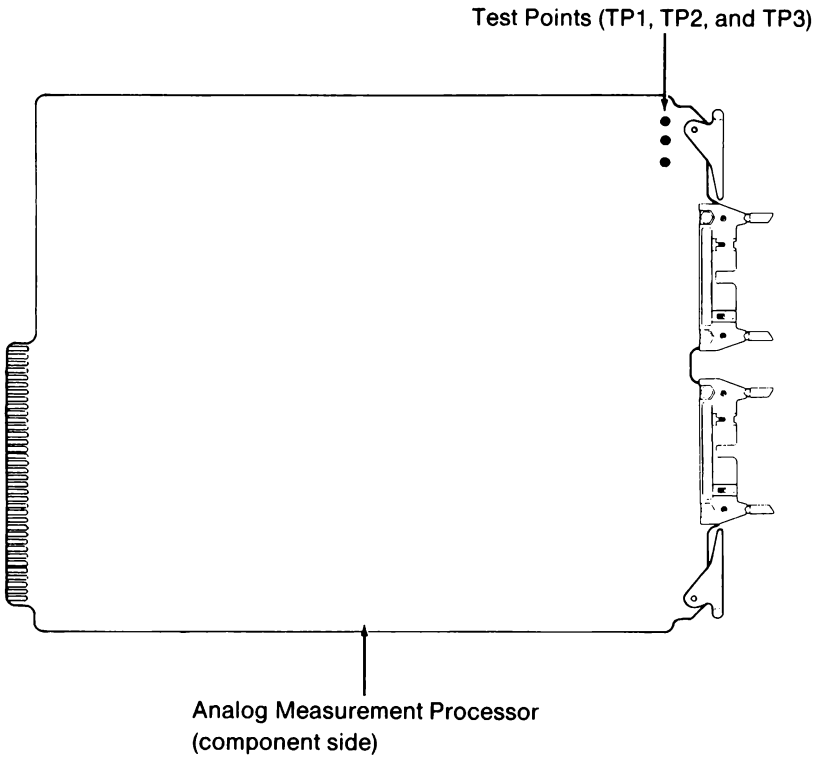
6. Switch the 1752A power On.

7. Enter FDOS (type ⟨CTRL⟩/p) and type the following from the 1752A keyboard, followed by the RETURN key:

   FDOS⟩ cal

8. Hook the + input lead of the DMM to TP2 and the - input lead to TP3. (See the accompanying illustration to locate the test points). Using the 1752A keyboard, enter the reading of the DMM to the nearest ± 100 μV following the 6.95V reference prompt.

TEST POINT LOCATIONS



9. Place the DMM in the 2V range. Hook the + input lead of the DMM to TP1 and the - input lead to TP3. Using the 1752A keyboard, enter the reading of the DMM to the nearest $\pm$ 10 μV following the 0.695V reference prompt.

10. Switch the 1752A power off.

11. Remove the Analog Measurement Processor.

12. Protect the board's nonvolatile memory as follows:

    a. Open the write-enable switch (segment 1 of Address Selection Switch S1).

    b. Remove the jumper from the write-enable pins (JPR36) and return the jumper to its original location with the other voltage/current configuration jumpers.

CAUTION

Failure to open the write-enable switch and return the jumper to its original location may cause the respective channel to malfunction and/or alter the board's firmware.

13. Reinstall the Analog Measurement Processor in the 1752A. This completes the calibration procedure.

Section 4
Analog Control

CONTENTS

INTRODUCTION

This section contains installation and programming instructions for the Analog Output module (Option 1752A-011). The section includes a description of the module, hardware set-up instructions, operating notes, introductory programming notes, sample applications, and a complete description of the analog output subroutines that are used to control the module.

A calibration procedure is provided at the end of this section. For troubleshooting and repair information, refer to the 1752A Service Manual.

GENERAL DESCRIPTION

The Analog Output module allows the 1752A Data Acquisition System to send programmable voltages or currents to external control points, under the control of a BASIC program or BASIC commands. The Analog Output module gives the 1752A the ability to control many kinds of devices and processes.

The Analog Output module has four fully-isolated, addressable output channels. By setting jumpers on the module, you can configure each output channel to output either voltage or current. When the jumpers are changed, the channel must be recalibrated using the calibration procedure provided at the end of this section. (The module can also be calibrated at a Fluke Technical Service Center.)

Output voltage from the Analog Output module is programmable over a -10.2375V to +10.2375V range, with a resolution of 2.5 mV. Current from the module can be programmed over a 0 to 20.475 mA range, with a resolution of 5 μA. Each channel is isolated from digital common and the other channels on the board (maximum 30V common mode).

Each Analog Output module is assigned a board address by setting switches on the module. The board address determines the channel numbers for the four outputs. An address selection procedure is provided in "Hardware Setup."

The Analog Output module is controlled by subroutines that can be called from programs written in BASIC. The subroutines are collected together in the AIOLIB library, which is supplied on the 1752A System Disk.

SPECIFICATIONS

Output Channels:	Four per module
System Capacity:	Two modules (eight channels per 1752A)
Configuration:	Each channel user-configurable for voltage or current. (Note: When changing configuration, the channel must be recalibrated.)
Update Rate:	1000 updates/sec
Slew Rate:	1.0V/μsec
Voltage Configuration	
Range:	±10.0 (±4095 counts at 2.5 mV per count)
Maximum Source Current:	±5 mA
Capacitive Load:	Will drive up to 10,000 pF without instability.
Output Protection:	All outputs are short-circuit protected.
Current Configuration	
Range:	0 to 20.0 mA (4095 counts at 5 μA per count)
Maximum Load:	750 ohms
Maximum External Voltage:	±24V
Compliance Voltage:	15V
Accuracy:	0.1% of full scale (90 days, 18°C to 28°C)
Isolation:	Outputs are isolated from each other and from ground up to 30V dc.
Compatible Connectors:	Fluke Option 2400A-110 Screw Terminal Connector or 2400A-111 Solder Pin Connector.
Mounting:	Plugs into the 1752A chassis.
Weight:	1.4 kg (3 lbs)

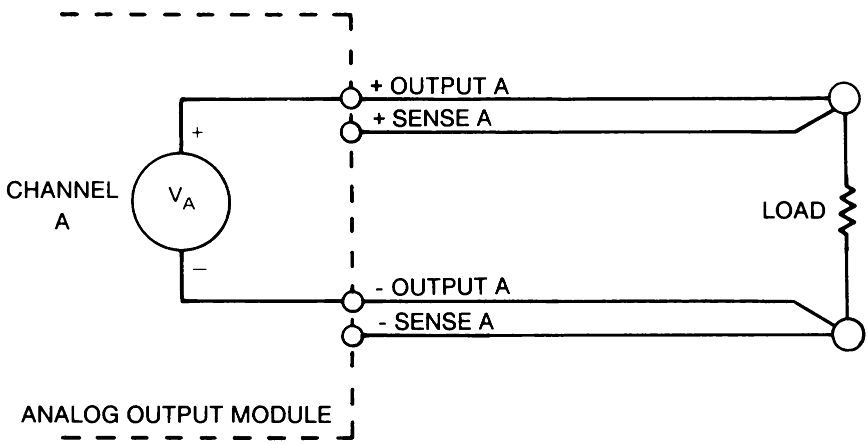
OPERATING NOTES

Channel Connections to Load

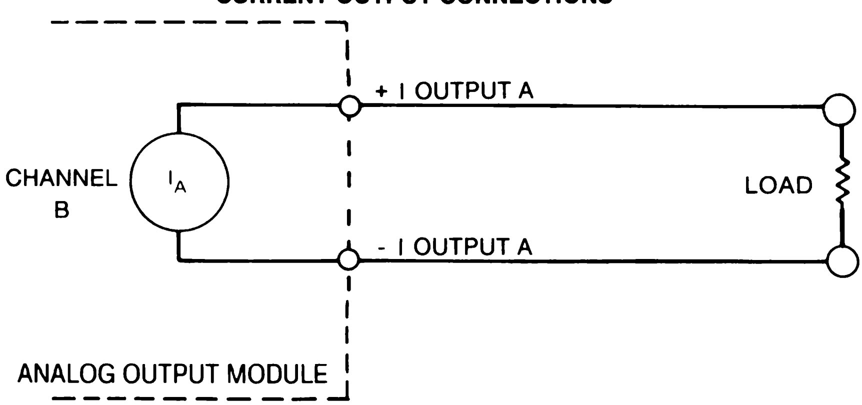
In voltage output mode, each channel has a four-wire connection to the load. Two wires carry the voltage output. The other two wires are for voltage sense measurement. The voltage sense lines eliminate errors introduced by wire resistance.

In the current output mode, two wires are connected for each channel: current source and current return.

VOLTAGE OUTPUT CONNECTIONS



CURRENT OUTPUT CONNECTIONS



Sense Line Connections

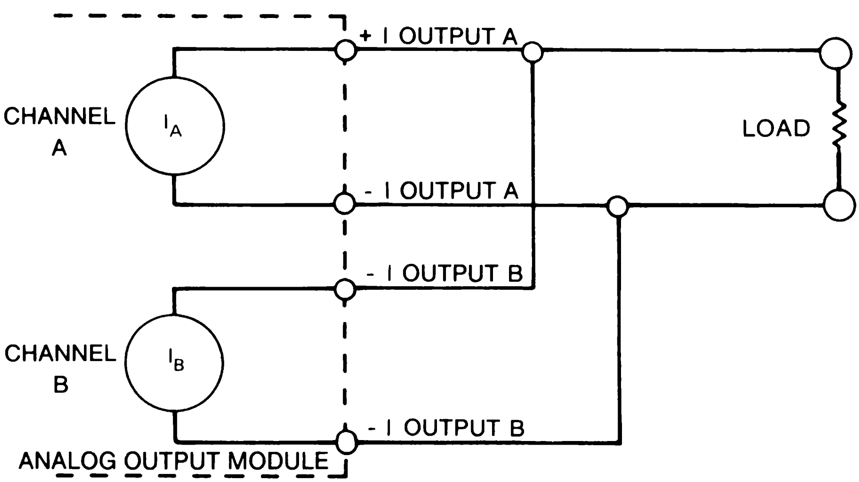
For maximum accuracy in voltage output applications requiring long wire runs, where resistance between output and load may be of concern, the voltage sense lines should be used. By connecting the positive and negative voltage output lines to the corresponding sense lines at the load, the Analog Output circuitry is allowed to adjust the output voltage to maintain the desired voltage level at the load. This procedure applies only to voltage outputs.

Where accuracy is not critical, the sense lines may be omitted.

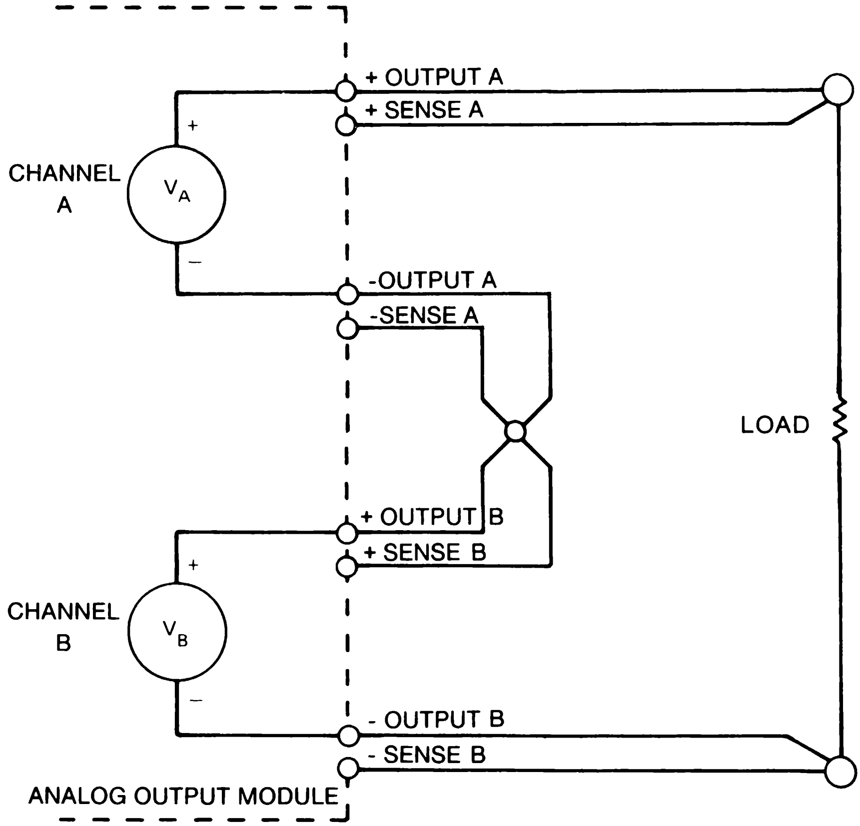
Output Range Doubling

Since the four output channels are isolated from each other, it is possible to obtain higher output values from the voltage outputs by connecting channels in series. As an example, consider connecting channels A and B in series to the load. If the POS output of B is connected to the NEG output of A, then the remaining two output lines can provide double the normal output range. In such a case, connecting the sense lines proceeds as described for a single output, except the POS sense line for channel B must be connected to the NEG sense line for channel A (see the next page). Current outputs may also be linked together to achieve a higher-than-specified output. By connecting two current outputs in parallel (see the figure below), the output current range may be doubled.

CURRENT OUTPUT RANGE DOUBLING



VOLTAGE OUTPUT RANGE DOUBLING



HARDWARE SETUP

If the Analog Output module is ordered at the same time as the 1752A, the module is installed in the instrument chassis at the factory. If the Analog Output module is ordered at a later time, it must be installed as described later in this section under the heading "Installation."

Before installing the Analog Output module, the board address must be selected and the configuration of each output channel must be checked, and changed if necessary. The following paragraphs describe these hardware configuration settings.

Board Address Selection

The 1752A may have up to two Analog Output modules, each with four addressable output channels. The output channels are labeled consecutively from 0 to 127.

The addresses are assigned by giving a "board address" to each module. The board addresses correspond to the channel numbers as follows:

Board address 0 = output channels 0 through 3

Board address 1 = output channels 4 through 7

Board address 2 = output channels 8 through 11

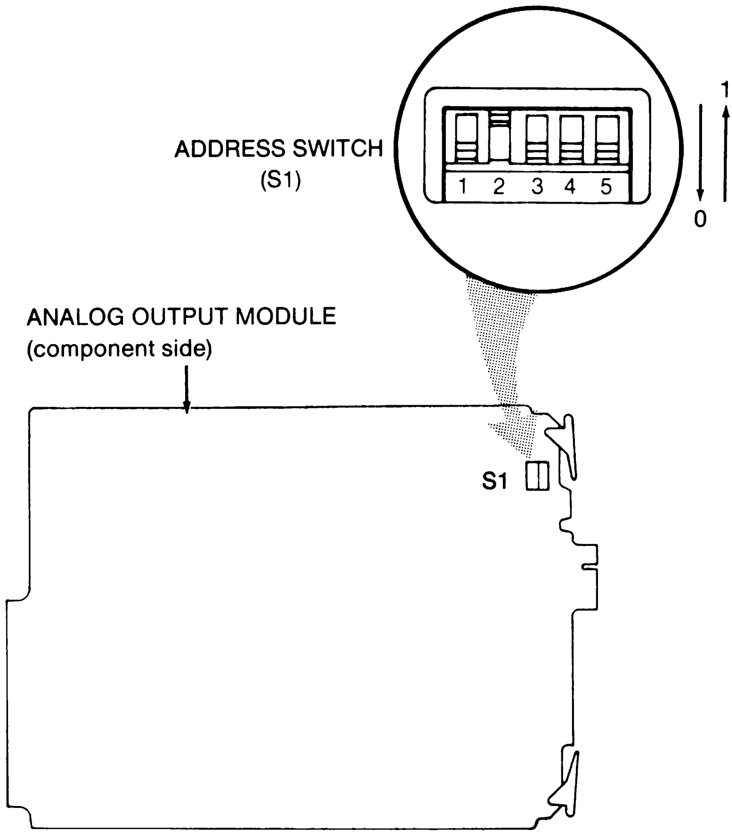
Board address 29 = output channels 116 through 119

Board address 30 = output channels 120 through 123

Board address 31 = output channels 124 through 127

The address is assigned by setting the Address Switch on the module. The location of the Address Switch is shown in the following figure. Normally, assign board address 0 to the first Analog Output module in the system, and address 1 for the second Analog Output module. The switch settings for each address are shown in the following table.

BOARD ADDRESS SELECTION



BOARD ADDRESS SWITCH SETTINGS

S1 SWITCH SETTING = X X X X X

LEFT = ONE, RIGHT = ZERO

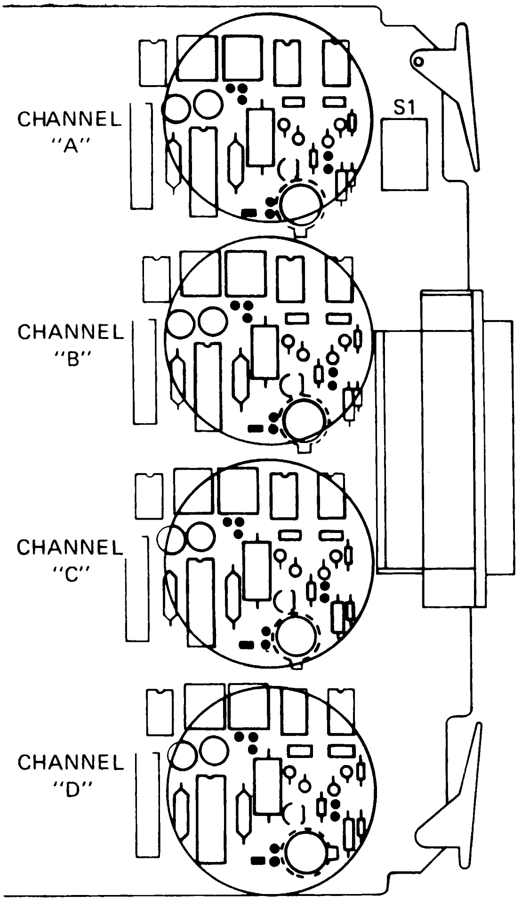
Board Address	Switch Segments					Analog Output channels (A, B, C, D) assigned:			
	B5	B4	B3	B2	B1	A	B	C	D
0	0	0	0	0	0	0	1	2	3
1	0	0	0	0	1	4	5	6	7
2	0	0	0	1	0	8	9	10	11
3	0	0	0	1	1	12	13	14	15
4	0	0	1	0	0	16	17	18	19
5	0	0	1	0	1	20	21	22	23
6	0	0	1	1	0	24	25	26	27
7	0	0	1	1	1	28	29	30	31
8	0	1	0	0	0	32	33	34	35
9	0	1	0	0	1	36	37	38	39
10	0	1	0	1	0	40	41	42	43
11	0	1	0	1	1	44	45	46	47
12	0	1	1	0	0	48	49	50	51
13	0	1	1	0	1	52	53	54	55
14	0	1	1	1	0	56	57	58	59
15	0	1	1	1	1	60	61	62	63
16	1	0	0	0	0	64	65	66	67
17	1	0	0	0	1	68	69	70	71
18	1	0	0	1	0	72	73	74	75
19	1	0	0	1	1	76	77	78	79
20	1	0	1	0	0	80	81	82	83
21	1	0	1	0	1	84	85	86	87
22	1	0	1	1	0	88	89	90	91
23	1	0	1	1	1	92	93	94	95
24	1	1	0	0	0	96	97	98	99
25	1	1	0	0	1	100	101	102	103
26	1	1	0	1	0	104	105	106	107
27	1	1	0	1	1	108	109	110	111
28	1	1	1	0	0	112	113	114	115
29	1	1	1	0	1	116	117	118	119
30	1	1	1	1	0	120	121	122	123
31	1	1	1	1	1	124	125	126	127

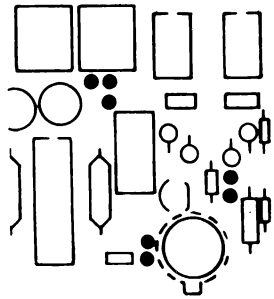
Voltage/Current Configuration

All four channels of the Analog Output module are configured as voltage outputs when shipped from the factory. Normally, a channel is reconfigured by Fluke service personnel at the factory, but the user can perform this task if he or she has access to the required equipment. (See the heading, "Calibration.")

To determine the configuration of each channel, examine the assembly. Looking at the component side of the printed circuit board, locate the jumpers shown in the following illustration. Compare the jumper locations to the detailed sections of the figure to identify channel configuration.

If you elect to change the channel configuration yourself, first move the jumpers according to the illustration. Once the output configuration of a channel is changed (from voltage to current or current to voltage), the channel must be recalibrated as described under "Calibration" to obtain the 0.1% accuracy listed in the specifications.





JUMPER LOCATION DETAIL

VOLTAGE

CURRENT

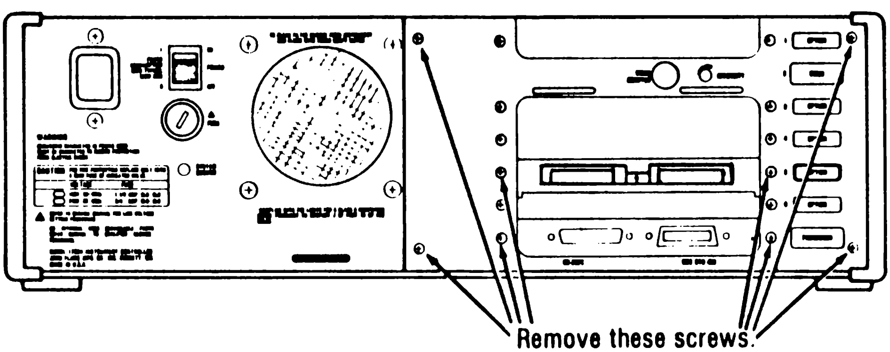
JUMPER CONFIGURATION

Installation

After reading and following the previous hardware setup instructions, the Analog Output module may be installed in the 1752A chassis. Use the following procedure:

1. Power down the 1752A and remove the line cord.

2. Remove the rear card cage cover, illustrated below. Depending on the number of options that may already be installed, more screws than those indicated may also have to be removed.



CAUTION

Handle the Analog Output module by its edges to avoid contaminating it with oil from the hands. The use of gloves is recommended.

3. Carefully slide the option module into slot 1, 4, or 5 in the card cage. Make sure the module is fully seated so that it makes solid contact with the card-edge connector.

NOTE

If you mount the Analog Output module in slots 4 or 5, the slot immediately above the module must remain empty. For that reason, it is recommended that slot 1 be used for the Analog Output module if possible.

4. Remove the cover plate from the corresponding slot on the card cage cover by removing the two screws.

5. Reinstall the card cage cover.

6. Thread the screws removed in step 4 through the card cage cover and into the shield plate surrounding the output connector.

Once installation is complete, the module can be tested by running the System Diagnostic as described in Appendix G of the 1752A System Guide. This program verifies that the module is properly installed and functioning.

CONNECTOR DESCRIPTION

Once installed in the 1752A, the Analog Output module is ready to be wired to external control points.

Pinouts

The four channels on the Analog Output module are available at the male 50-pin D-connector supplied with the option. This connector is permanently connected to the module. Pin assignments for the output connector are shown in the following table.

PIN ASSIGNMENTS

PIN	SIGNAL	PIN	SIGNAL
50	+ Voltage Output A	22	- Current Output C
49	- Voltage Output A	40	Test Point 26C
32	+ Voltage Sense A	41	Test Point 26C
31	- Voltage Sense A	6	Test Point 27C
17	+ Current Output A	9	Not Used
16	- Current Output A	1	+ Voltage Output D
47	Test Point 26A	2	- Voltage Output D
48	Test Point 26A	19	+Voltage Sense D
33	Test Point 27A	18	- Voltage Sense D
3	Not Used	35	+ Current Output D
12	+ Voltage Output B	20	- Current Output D
13	- Voltage Output B	36	Test Point 26D
28	+ Voltage Sense B	37	Test Point 26D
29	- Voltage Sense B	34	Test Point 27D
10	+ Current Output B	14	Not Used
27	- Current Output B	15	Not Used
44	Test Point 26B	21	Not Used
45	Test Point 26B	25	Not Used
11	Test Point 27B	26	Not Used
4	Not Used	30	Not Used
7	+ Voltage Output C	38	Not Used
8	- Voltage Output C	39	Not Used
23	+ Voltage Sense C	42	Not Used
24	- Voltage Sense C	43	Not Used
5	+ Current Output C	46	Not Used

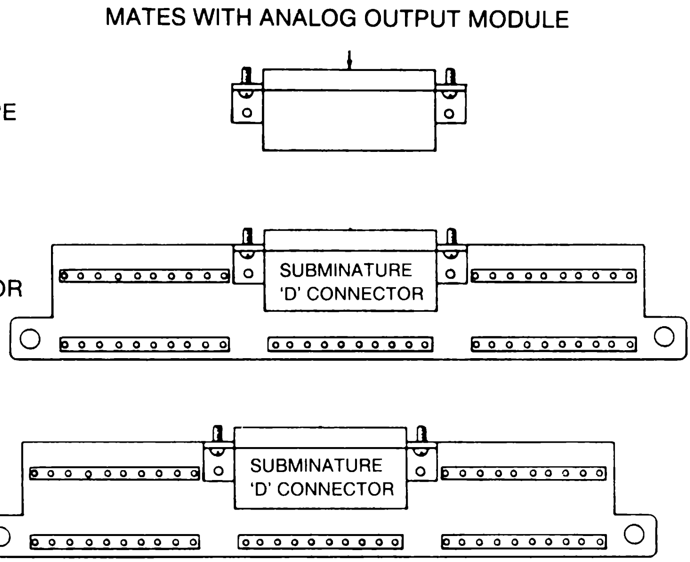
Connector Types

The output connector mates to either the Fluke Option 2400A-110 Screw Terminal Connector, the 2400A-111 Solder Pin Connector, or a commonly available 50-pin female subminiature D-type connector. These three choices are illustrated below.

50-PIN FEMALE
SUBMINIATURE D-TYPE
CONNECTOR

2400A-110 SCREW
TERMINAL CONNECTOR

2400A-111 SOLDER
PIN CONNECTOR



The 2400A-110 and 2400A-11 connectors provide numbered screw terminals or solder pins for convenient wire attachment. If only the female D-connector is used, external wiring must be soldered to the internal pins on the female connector.

GETTING STARTED

The Analog Output is controlled by BASIC subroutines that are supplied on the 1752A System Disk. You can call the subroutines from programs that you write in BASIC, or you can call the the subroutines directly by using Interpreted BASIC in the Immediate mode.

The subroutines are supplied on the 1752A System Disk in two forms: in the AIOLIB library, for use with Interpreted BASIC, and in BASIC.LIB, for use with Compiled BASIC or Extended BASIC.

It is a simple matter to use the subroutines in a program. Here are a few things to keep in mind:

- You must first link to the library. In Interpreted BASIC, the line reads, LINK "AIOLIB". For Compiled BASIC or Extended BASIC, consult the programming manual for those languages.
- Most of the subroutines can be used simply by giving the program name followed by any parameters or arguments required.
- Parameters in which a value is returned from a subroutine must be initialized (assigned a value) before they can be used with the subroutines.

APPLICATIONS

Voltage Output

The Analog Output module gives your 1752A system the ability to control devices that require a continuously variable voltage. These include such things as voltage-controlled power supplies, process controllers, 0V to 5V actuators, etc.

To show you how to use the Analog Output module to generate dc voltage outputs, you will be walked line-by-line through a sample BASIC program. You can then refer to the subroutine reference pages for more detailed programming information.

Required Components

Applications involving dc voltage outputs require the following option assemblies:

1752A-011	Analog Output module
2400A-110	Screw Terminal Connector
	(or)
2400A-111	Solder Pin Connector

The two connectors perform the same function. The difference is that the 110 allows you to attach external wires with a screwdriver, while the 111 allows you to solder external wires to the connector for positive electrical contact.

Sample Program: Generating a Voltage Output

The following BASIC program generates a voltage output of 6.2V on analog output channel 3. It is assumed that channel 3 is configured as a voltage output.

```
110  LINK "AIOLIB"
120  VT = 6.2
130  AOVLTG(3%, VT)
140  END
```

The LINK statement in line 110 causes the 1752A to load the AIOLIB Library from the System Disk into memory. This makes the library available for use in the program.

You can set the voltage output level in two ways. One way is to create a floating-point variable and assign to it the voltage you would like (between -10.2375V and 10.2375V). The other way is to enter the voltage directly in the function call. This program uses the first method; on line 120, the voltage we want to generate is arbitrarily defined as VT and given the value 6.2V.

On line 130, the subroutine is called to output the voltage VT. The first parameter (3%) identifies the channel where the output voltage is to be directed. The percent sign is necessary to define the parameter as an integer, which is required by the subroutine.

Current Output

The Analog Output module gives your 1752A system the ability to control devices that require a continuously variable current. These include such things as current-controlled power supplies, process controllers, 4 mA to 20 mA actuators, etc.

To show you how to use the Analog Output module to generate dc current outputs, you will be walked line-by-line through a sample BASIC program. You can then refer to the subroutine reference pages for more detailed programming information.

Required Components

Applications involving current outputs require the following option assemblies:

1752A-011	Analog Output Module
2400A-110	Screw Terminal Connector
	(or)
2400A-111	Solder Pin Connector

The two connectors perform the same function. The difference is that the 110 allows you to attach your wires with a screwdriver, while the 111 allows you to solder your wires to the connector for positive electrical contact.

Sample Program: Generating a Current Output

The following BASIC program generates a current output of 13.5 mA on analog output channel 2. It is assumed that channel 2 is configured as a current output.

```
110  LINK "AIOLIB"
120  AM = 0.0135
130  AOCRNT(2%, AM)
140  END
```

The LINK statement in program line 110 causes the 1752A to load the AIOLIB library from the 1752A System Disk into memory. This makes the library available for use in the program.

You can set the current output level in two ways. One way is to create a floating-point variable and assign to it the current you would like (between 0 and 20.475 mA). The other way is to enter the current directly in the function call. This sample program uses the first method: on line 120, the current we want to generate is arbitrarily defined as AM and given the value 13.5 mA.

On line 130, the subroutine is called to output the current AM. The first parameter (2%) identifies the channel where the output current is to be directed. The percent sign is necessary to define the parameter as an integer, which is required by the subroutine.

ANALOG OUTPUT SUBROUTINES

This subsection presents the subroutines in the 1752A AIOLIB Library that control the Analog Output module. After a summary of the subroutines and some notes about parameter conventions, the subroutines are described in detail in reference page format.

Error messages that might be returned for each subroutine are included on the respective reference pages. An annotated list of error messages follows the reference pages.

Subroutine Summary

AOVLTG	Outputs a dc voltage to a channel.
AOCRNT	Outputs a dc current to a channel.

Parameter Conventions

The following conventions are used for parameters and variables:

- Parameters that are spelled out (such as channel, amps, and volts) can be either numeric values or variables in a program.
- A percent sign following a parameter signifies an integer variable or constant, while lack of a percent sign signifies a floating-point variable or constant.

AOCRNT
AIOLIB

Usage

BASIC: [CALL] AOCRNT(channel%,amps)

Description

This subroutine outputs dc current to a channel. On power-up or a cold start all channels are set to 0. The channel must be configured to the current mode by jumpers.

Parameters

channel — The channel parameter represents the output channel number. It must be between 0 and 127, inclusive.

amps — Amps equals the value of the desired current output, expressed as a floating-point number between 0.0 and 0.020475 amperes, inclusive

See Also

AOVLTG. Also see "Applications" for current output information.

Example

The following BASIC program sets the output of Analog Output channel number 1 to 2.1 mA.

```
100  LINK "AIOLIB"
110  AOCRNT(1%,0.0021)
120  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1501 The analog output channel is not installed.
1502 Illegal analog output channel number.
1518 Illegal parameter for the AOCRNT function.

Usage

BASIC: [CALL] AOVLTG(channel%,volts)

Description

This subroutine outputs a dc voltage to a channel. On power-up or a cold start, all channels are set to 0. The channel must be configured to the voltage mode by jumpers. (See "Installation Notes.")

Parameters

channel	The channel parameter represents the output channel number. It must be between 0 and 127, inclusive.
volts	Volts equals the value of the desired output voltage, expressed as a floating-point number between -10.2375 and 10.2375 inclusive.

See Also

AOCRNT

Example

The following BASIC program sets Analog Output module channel number 1 to 3.97V.

```
100  LINK "AIOLIB"
110  AOVLTG(1%,3.97)
120  END
```

Possible Error Messages

1500 AIOLIB software drivers have not been linked with FDOS.
1501 The analog output channel is not installed.
1502 Illegal analog output channel number.
1517 Illegal parameter for the AOVLTG function.

ERROR MESSAGE SUMMARY

Listed below are all possible error messages that can be returned by the AIOLIB subroutines that control the Analog Output module. All of these errors are recoverable.

1500 AIOLIB software drivers have not been linked with FDOS.

Use the System Generation Utility program to link in the AIOLIB drivers.

1501 The analog output channel is not installed.

The specified analog output channel has not been assigned by the Address Switch on the module. See "Hardware Setup" to set the Address Switch.

1502 Illegal analog output channel number.

The value specified for the analog output channel is not in the range of 0 to 127.

1517 Illegal parameter for the AOVLTG function.

The value passed to the AOVLTG function was not in the range of 10.2375 to -10.2375.

1518 Illegal parameter for the AOCRNT function.

The value passed to the AOCRNT function was not in the range of 0 to 0.020475.

CALIBRATION

To obtain the specified accuracy, the following calibration procedures should be performed every 90 days and whenever the mode of a channel is changed from voltage mode to current mode or from current mode to voltage mode. There is a separate procedure for voltage mode and current mode; be sure to use the appropriate procedure.

Calibration service is available from Fluke Technical Service Centers. See the list of Service Centers in the appendix.

Required Equipment

The following equipment is required to calibrate a channel on the Analog Output module:

DESCRIPTION	RECOMMENDED MODEL/TYPE
Digital Multimeter	Fluke Model 8840A
Extender PCB	Fluke Accessory Y1704
I/O Connector	Fluke Option 2400A-110 or 2400A-111
100Ω Precision Resistor	Fluke Accessory Y2022 Divider

Voltage Mode Calibration Procedure

Once you have changed a channel to voltage mode, or after 90 days of operation, calibrate each voltage output channel using the following steps:

1. Switch the 1752A power off.

2. Remove the Analog Output module, install a pcb extender in the slot, then install the Analog Output module on the extender.

3. Switch on the 1752A power and insert the 1752A System Disk. The booting-up sequence sets all analog outputs to zero.

4. Allow a 20-minute warm-up period before continuing this procedure.

5. (Refer to the "Calibration Potentiometers and Test Points" figure.) Connect the DMM input leads to the appropriate test points listed in the "Zero Test Points and Adjustment Potentiometers" table for the channel being calibrated. Adjust the corresponding ZERO potentiometer for a DMM indication of 0.00 mV ± 0.05 mV.

6. Move the DMM connections to the VO- and VO+ output pins for the channel being calibrated. (Refer to the "Voltage Test Points and Potentiometers" table.) Adjust the appropriate OFFSET potentiometer listed in the "Voltage Test Points and Potentiometers" table for a DMM indication of 0.00 mV ± 0.1 mV.

7. Assuming the channel being calibrated is channel 3, enter the following immediate mode program steps, following each with the RETURN key, to set the channel output to 10.0V.

```
LINK "AIOLIB"
AOVLTG(3%, 10.0)
```

8. Adjust the appropriate FULL SCALE potentiometer listed in the "Voltage Test Points and Potentiometers" table to obtain a DMM indication of 10.000V ± 0.001V.

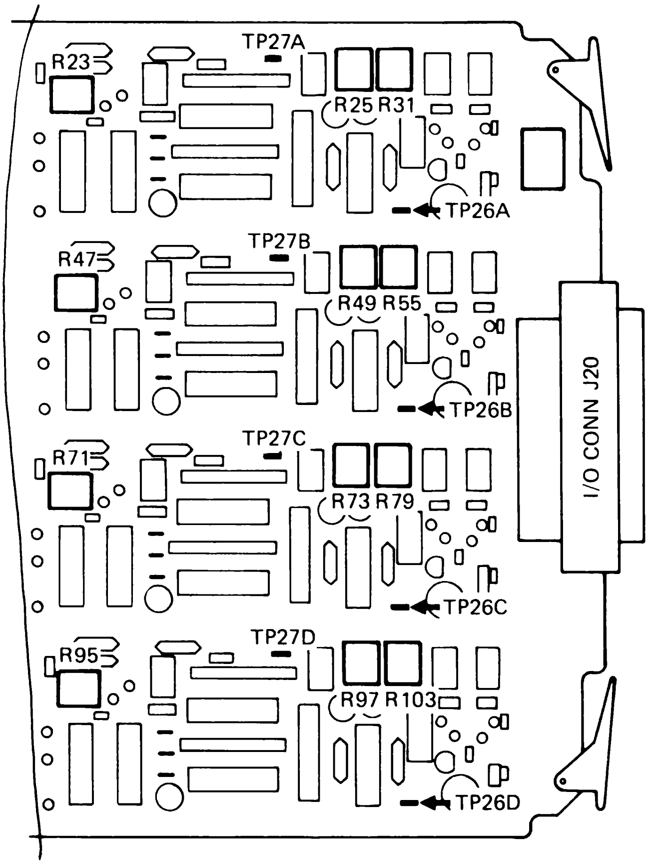
9. Enter the following step, followed by the RETURN key (again, assuming the channel being calibrated is channel 3):

```
AOVLTG(3%, -10.0)
```

10. Verify that the indication on the DMM is -10.000V ± 0.001V.

11. Repeat steps 5 through 10 for the remaining voltage output channels on the assembly. If no other calibration or testing is required, return the 1752A to normal service.

CALIBRATION POTENTIOMETERS AND TEST POINTS



ZERO TEST POINTS AND ADJUSTMENT POTENTIOMETERS

CHANNEL	+METER CONNECTION	-METER CONNECTION	POTENTIOMETER
A	J20, PIN 33 (TP27A)	J20, PIN 48 (TP26A)	R25
B	J20, PIN 11 (TP27B)	J20, PIN 44 (TP26B)	R49
C	J20, PIN 6 (TP27C)	J20, PIN 40 (TP26C)	R73
D	J20, PIN 34 (TP27D)	J20, PIN 36 (TP26D)	R97

VOLTAGE TEST POINTS AND POTENTIOMETERS

CHANNEL	POTENTIOMETER		OUTPUT CONNECTIONS
	OFFSET	FULL SCALE	
A	R31	R23	J20, PIN 49 (VO-) : J20, PIN 50 (VO+)
B	R55	R47	J20, PIN 13 (VO-) : J20, PIN 12 (VO+)
C	R79	R71	J20, PIN 8 (VO-) : J20, PIN 7 (VO+)
D	R103	R95	J20,PIN 2 (V0-) : J20, PIN 1 (V0+)

Current Mode Calibration Procedure

Once you have changed a channel to current mode, or after the end of 90 days of operation, calibrate each current output channel using the following steps:

1. Switch the 1752A power off.

2. Remove the Analog Output module, install a pcb extender in the chassis slot, then install the Analog Output module on the extender.

3. Switch the 1752A power on and insert the 1752A System Disk. The booting-up sequence resets all Analog Outputs to zero.

4. Allow a 20-minute warm-up period before continuing with this procedure.

5. Connect the DMM to the appropriate test points listed in the "Zero Test Points and Adjustment Potentiometers" table for the channel being calibrated.

6. Adjust the corresponding ZERO potentiometer to obtain a DMM indication of 0.00 mV ±0.05 mV.

7. Select the 200 mV range on the DMM, and connect the DMM to +S and -S terminals on the Y2022 Voltage Divider. Connect the +V and -V terminals of the Y2022 to the appropriate +I and -I pins for the channel being calibrated as listed in the "Current Test Points and Potentiometers" table.

8. Assuming that the channel being calibrated is channel 3, enter the following immediate mode steps, following each with the RETURN key:

```
LINK "AIOLIB"
AOCRNT(3%, 0.0)
```

9. Adjust the appropriate OFFSET potentiometer listed in the "Current Test Points and Potentiometers" table for a DMM indication of 200 μV ± 100 μV. The 200 μV indication corresponds to an output current of 2 μA.

10. Select the 2V range on the DMM.

11. Set the output to 19 mA by entering the following immediate mode commands, followed by the RETURN key (again, assuming that the channel under test is 3):

```
AOCRNT (3%, 0.019)
```

12. Adjust the FULL SCALE potentiometer for the channel being calibrated for a DMM indication of 1.9V $\pm$ 0.0001V. The 1.9V indication corresponds to 19 mA current output.

13. Repeat steps 5 through 12 for the remaining current output channels on the assembly. If no other calibration or testing is to be performed, return the 1752A to normal service.

CURRENT TEST POINTS AND POTENTIOMETERS

CHANNEL	POTENTIOMETER		OUTPUT CONNECTIONS
	OFFSET	FULL SCALE	
A	R31	R23	J20, PIN 16 (I-) : J20, PIN 17 (I+)
B	R55	R47	J20, PIN 27 (I-) : J20, PIN 10 (I+)
C	R79	R71	J20, PIN 22 (I-) : J20, PIN 5 (I+)
D	R103	R95	J20, PIN 20 (I-) : J20, PIN 35 (I+)

Section 5
Frequency Measurement

CONTENTS

INTRODUCTION

This section contains installation and programming instructions for the Counter/Totalizer (Option 1752A-012). The section includes a description of the module and its accessories, and provides operating notes, hardware set-up instructions, introductory programming notes, sample applications, and a complete description of the BASIC subroutines used to control the Counter/Totalizer.

For service information, refer to the 1752A Service Manual. The Counter/Totalizer does not require calibration.

GENERAL DESCRIPTION

The 1752A-012 Counter/Totalizer is a plug-in module that measures frequency and time, and totalizes with a gateable bidirectional totalizer. The different modes of operation are selected under software control.

The Counter/Totalizer provides several inputs, including two frequency and time measurement inputs, two gating inputs, one trigger input, and four totalizer inputs. All of the measurement inputs may include switch closures or logic levels except the analog input for frequency and time measurement; these inputs are not isolated from the 1752A or ground. The analog input for frequency and time measurement may be a periodic analog signal; this input is isolated from the 1752A and ground.

The Counter/Totalizer also provides an output, which indicates an overflow condition. This output is a logic level and is not isolated from the 1752A or ground.

Several features of the Counter/Totalizer assembly provide for system synchronization. Such features include external triggering, single versus continuous measurement cycling, presettable bidirectional two-quadrant gateable totalizing, logic-level gating, start-stop gating, and start-stop time measurement.

The Counter/Totalizer mounts in option slots 1, 4, or 5 in the 1752A chassis. The 12-contact, screw-terminal connector attached to the module provides connection for all nine inputs, one output, isolated common, and non-isolated common.

SPECIFICATIONS

NUMBER OF PCB ASSEMBLIES ...	2 Counter/Totalizer Modules per 1752A, maximum
NONISOLATED INPUTS	TTL Input, Gate 1, Gate 2, Trigger, $\overline{\text{Count Up}}$, $\overline{\text{Count Down}}$, Up / $\overline{\text{Down}}$, $\overline{\text{Count}}$, Common (Nonisolated).
ISOLATED INPUTS	Analog Input and Common (Isolated). These inputs are isolated in common from the 1752A and/or ground, up to 30V and 1.0 volt/microsecond maximum slew rate.
INPUT LOGIC	
Nonisolated Inputs	Pull-up resistors are installed to allow contact closures and logic levels as inputs.
Isolated Inputs (Analog Input)	Any periodic analog signal that satisfies signal level, frequency, duty cycle, and isolation requirements is allowed.
LOGIC LEVELS	All nonisolated inputs are low power Schottky inputs with static protection and a minimum of 400 mV of hysteresis. 0V to 0.5V for input low, 2.0V to 7V for input high.
OVERFLOW OUTPUT	
Output Isolation	The $\overline{\text{Overflow}}$ output is not isolated from the 1752A or ground.
Output Circuitry	Open - collector TTL output.
Maximum Sink Current	40 mA.
Output Voltage	
AT 40 mA SINK CURRENT	0.7V max
AT 16 mA SINK CURRENT	0.4V max
Maximum OFF-State Voltage	30V
TTL Compatibility	The output can drive up to six standard TTL loads or up to twelve low-power Schottky loads. An external pull-up resistor is not required.
FREQUENCY MEASUREMENTS	
Inputs	TTL Input, Analog Input, Trigger
Range	
NONISOLATED INPUT	0 to 900 kHz
ISOLATED INPUT	10 Hz to 200 kHz

Gate Times

1	3.277 ms
2	26.21 ms
3	209.7 ms
4	3.355 sec

Resolution

1	305 Hz
2	38.2 Hz
3	4.77 Hz
4	0.298 Hz

Accuracy .... ±1 count ± timebase accuracy

TIME MEASUREMENTS

Inputs .... TTL Input, Analog Input, Gate 1, Gate 2, Trigger

Range

NONISOLATED INPUT	
Fast Rate	1.2 μs to 6.7s (all)
Slow Rate	819 μs to 3.82 hr (G1, G2 only)
ISOLATED INPUT	2.5 μs to 50 ms pulse width or 5μs to 100ms period

Frequency Counted

FAST RATE	2.5 MHz (all)
SLOW RATE	1.221 kHz (G1, G2 only)

Resolution

FAST RATE	400 ns (all)
SLOW RATE	819 μs (G1, G2 only)

Accuracy .... ±1 count ± timebase accuracy ± trigger error of signal on input

TOTALIZE

Count Inputs .... $\overline{\text{Count Up}}$, $\overline{\text{Count Down}}$, $\overline{\text{Count}}$, Up / $\overline{\text{Down}}$

Gate Inputs .... Gate 1, Gate 2

Range .... DC to 900 kHz

Capacity .... -8,388,608 to +8,388,607

ANALOG INPUT SENSITIVITY

Sinewave

10 Hz to 100 kHz	50 mV rms
100 kHz to 200 kHz	100 mV rms
Pulse	150 mV with minimum pulse width of 2.5 μs. 5% $<$ duty cycle $<$ 95%.

ANALOG INPUT IMPEDANCE

Nonlimiting .... 10 megohm, ≤50 pF

Limiting .... 1.2 megohm in parallel with 47 pF

TIMEBASE

Frequency .... 10.000 MHz

Accuracy .... ±50 ppm

NONISOLATED INPUT TIMING .... See timing diagram

Trigger Input

TRIGGERABLE MODES .... Frequency, Time

PULSE WIDTH (Tpw) .... 100 ns min.

Input Debouncing

INDIVIDUALLY DEBOUNCEABLE INPUTS (SWITCH SELECTABLE) ...... $\overline{\text{Count}}$, $\overline{\text{Count Up}}$, $\overline{\text{Count Down}}$, Gate 1, Gate 2

INPUT PULSE WIDTH TO CHANGE STATE (Tip) .... 15 ms min.

BOUNCE PULSE WIDTH (Tbp) . 10 ms max.

Measurement Input Timing (All Debouncers Off)

APPLICABLE INPUTS .... TTL Input, Gate 1, Gate 2, $\overline{\text{Count}}$, $\overline{\text{Count Up}}$, $\overline{\text{Count Down}}$, Trigger

INPUT PULSE WIDTH EXCEPT TRIGGER (Tpw) ...... 500 ns min.

TRIGGER SET-UP TIME IN TIME MODES (TTRsu) .... 1.0 μs minimum to guarantee that the period or time interval immediately following the trigger is the one measured.

GATE 1- TO -GATE 2 OR GATE 2- TO -GATE 1 SEPARATION (TGGsep) .... 500 ns minimum to guarantee that the positive edge of one input is recognized as occurring before the other.

GATE TO COUNT OR COUNT TO GATE SEPARATION (TGCsep) .... 1.0 μs minimum to guarantee that count pulses are totalized after the gate enables the totalizer and not before, and that count pulses are totalized before the gate disables the totalizer and not after.

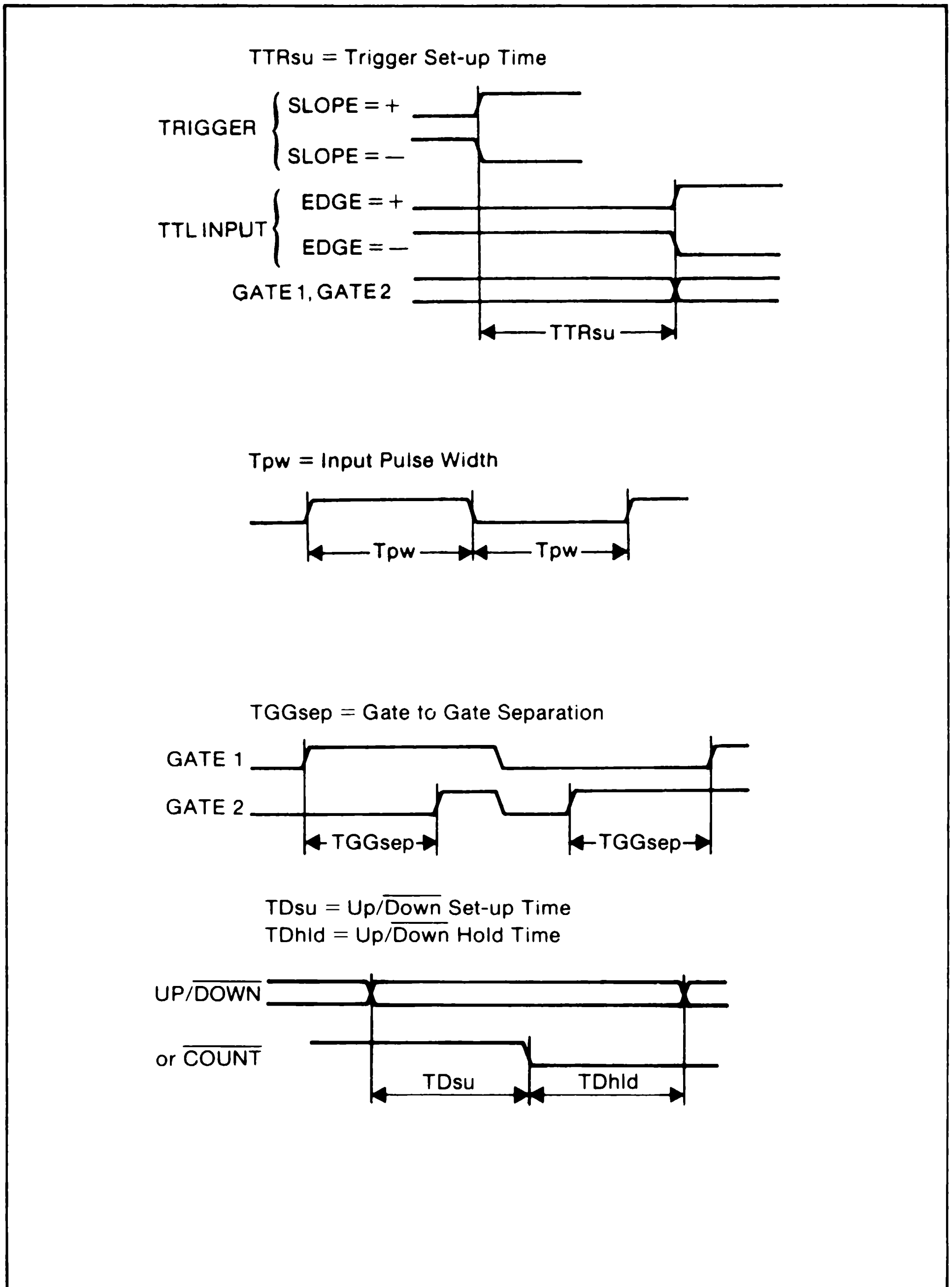
UP/DOWN INPUT STABLE SET-UP (TDsu) .... 0 ns minimum prior to Count.

UP/DOWN INPUT STABLE HOLD (TDhld) .... 1.0 μs minimum after Count.

POWER CONSUMPTION .... 12 watts typical per PCB assembly added to the system.

WEIGHT .... 0.4 kg (1.0 lb)

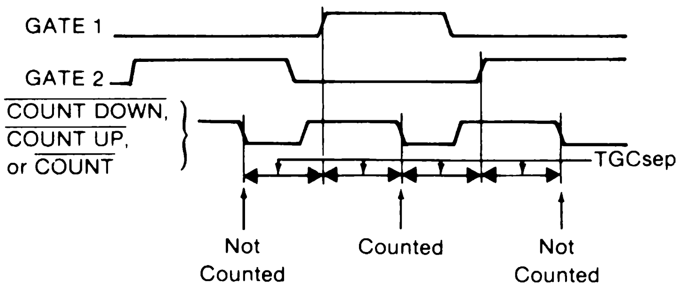
NON-ISOLATED INPUT TIMING



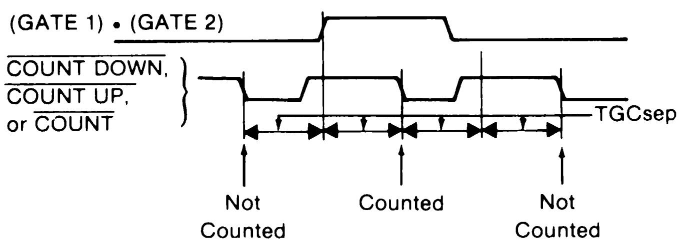
NON-ISOLATED INPUT TIMING (CONT)

TGCsep = Gate to Count/Count to Gate Separation

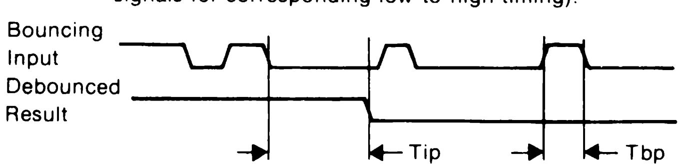
Case 1 : GATE = G1 TO G2



Case 2 : GATE = G1 AND G2



Tbp = Bounce Pulse Width
Tip = Change State Pulse Width
(shown for a high-to-low input transition, invert signals for corresponding low-to-high timing).



OPERATING NOTES

The Counter/Totalizer can be viewed as having three distinct and functionally different measurement modes: totalizing, time measurement, and frequency measurement. Each of the measurement modes share some inputs and the single output. The following table lists each of the measurement modes and shows their inputs, outputs, and applicable subroutines. The Counter/Totalizer is programmed to any of the measurement modes by software. Only one type of measurement may be performed at a time.

MEASUREMENT MODES

MEASUREMENT MODE	MEASURED INPUTS	SHARED INPUTS AND OUTPUTS	APPLICABLE SUBROUTINES
Totalizer	$\overline{\text{Count Up}}$ $\overline{\text{Count Down}}$ $\overline{\text{Count}}$ Up/$\overline{\text{Down}}$ Gate 1 * Gate 2 *	$\overline{\text{Overflow}}$ Common (Non-isolated)	CTTOTL CTTRCF CTTRGR CTRDY CTREAD CTSCAN
Frequency Measurement	TTL Input Analog Input Common (isolated)	$\overline{\text{Overflow}}$ Common (Non-isolated) Trigger	CTTIME CTTRCF CTTRGR CTMODE CTRDY CTREAD CTSCAN
Time Measurement	TTL Input Analog Input Common (isolated) Gate 1 Gate 2	$\overline{\text{Overflow}}$ Common (Non-isolated) Trigger	CTTIME CTTRCF CTTRGR CTMODE CTRDY CTREAD CTSCAN
* Gate 1 and Gate 2 are used for gated totalizing.			

Totalizer Mode

While totalizing, the TTL input, analog input, and trigger input have no effect. When the totalizer is enabled, a negative transition (falling edge) on a count input to the bidirectional totalizer causes it to either increment or decrement.

Count Up and Count Down Inputs

A negative transition at the Count Up input (terminal 7) causes the totalizer to increment once. A negative transition at the Count Down input (terminal 8) causes the totalizer to decrement once. Positive transitions and simultaneous negative transitions at both Count Down and Count Up have no effect on totalizer count.

Count and Up/Down Inputs

The Up/Down input (terminal 9) determines whether a negative transition on the Count input (terminal 10) will increment or decrement the totalizer value. That is, if Up/Down is high when a negative transition at the Count input occurs, the totalizer will increment once. Conversely, if Up/Down is low during the negative transition at the Count input, the totalizer will decrement once. Positive transitions at the Count input and any legal transitions at the Up/Down input have no effect on the accumulated total. The Up/Down input should be stable during a negative edge at the Count input.

Count Up and Count Down Inputs versus Count and Up/Down Inputs

The Count Up and Count Down inputs form a bidirectional counting pair; the Count and Up/Down inputs form another pair. The two counting pairs are not intended to be used simultaneously. If only one pair is to be used, the unused pair is left unconnected. If both pairs are to be used at different times, care must be taken to observe the following rules:

- If the Count Up and Count Down inputs are being used, the Count input must be high or unconnected. The Up/Down input has no effect.

- If the Count and Up/Down inputs are being used, both Count Up and Count Down must be high or unconnected.

Gated Totalizing

The totalizer can be enabled and disabled by external events applied to the Gate 1 (terminal 4) and Gate 2 (terminal 5) inputs or by software control. Either the levels or the transitions applied to these inputs are significant, depending on the mode selected. External gating can be disabled such that the Gate 1 and Gate 2 inputs have no effect on totalizer operation.

Gate 1 to Gate 2 Operation

During Gate 1 to Gate 2 totalizer operation, transitions at Gate 1 and Gate 2 inputs are significant. A positive transition at the Gate 1 input is interpreted as the start signal, and a positive transition at the Gate 2 input is interpreted as the stop signal. If the totalizer is disabled, a positive transition at the Gate 1 input enables the totalizer. If the totalizer is enabled, a positive transition at Gate 2 input disables the totalizer. Positive transitions at the Gate 1 input with the totalizer enabled, positive transitions at the Gate 2 input with the totalizer disabled, and negative transitions at either the Gate 1 or Gate 2 input have no effect on operation.

Gate 1 and Gate 2 Operation

During Gate 1 and Gate 2 totalizer operation, the levels at the Gate 1 and Gate 2 inputs are significant. The totalizer is enabled when both inputs are made logic high or left unconnected. The totalizer is disabled when either the Gate 1 or Gate 2 input is made logic low.

Gate 1 and Gate 2 Disabled

If external gating is disabled, the Gate 1 and Gate 2 inputs have no effect on totalizer operation. If the Gate 1 and Gate 2 inputs are not used for totalizer gating, they can be used as inputs to time external events. (See "Time Measurement Mode," later in this section.) This mode also makes it possible to gain information on the effect that external gating has on the totalizer for a given process.

Software Gating

The totalizer can be disabled by software by calling the function CTTRCF and specifying the software trigger. Any other trigger type has no effect. The totalizer can then be enabled by calling the CTTRGR function. Calling CTTRGR with the totalizer enabled or CTTRCF with the totalizer disabled has no effect.

Input Debouncing

Debouncing eliminates the risk of counting mechanical contact bounces when totalizing contact closures. A reading is debounced by waiting for a minimum pulse width after each input transition to reject the contact bounce pulses. At the end of the timing pulse the input is accepted as having changed states. The following inputs can be individually selected for debouncing: Count, Count Up, Count Down, Gate 1, and Gate 2.

Debouncing selection is made by locating the debounce enable switches and setting them as desired according to the following table. To locate Switch S1 on the Counter/Totalizer, refer to "Setting the Board Address," later in this section.

INPUT DEBOUNCING SWITCH SETTINGS

UP = ON, DOWN = OFF S1 Switch Settings		
NUMBER	**LABEL**	**INPUT DEBOUNCED**
S1-1	CD	$\overline{\text{Count Down}}$
S1-2	CU	$\overline{\text{Count Up}}$
S1-3	G1	Gate 1
S1-4	G2	Gate 2
S1-5	C	$\overline{\text{Count}}$

Frequency Measurement Mode

In the frequency measurement mode, the Counter/Totalizer counts input pulses during a specified gate time (four software-selectable gate times are provided). Both the TTL input and the analog input are available for frequency counting. During operation in the frequency measurement mode, the trigger input can be used to trigger new measurements. (The Trigger input is described under the heading "Trigger Input.")

In the frequency measurement mode, the Overflow output goes low when the measurement overflows, and stays low until the next measurement is initiated. (In the frequency measurement mode, the Count, Up/Down, Count Up, Count Down, Gate 1, and Gate 2 inputs have no effect on operation.) The default mode on power-up is the frequency measurement mode with a 3.277 msec gate time.

Time Measurement Mode

In the time measurement mode of operation, the Counter/Totalizer measures the interval between two transitions on the TTL or analog input signals, or two events on the Gate 1 and Gate 2 inputs. During time measurement, signals applied to the Count, Up/Down, Count Up, and Count Down inputs have no effect on operation.

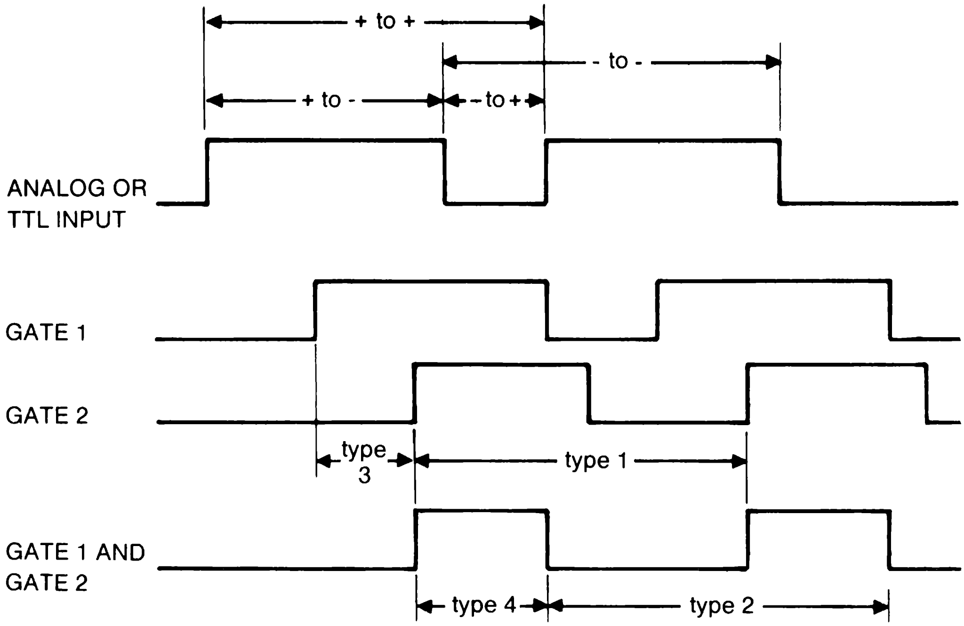
Analog and TTL Inputs

When performing time measurements on the analog or TTL inputs, the counter chain measures the interval between successive transitions of the selected input. (See the accompanying "Time Measurement Timing Diagrams.") The polarity of the transitions can be selected from four combinations:

Rising edge to rising edge
Falling edge to falling edge
Rising edge to falling edge
Falling edge to rising edge

Selecting one of these combinations allows you to measure any pulse width or period within the Counter/Totalizer specifications.

TIME MEASUREMENT TIMING DIAGRAM



Gate Inputs

When performing time measurements on the Gate inputs, four types of measurements may be made. (See the previous "Time Measurement Timing Diagram.")

Type 1 measures the time between positive transitions on the Gate 2 input. The positive transitions need not be successive because the start and stop transitions on Gate 2 must each be enabled by a positive transition on the Gate 1 input. This type of measurement is first enabled with a positive transition on the Gate 1 input. Further positive transitions on the Gate 1 input have no effect until a positive transition on Gate 2 occurs. This positive transition at the Gate 2 input starts the measurement. Another positive transition on Gate 1 is required before the measurement can be completed. After this positive transition on Gate 1, the next positive transition on Gate 2 stops the measurement. The time measured is the time between the positive transitions on the Gate 2 input, but these two positive transitions must each be enabled by a positive transition on the Gate 1 input.

Type 2 measures the time between successive negative transitions of the logical AND of the Gate 1 and Gate 2 inputs. The measurement is started with a negative transition on either Gate 1 or Gate 2 (i.e., when the logical AND of the signals on the Gate 1 and Gate 2 inputs becomes false). Note that both inputs must have been made high at the same time to initiate the measurement. Both inputs must be made high at the same time again to prepare for the measurement to be terminated. The measurement is terminated when either Gate 1 or Gate 2 goes low after both inputs have been high at the same time. This measurement is used to measure the period of the logical AND of the Gate 1 and Gate 2 inputs.

Type 3 measures the time between successive positive transitions on the Gate 1 and Gate 2 inputs. The measurement is started by a positive transition on the Gate 1 input. The measurement is terminated by the next positive transition on the Gate 2 input. The measurement may be performed with either a fast-rate clock or a slow-rate clock to measure long or short times.

Type 4 measures the logical AND of the Gate 1 and Gate 2 inputs. The measurement is started when both Gate 1 and Gate 2 inputs are made high. The measurement is completed when either Gate 1 or Gate 2 goes low. This measurement may also be performed with either a fast-rate clock or a slow-rate clock to measure long or short times.

Triggering Time and Frequency Measurements

Time and frequency measurements are generally triggered in two steps. First, you select a trigger configuration using the subroutine CTTRCF and select whether single or continuous measurements are going to be made, using the subroutine CTMODE. Then, a measurement is triggered with the external trigger input, a software trigger, or by an internal, continuous trigger.

How a measurement is triggered depends whether you have selected the single measurement mode or the continuous measurement mode. (The two modes are selected using the subroutine CTMODE.)

Triggering in the Single-Measurement Mode

The purpose of the single-measurement mode is to be able to take a measurement started by one of the triggers, and then read that particular measurement. Additional measurements will not be started by subsequent triggers until the trigger has been re-enabled.

Triggering is enabled or re-enabled by calling the subroutine CTTRCF with the software or external trigger. If CTTRCF is set for no trigger, triggering is disabled. CTTRCF also lets you select between the rising and falling edge of the external trigger input.

Once triggering is enabled, a measurement is triggered by the external trigger input or by the software trigger (i.e., by executing the subroutine CTTRGR). When no trigger is set, software or external triggers have no effect.

The subroutines CTREAD and CTSCAN effect triggering in the following way:

- They trigger a measurement if CTTRCF is set to software trigger or no trigger, and a measurement has not been made.

- They enable the trigger if CTTRCF is set to hardware trigger.

After the measurement is completed, triggering is left enabled. See the reference pages for CTREAD and CTSCAN (later in this section) for more information about these subroutines.

Triggering in the Continuous Measurement Mode

In the continuous measurement mode, triggering is always enabled. The type of trigger enabled depends on the selection made using subroutine CTTRCF. Therefore, before you trigger a measurement, you must first select the type of trigger you want using the subroutine CTTRCF.

- If CTTRCF is set for external trigger input, the external trigger input is always enabled and the software trigger is disabled. A measurement is triggered by applying the appropriate voltage to the external trigger input.

- If CTTRCF is set for software trigger, the software trigger is enabled and hardware triggers are disabled. To trigger a measurement, call subroutine CTTRGR.

- If CTTRCF is set for no trigger, the Counter Totalizer is continuously triggered by an internal, automatic trigger. In this case, both hardware and software triggers are disabled.

Note that subroutines CTREAD and CTSCAN will trigger a measurement if CTTRCF is set for software trigger and a measurement has not been triggered by calling CTTRGR.

Triggering Totalizing Measurements

When totalizing, counting may be disabled and re-enabled under software control. This is equivalent to the function provided by the Gate 1 and Gate 2 inputs.

Counting is disabled by setting the subroutine CTTRCF for software trigger. Setting CTTRCF for hardware trigger or no trigger has no effect when in the totalizing mode. Counting is re-enabled by the software trigger (i.e., by executing the subroutine CTTRGR).

Whether the Counter/Totalizer is set to the single or continuous measurement mode has no effect on totalizing, since this type of measurement is an accumulating measurement.

Subroutines CTREAD and CTSCAN neither disable nor enable totalizing, but leave the totalizer in its current state.

Overflow Output

In the frequency and time measurement modes, a low Overflow output shows that an overflow has occurred on the measurement in progress. The output remains low until a new measurement is initiated; then the overflow status is cleared and the output goes high.

In the totalizer mode, a low Overflow output indicates that either an overflow or an underflow has occurred on the measurement in progress. The output remains low until a new initial value is set; then the overflow status is cleared and the output goes high.

HARDWARE SETUP

If the Counter/Totalizer is ordered at the same time as the 1752A, it is installed in the instrument chassis at the factory. If the Counter/Totalizer is ordered at a later time, it must be installed as described later in this section under the heading "Installation."

Setting the Board Address

CAUTION

Handle the Counter/Totalizer by its edges to avoid contaminating it with oil from the hands. The use of gloves is recommended.

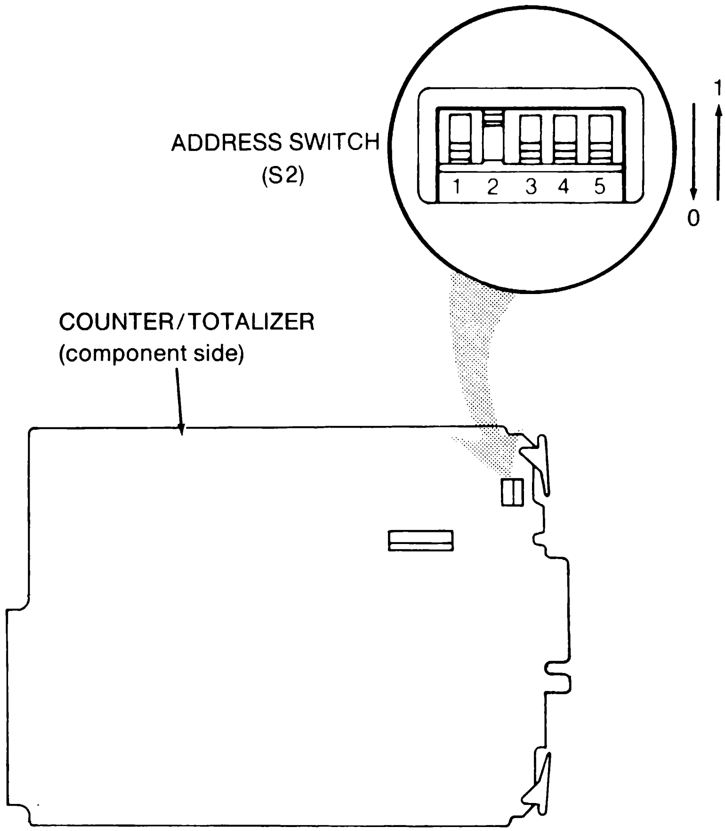
You must assign a unique board address to each Counter/Totalizer in your 1752A System. The address is assigned by setting the Address Switch (S2) as shown in the following table. The location of the Address Switch is illustrated in the accompanying figure.

The board address can range from 0 to 31, inclusive. Setting the board address also assigns the corresponding number to the board's single channel. (Board 0 would have channel 0, board 1 would have channel 1, etc.)

NOTE

Switch S1 is used to select input debouncing. Its use is described later in this section, under the heading "Input Debouncing."

ADDRESS SWITCH LOCATION



ADDRESS SWITCH SETTINGS

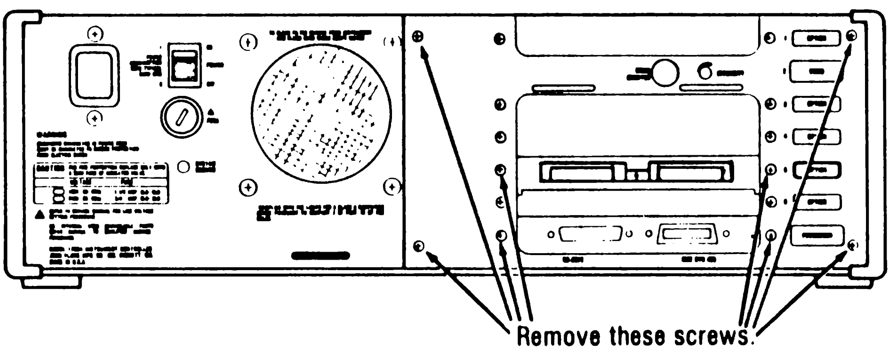
LEFT = ONE, RIGHT = ZERO S2 SWITCH SETTING = X X X X X						
Board Address	**Address Switch Segments**					**Counter/Totalizer Channel Assigned**
	B5	**B4**	**B3**	**B2**	**B1**	
0	0	0	0	0	0	0
1	0	0	0	0	1	1
2	0	0	0	1	0	2
3	0	0	0	1	1	3
4	0	0	1	0	0	4
5	0	0	1	0	1	5
6	0	0	1	1	0	6
7	0	0	1	1	1	7
8	0	1	0	0	0	8
9	0	1	0	0	1	9
10	0	1	0	1	0	10
11	0	1	0	1	1	11
12	0	1	1	0	0	12
13	0	1	1	0	1	13
14	0	1	1	1	0	14
15	0	1	1	1	1	15
16	1	0	0	0	0	16
17	1	0	0	0	1	17
18	1	0	0	1	0	18
19	1	0	0	1	1	19
20	1	0	1	0	0	20
21	1	0	1	0	1	21
22	1	0	1	1	0	22
23	1	0	1	1	1	23
24	1	1	0	0	0	24
25	1	1	0	0	1	25
26	1	1	0	1	0	26
27	1	1	0	1	1	27
28	1	1	1	0	0	28
29	1	1	1	0	1	29
30	1	1	1	1	0	30
31	1	1	1	1	1	31

Installation

Before installing the Counter/Totalizer, check that its board address is set correctly, as explained earlier in this section. If the address is correct, use the following procedure to install the Counter/Totalizer in the 1752A chassis.

1. Power down the 1752A and remove the line cord.

2. Remove the rear card cage cover, illustrated below. Depending on number of modules that may already be installed, you may have to remove more screws than those indicated here.



CAUTION

Handle the Counter/Totalizer by its edges to avoid contaminating the use set (Board address shown as your it with oil from the hands. The use of gloves is recommended.

3. Carefully slide the Counter/Totalizer into slot 1, 4, or 5 in the card cage. (The Counter/Totalizer may be used in these slots only.) Make sure the module is fully seated so that it makes solid contact with the card-edge connector.

NOTE

If you mount the Counter/Totalizer in slots 4 or 5, the slot immediately above the Counter/Totalizer must remain empty. For that reason, it is recommended that slot 1 be used for the Counter/Totalizer if possible.

4. Remove the cover plate from the corresponding slot on the card cage cover by removing the two screws.

5. Reinstall the card cage cover.

CONNECTOR DESCRIPTION

The Counter/Totalizer has a 12-terminal connector for connecting to remote input source(s). Connector pin assignments are shown below. For signal level and timing specifications, refer to the specifications presented earlier in this section, including the Non-Isolated Input Timing diagram. All inputs are TTL-level signals except the Analog input.

Before connecting the Counter/Totalizer to the remote input source(s), it may be helpful first to read the "Operating Notes" earlier in this section.

CONNECTOR PIN ASSIGNMENTS

TERMINAL	SIGNAL	COMMON TERMINAL
1	Common (Isolated)	N.A.
2	Analog Input	1
3	$\overline{\text{Overflow}}$	12
4	Gate 1	12
5	Gate 2	12
6	Trigger	12
7	$\overline{\text{Count Up}}$	12
8	$\overline{\text{Count Down}}$	12
9	Up / $\overline{\text{Down}}$	12
10	$\overline{\text{Count}}$	12
11	TTL Input	12
12	Common (Non-isolated)	N.A.

GETTING STARTED

The Counter/Totalizer is controlled by BASIC subroutines that are supplied on the 1752A System Disk. You can call the subroutines from programs that you write in BASIC, or you can call the subroutines directly by using Interpreted BASIC in the Immediate mode.

The subroutines are supplied on the 1752A System Disk in two forms: in the DIOLIB library, for use with Interpreted BASIC, and in BASIC.LIB, for use with Compiled BASIC or Extended BASIC.

It is a simple matter to use the subroutines in a program. Here are a few things to keep in mind:

- You must link to the library before using the subroutines. In Interpreted BASIC, the line reads, LINK "DIOLIB". For Compiled BASIC or Extended BASIC, consult the programming manual for those languages.

- Most of the subroutines can be used simply by giving the program name followed by any parameters or arguments required.

APPLICATIONS

Frequency Measurement

The frequency measurement mode gives your 1752A system the ability to read the frequency of pulsating signals encountered in industrial situations, such as the output from a flowmeter. The frequency measurement mode is especially useful with signals like tachometer outputs, incremental resolver outputs, etc. The frequency measurement mode can also be used to measure RPM by taking the frequency of the input signal and dividing it by the number of cycles per revolution; this gives the number of revolutions per second, which can then be scaled to revolutions per minute.

There can be a maximum of two Counter/Totalizers in a 1752A system. A channel number is assigned to each Counter/Totalizer module using switches located on the outside edge of the module.

There are two measurement inputs and a trigger input on each Counter/Totalizer module that can be used in the frequency measurement mode. The TTL input is nonisolated, dc coupled, and operates at TTL levels. The analog input is isolated, ac coupled, and works down to a 50 mV ac signal. The advantage of the TTL input is its wider frequency range. The analog input, on the other hand, is isolated from logic common and works with low-level signals.

A frequency measurement is made by connecting signals to either the analog or TTL inputs. You should use the analog input for low-level signals or if you need isolation to break possible ground loops. You should use the TTL input if your signal is of very low or high frequency and is TTL compatible. The trigger input can be used to synchronize the operation of the counter with another event or to trigger single readings.

Frequency Measurement Commands

The Counter/Totalizer powers-up in the frequency measurement mode. Commands that can be used to change the parameters of the Counter/Totalizer in the frequency mode are the subroutines CTFREQ, CTMODE, and CTTRCF.

The subroutine CTFREQ sets up the signal source and gate time for the channel number (which is the same as the board number assigned on the Address Switch). CTMODE is used to select either single or continuous measurement mode. Another subroutine, CTTRCF, determines how a new measurement is to be triggered.

Each of the parameters for CTMODE and CTTRCF has a default (continuous measurement and no trigger required, respectively). If you want the default settings, you do not have to call these subroutines unless the settings have been changed since power-up.

The following example sets up Counter/Totalizer channel 0 to make a continuous frequency measurement on the TTL input.

```
100  LINK "DIOLIB"
110  CTMODE(0%, 1%)
120  CTTRCF(0%, 1%)
130  CTFREQ(0%, 1%, 1%)
140  END
```

The Counter/Totalizer measurement subroutine, CTREAD, is used to read the latest measurement taken. In continuous mode, the module starts a new measurement immediately on completing the last measurement. So, when you read the value on a channel, you get the most current completed measurement.

Another subroutine is available that reads (or "scans") a group of channels and puts the readings into an array. This subroutine is CTSCAN. CTSCAN performs readings just like CTREAD, but for more than one channel or more than one reading or sets of readings.

The Counter/Totalizer status subroutine, CTRDY, is used to read the status of an input channel. When the reading on the channel is ready, CTRDY returns a 1 in variable RD%; otherwise RD% is 0. You should use this function before reading a value from the channel to avoid taking a reading before one is available. This is because after being called, the subroutines CTSCAN and CTREAD wait until a reading is completed before returning. If you are not sure if a reading is available, use CTRDY to find out before using CTSCAN and CTREAD.

Sample Frequency Measurement Program

The following BASIC program illustrates frequency measurement.

```
100   LINK "DIOLIB"
110   CTMODE(0%,1%)                  ! Continuous measurements
120   CTTRCF(0%,1%)                  ! No trigger
130   CTFREQ(0%,1%,1%)               ! TTL source, 3.277 msec gate time
140   RD% = 0 \ RE = 0               ! Initialize variables for use
150   CTRDY(0%,RD%)                  ! Check to see if reading is ready
160   IF RD%=1% THEN GOTO 180
170   PRINT CPOS(1,1) "Not ready . . ." \ GOTO 150
180   CTREAD(0%,RE)
190   PRINT "Channel 0 frequency = "; RE; "Hz"
200   END
```

This example sets up a frequency measurement channel. The channel is a continuous measurement channel using the TTL input on the Counter/Totalizer.

The program first checks to see if a reading is ready on the channel. If it is not, the program prints "Not ready" on the display and checks again, repeating this procedure until the reading is ready. When the reading is ready on the channel, CTREAD takes the reading and prints a message and the variable RE, which contains the value of the reading.

A line-by-line explanation follows:

Line 100	Loads the Counter/Totalizer subroutines.
Line 110	Sets channel 0 to continuously repeat measurements.
Line 120	Disables the hardware and software triggers.
Line 130	Sets channel 0 to the frequency mode, TTL input, and 3.277 gate time.
Line 140	Variables used in functions must be initialized before they are used. Variables need to be initialized only once.
Line 150	Gets the status of the reading to see if it is ready. This line ensures that the reading is ready; otherwise CTREAD waits for the reading. (If the reading never becomes ready, CTREAD waits forever.)
Line 160	Prints "Not ready . . ." if the reading is not ready and tries again (Line 170); otherwise it takes the reading (Line 180).
Line 190	Prints the reading.

See Also

See the reference pages for subroutines CTFREQ, CTMODE, CTTRCF, CTRDY, CTREAD, CTSCAN, and CTTRGR.

Time Measurement

The time measurement mode lets you measure the period or the pulse width of signals that could be encountered in industrial situations.

The time measurement mode makes use of two measurement inputs, two gate inputs, and a trigger input on each Counter/Totalizer. The TTL measurement input is nonisolated, dc coupled, and operates at TTL levels. The analog measurement input is isolated, ac coupled, and works down to a 50 mV ac signal. The advantage of the TTL input is its wider frequency range. The analog input, on the other hand, is isolated from logic common and works with low-level signals.

Time measurement is performed on signals wired to the analog measurement input, the TTL measurement input, or the gate inputs. The decision whether to use the analog or TTL input should be based on the same considerations that apply to frequency measurements. The trigger input can be used to synchronize the operation of the counter with another event.

In period measurement, the Counter/Totalizer measures the time between successive transitions of the same polarity of the input. Thus, periods beginning with a positive or negative edge can be measured.

Interval measurement is made between one edge of the input signal and the opposite edge. The slopes of the edges are selectable. Thus, positive and negative pulses can be measured.

The Gate 1 and Gate 2 inputs can be used to measure the period of the combination of two signals or the interval between two signals. There are two counting rates available when measuring the interval between two signals. The fast rate should be used for signals which have interval times of less than 1 second. The slow rate should be used for signals which have interval times of greater than 1 second.

Time Measurement Commands

Before the 1752A system can take a time reading, the system must first receive commands that set up the parameters for time measurement. Commands that can be used to set up parameters of the Counter/ Totalizer are the DIOLIB subroutines CTTIME, CTMODE, and CTTRCF.

The subroutine CTTIME sets up the time measurement mode, signal source, and slopes for a specific channel. (The channel number is the same as the board address assigned on the Address Switch). CTMODE selects either continuous or single measurement mode. Another subroutine, CTTRCF, sets up whether the reading is to be triggered by the external trigger input, by a software trigger, or by no trigger. The trigger input slope is also set by this subroutine.

The parameters for CTMODE and CTTRCF have defaults (continuous measurement mode and no trigger, respectively). If you want the default settings, you do not have to call these subroutines. An example of setup commands follows.

```
100   LINK "DIOLIB"
110   CTTIME(1%,3%,3%)
120   CTMODE(1%,0%)
130   CTTRCF(1%,3%)
140   END
```

This example sets up channel 1 as a time measurement channel to measure the period of the signal connected to the gate inputs. After a positive transition on Gate 1, a positive transition on Gate 2 starts the measurement; the measurement is completed by the next positive transition on Gate 2 after at least one positive transition on Gate 1. The reading mode is the single measurement mode and the trigger is active on the negative transition of the external trigger input. Therefore, the measurement cannot be taken until a negative transition occurs on the trigger input.

The subroutines CTTRCF and CTTRGR can be used to trigger a measurement in software (rather than from the hardware trigger input).

The subroutine CTREAD is used to read the latest measurement on the input. In continuous mode, the module starts a new sampling immediately upon completing the last and latching the result. So, when you read the value on a channel, you get the latest completed measurement.

Another subroutine is available that reads ("scans") a group of channels and puts the readings into an array. This subroutine is CTSCAN. CTSCAN performs readings just like CTREAD, but for more than one channel or more than one reading.

The subroutine CTRDY is used to read the status of an input channel. When the reading on the channel is ready, CTRDY returns a 1 in variable RD%; otherwise RD% is 0. You should use this function before reading a value from the channel to avoid taking a reading before the reading is available.

CTREAD and CTSCAN wait until a reading is ready before they return to the calling program. Therefore, in cases where long measurement times are expected, or when there is a chance that a measurement will never become ready, use CTRDY to determine the status of the reading before calling CTREAD or CTSCAN.

Example

The following BASIC program illustrates time measurement.

```
90   LINK "DIOLIB"
100  CTTIME(0%, 1%, 1%)                   ! TTL source, + edge to + edge
110  CTMODE(0%, 1%)                       ! Continuous measurement mode
120  CTTRCF(0%, 1%)                       ! No trigger required
130  ST% = 0 \ RE = 0                     ! Initialize variables for use
140  CTRDY(0%, ST%)                       ! Get status of reading
150  IF ST% = 1 THEN CTREAD(0%, RE) ELSE GOTO 180    ! Read if channel ready
160  PRINT "TTL input period = "; RE; "secs"        ! Print reading
170  STOP
180  PRINT "Reading not available"
190  END
```

This program sets up a period measurement on the TTL input for channel 0. Channel 0 continuously measures the TTL input, starting each measurement on the positive transition of the input. When a reading on the channel is available, the value is transferred to variable RE. The value for the period is then printed.

A line-by-line explanation follows:

Line 90	Loads the Counter/Totalizer subroutines.
Line 100	Sets channel 0 to measure the period of the TTL input.
Line 110	Sets channel 0 to the continuous measurement mode.
Line 120	Sets channel 0 for no trigger required.
Line 130	Initializes the status and reading variables before they are used. (This only needs to be done once.)
Line 140	Finds out if a reading is available.
Line 150	If a reading is ready, takes it.
Line 160	Prints the reading.
Line 170	Stops the program.
Line 180	The reading was not ready, so prints the message.
Line 190	End of program.

See Also

See the reference pages for subroutines CTTIME, CTMODE, CTTRCF, CTTRGR, CTRDY, CTREAD, and CTSCAN.

Event Totalizing

The totalizer mode gives your 1752A the ability to count events. This lets you measure many types of parameters, such as angular position with incremental resolvers, production quantities with light interrupters, etc. This type of measurement is used whenever you want to know how many times an event has happened.

Each Counter/Totalizer has four measurement inputs and two gate inputs that are used in various ways to totalize events. The Count Up and Count Down inputs are used together, or the Count and Up/Down inputs are used together. The Gate 1 and Gate 2 inputs can be used to start and stop the totalizing process. All the totalizing inputs accept TTL signal levels.

If the Count Up and Count Down inputs are used, a negative transition on the Count Up line will cause the totalizer to increment by one, while a negative transition on the Count Down line will cause the totalizer to decrement by one. Simultaneous negative transitions at both the inputs and positive transitions at either input have no effect on the total.

If the Count and Up/Down inputs are used, the effect of a negative transition at the Count input depends on the state of the Up/Down line. If the Up/Down line is high, the totalizer will increment by one; if the Up/Down line is low, the totalizer will decrement by one. Positive transitions on the Count input have no effect on the total. The pairs of inputs are not intended to be used simultaneously. The unused pair of lines should be left unconnected.

You can enable and disable totalizing of events by using the Gate 1 and Gate 2 lines. See the discussion of gating earlier in this section for the proper combinations of these signals to invoke the various enable and disable modes. Totalizing can also be disabled by software under program control.

Event Totalizing Commands

Before the 1752A system can totalize, the system must first receive commands that set up the parameters for totalizing. Commands that can be used to set up these parameters are the subroutines CTTOTL and CTTRCF.

The subroutine CTTOTL sets up the gate configuration and specifies an initial value for the counter on a specific channel. Two set-up examples are:

```
CTTOTL(0%, 0%, 0%)
CTTOTL(1%, 1%, 1000%)
```

The first example sets up channel 0 as a totalizer with no external gating signals to turn the counter on and off, and sets the counter to an initial value of zero. (The channel number is the same as the board address, which is set on the Address Switch.)

In the second example, channel 1 is set up to totalize, controlled by the signals connected on Gates 1 and 2 (so that when both are high, the totalizer is enabled, and when either is low, the totalizer is disabled). The totalizer is initialized to 1000, so that it will start counting from 1000.

The subroutine CTREAD is used to read the latest measurement stored in the counter.

Another subroutine is available that reads ("scans") a group of totalizer channels and puts the readings into an array. This subroutine is CTSCAN. It performs readings just like CTREAD, but for more than one channel or more than one set of readings.

Subroutines CTTRCF and CTTRGR may be used to disable and enable counting under software control.

Example

The following BASIC program illustrates totalizing measurement.

```
90    BX = 0 \ RE = 0
100   LINK "DIOLIB"
110   CTTOTL(3%,1%,-1000)
120   CTREAD(3%,RE)
130   IF RE < 0 GOTO 120
140   BX = BX + 1
150   PRINT BX; "Kilo-boxes have been counted"
160   GOTO 110
170   END
```

The program first initializes count variable BX and total variable RE to zero. Then it sets up Counter/Totalizer channel number 3 as a totalizer initialized to -1000. The totalizer starts counting boxes until it reaches a value of 0 (1000 boxes counted). At this point, BX is incremented by 1 and "1 Kilo-boxes have been counted" is printed on the display. Counting continues and each time another 1000 boxes are counted, a new message is printed on the display.

A line-by-line explanation follows:

Line 90	Initializes the variables for use in the program.
Line 100	Loads the Counter/Totalizer subroutines for access by the program.
Line 110	Sets channel 3 to totalizing mode with no external gating and an initial value of -1000.
Line 120	Reads the count value.
Line 130	If the value has not reached 0, reads again.
Line 140	Increment the variable BX to indicate that 1000 boxes have been counted.
Line 150	Prints message.
Line 160	Checks for next 1000 boxes.

See Also

See the reference pages for subroutines CTTOTL, CTREAD, CTSCAN, CTTRCF, and CTTRGR.

COUNTER/TOTALIZER SUBROUTINES

The following pages describe the subroutines that control the Counter/Totalizer. The subroutines are summarized first, followed by a few parameter conventions. Then the subroutines are presented in reference page format, arranged alphabetically.

Error messages that can be returned from the subroutines are included in the corresponding reference pages. An annotated list of all of the error messages follows the reference pages.

Subroutine Summary

Every subroutine that applies to the Counter/Totalizer is briefly described below. The subroutines are arranged here in two functional categories: Set-Up Functions, and Measurement Functions.

Set-Up Functions

CTFREQ	Sets up the specified Counter/Totalizer channel for frequency measurement.
CTTIME	Sets up the specified Counter/Totalizer channel for time measurement.
CTTOTL	Sets up the specified Counter/Totalizer channel for totalizing measurement.
CTMODE	Puts the specified Counter/Totalizer channel in the continuous or single measurement mode. CTMODE is valid only for frequency or time measurements. Totalizing is always in the continuous measurement mode.
CTTRCF	Enables or disables the external and software triggers on a Counter/Totalizer channel.

Measurement Functions

CTRDY	This subroutine is used to determine if a reading has been completed and is available.
CTTRGR	This subroutine triggers a measurement in the time and frequency modes, or enables counting in the totalizing mode.
CTREAD	Takes a reading from a single Counter/Totalizer channel.
CTSCAN	Takes readings from a group of Counter/Totalizer channels.

Parameter Conventions

The following conventions are used for parameter references in the subroutine reference pages:

- Parameters that are spelled out (such as channel, source, and trigger) can be either numeric values or variables in a program.
- Parameters that are two-character names (numbers or capital letters), and that are valid BASIC variables, are only used as variables for information storage in a program.
- A percent sign following a parameter signifies an integer variable or constant, while lack of a percent sign signifies a floating-point variable or constant.

Parameters
Usage

BASIC: [CALL] CTFREQ(channel%,source%,gatetime%)

Description

This subroutine sets up the Counter/Totalizer to measure the frequency of of a signal applied to the input selected. The gate time for making the frequency measurement is programmable. Measurements are initiated according to the settings of the CTTRCF and CTMODE functions. Measurements are completed in the specified gate time plus a small amount of time for internal computation. Values are returned in Hertz.

Parameters

channel The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

source Source defines the input signal for the frequency measurement mode as follows:

1 TTL
2 Analog

Note that frequency cannot be measured on the Gate 1 or Gate 2 inputs.

gatetime This parameter selects the gate time for frequency measurement. The gatetime parameter number must be a number 1 through 4 and corresponds to the times shown below. The number in Hz, below, is the resolution for each gate time.

1 3.22 msec, 305.2 Hz
2 26.21 msec, 38.15 Hz
3 209.7 msec, 4.769 Hz
4 3.355 sec, 0.2999 Hz

See Also

CTMODE, CTTRCF, CTTRGR

Example

The following BASIC program sets up the Counter/Ttalizer to measure the frequency of a TTL-level signal connected to the TTL input with a gate time of 3.355 seconds on channel number 1 and prints the reading.

```
100  LINK "DIOLIB"
110  CTFREQ (1%, 1%, 4%)
120  CTMODE(1%, 1%)
130  CTTRCF(1%, 1%)
140  BR = 0
150  CTREAD(1%, BR)
160  PRINT BR; "Hertz"
170  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.
1604 Illegal parameter for designating the source.
1606 Illegal parameter for setting the gate time for the CTFREQ function.

Usage

BASIC: [CALL] CTMODE(channel%,mode%)

Description

This subroutine places a Counter/Totalizer channel in either single measurement mode or continuous measurement mode. The CTMODE subroutine is only valid when making a frequency or time measurement. CTMODE does not have any effect when the Counter/Totalizer is totalizing.

In the continuous measurement mode, a measurement is taken every time a valid trigger occurs. If no trigger is set, measurements are taken continuously.

In the single measurement mode, one measurement is taken when a trigger occurs. If no trigger is set, no measurement is taken. Once a measurement is complete, no other measurement is taken until the current measurement is cleared by reading the measurement or by re-enabling the trigger by reassigning the trigger type.

Parameters

channel — The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

mode — Mode selects single or continuous measurement mode. Mode may be any number, corresponding to the following conditions:

0	Single measurement mode
Nonzero	Continuous measurement mode

See Also

CTTRCF, CTTRGR

Example

The following BASIC program puts Counter/Totalizer channel 0 into continuous-measurement mode.

```
100  LINK "DIOLIB"
110  CTMODE(0%, 1%)
120  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.
1610 (Warning) The function specified has no effect on totalizing.

Usage

BASIC: [CALL] CTRDY(channel%,RD%)

Description

This subroutine returns the status of a Counter/Totalizer channel, indicating whether a measurement is ready for the 1752A to read. Since totalizer readings are always available, calling this function when the Counter/Totalizer is in the totalizing mode always returns the status that a reading is available. Variable RD must be initialized before it is used.

Parameters

channel — The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

RD — This is the variable where the measurement status is stored. Its value has the following meaning:

0 Measurement is not ready
1 Measurement is ready

See Also

CTREAD, CTSCAN

Example

If the reading on Counter/Totalizer channel 0 is ready to be read by CTREAD or CTSCAN, the following BASIC program step returns a value of 1 in variable RD. If no reading is available on channel 0, a value of 0 is returned in RD.

```
90   LINK "DIOLIB"
100  RD% = 0
110  CTRDY(0%,RD%)
120  IF RD% = 1% PRINT "Reading available" ELSE PRINT "Not ready"
130  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.

Usage

BASIC: [CALL] CTREAD(channel%,RE)

Description

This subroutine takes a reading from the specified Counter/Totalizer channel and returns the reading in variable RE. Variable RE must be initialized before the subroutine is called. Note that RE must be a floating-point variable.

In cases where measurement times can be long, CTRDY should be used to determine if a reading is available. This is because CTREAD waits until the measurement is completed before returning.

CTREAD also enables another measurement when the Counter/Totalizer is in the single measurement mode. If the channel is waiting for a software trigger (measurement not ready), CTREAD will trigger the measurement. If the channel is waiting for a hardware trigger that does not occur, CTREAD waits forever.

Parameters

channel The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

RE Variable RE is where the reading is stored. RE must be a floating point variable. If a reading is out of range the value of 1 * 10**10 is stored in RE.

See Also

CTRDY, CTSCAN

Example

The following BASIC program steps take a reading from Counter/Totalizer channel 16 and store it in the variable BR. Line 40 initializes BR, since variables must be initialized before they are used. (Typically, variables are initialized early in a program.) Variables need to be initialized only once.

```
 40   BR = 0.0                  ! Initializes BR.
...   ...
...   ...
110   CTREAD(16%,BR)
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.
1611 (Warning) The reading for the specified channel is out of range.

Usage

BASIC: [CALL] CTSCAN(first%,last%,set%,AR())

Description

This subroutine reads a specified number of sets of Counter/Totalizer channels and stores the readings in an array. In cases where measurement times can be long, CTRDY should be used to ensure all readings are available. CTSCAN will not return to the calling program until all readings are completed.

When taking multiple sets of readings with long measurement completion times, CTSCAN takes the measurement completion time times the number of sets of readings before returning to the calling program. In the case of a slow time measurement of +Gate 1 to +Gate 2, the measurement time can be up to 3.82 hours. Two readings could take over 7 hours.

Also note that if the channel is waiting for a hardware trigger that does not occur, the measurement will never become ready.

In the single measurement mode, CTSCAN also enables another measurement on all channels and triggers a measurement on all channels that are waiting for a software trigger.

The measurements are stored in the array in the following order: One scan from the first to the last channel is taken and stored in the array starting at element 0. Additional sets of readings (depending on the set parameter) are then taken and stored in the array. The size of the array for the dimension must be $\geqslant$ ((last - first + 1) $*$ sets) - 1.

CAUTION

If the dimension of the array is less than required, memory may be overwritten, causing the program to fail.

Parameters

first — The first parameter equals the channel number of the first Counter/Totalizer channel to be read. Channel numbers 0 through 31 are allowable. First must be less than or equal to last.

last — The last parameter equals the channel number of the last Counter/Totalizer channel to be read. Channel numbers 0 through 31 are allowable.

set — Set is the parameter that defines the number of sets of readings to be taken. The value of this parameter must be 0 or a positive integer.

AR() — Variable AR() is the array variable where the readings are to be stored. Virtual arrays are not allowed.

See Also

CTREAD, CTRDY

Example

The following BASIC program steps read Counter/Totalizer channels 0 and 1, and store three sets of two readings in array B1(0) through B1(5). The DIM statement sets the dimension of the array variable B1 to the number of readings to be taken (six). The DIM statement also initializes B1.

```
100  LINK "DIOLIB"
110  DIM B1(5)
120  CTSCAN(0%, 1%, 3%, B1())
130  END
```

The readings are stored in the array as follows:

B1(0)	First reading of channel 0
B1(1)	First reading of channel 1
B1(2)	Second reading of channel 0
B1(3)	Second reading of channel 1
B1(4)	Third reading of channel 0
B1(5)	Third reading of channel 1

Possible Error Messages

1600	DIOLIB software drivers have not been linked with FDOS.
1601	The Counter/Totalizer channel is not installed.
1602	Illegal Counter/Totalizer channel number.
1603	The first channel parameter is greater than the last channel parameter.
1611	(Warning) The reading for the specified channel is out of range.

Usage

BASIC: [CALL] CTTIME(channel%,source%,slope%)

Description

This subroutine sets up the specified Counter/Totalizer channel to perform a time measurement on the specified source. The slope parameter specifies the beginning and end of the time being measured. Values are returned in seconds.

Measurements are enabled and disabled according to the CTTRCF and CTMODE functions. The time to complete the measurement is the time being measured.

CTRDY should be used before using CTSCAN or CTREAD to determine if the reading is available whenever long measurement times are expected.

Parameters

channel — The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

source — Source defines the type of signal to be measured as follows:

1 TTL
2 Analog
3 Gate 1, Gate 2

slope — Slope defines the beginning and end of the measurement as follows:

If source is 1 or 2:

1 + edge to a + edge
2 - edge to a - edge
3 + edge to a - edge
4 - edge to a + edge

If source is 3:

1 +G2 to +G2 (enabled by a +G1 before each +G2)
2 +G1 to +G2, fast (1.2 us to 6.7s)
3 +G1 to +G2, slow (819 us to 3.82hr)
4 -(G1&G2) to -(G1&G2)
5 +(G1&G2) to -(G1&G2) fast
6 +(G1&G2) to -(G1&G2) slow

See Also

CTTRCF, CTMODE, CTTRGR

Example

The following BASIC program sets Counter/Totalizer channel 4 to measure the time interval between the rising edge of the signal on Gate 1 to the rising edge of the signal on Gate 2 and prints the value.

```
100  LINK "DIOLIB"
110  CTTIME(1%,3%,3%)
120  CTMODE(1%, 1%)
130  CTTRCF(1%, 1%)
140  BR = 0
150  CTREAD(1%, BR)
160  PRINT BR; "seconds"
170  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.
1604 Illegal parameter for designating the source.
1605 Illegal parameter for setting the slope combination for CTTIME.

Usage

BASIC: [CALL] CTTOTL(channel%,gate%,initial)

Description

This subroutine sets the Counter/Totalizer board up to totalize. The totalizing inputs can be gated by the Gate 1 and Gate 2 inputs. Also, an initial value can be specified.

Totalizing can be enabled and disabled by using CTTRCF and CTTRGR. The total is always available using CTREAD and CTSCAN.

Parameters

channel — The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

gate — The gate parameter sets the external gate for the totalizing inputs. The gate parameter must be 1, 2, or 3, corresponding to the following gate configurations:

1 No external gating
2 +G1 to +G2
3 +(G1&G2) to -(G1&G2)

initial — This parameter sets the initial value of the counter for a totalization measurement. The value for initial must be between -8,388,608 and 8,388,607 inclusive.

See Also

CTTRCF, CTTRGR

Example

The following BASIC program sets Counter/Totalizer channel 0 to count events occurring on the totalizer inputs, gated by the rising edge of Gate 1 to the rising edge of Gate 2. The program also sets the Counter/Totalizer to start counting from 1000.

```
100  LINK "DIOLIB"
110  CTTOTL(0%, 1%, 1.0E3)
120  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.
1607 Illegal parameter for selecting the external gating when totalizing.
1608 The initial value parameter for totalizing was out of range.

Usage

BASIC: [CALL] CTTRCF(channel%,type%)

Description

This subroutine sets the trigger configuration for the corresponding Counter/Totalizer channel. The trigger starts a measurement in synchronization with another hardware or software signal. The trigger type can be set to no trigger, hardware external trigger, or software trigger under program control. The hardware external trigger can be set to a rising-edge or falling-edge trigger.

Calling CTTRCF resets the measurement status so that another measurement is enabled according to the trigger type.

When the Counter/Totalizer is set for no trigger and is in the continuous-measurement mode, frequency and time measurements are performed immediately and totalizing is enabled. In the single-measurement mode, frequency and time measurements are not triggered but totalizing is still enabled.

When the Counter/Totalizer is set for the external hardware trigger, frequency and time measurements are enabled when the external hardware trigger occurs. If the Counter/Totalizer is in the totalizing mode, the external hardware trigger has no effect and totalizing is enabled.

When the Counter/Totalizer is set to respond to a software trigger, frequency and time measurements are enabled when the CTTRGR subroutine is called. In the totalizing mode, programming the Counter/Totalizer for a software trigger disables totalizing. Calling the CTTRGR subroutine re-enables totalizing.

Parameters

channel — The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31 inclusive.

type — The type parameter selects the trigger configuration. The value of trigger corresponds to the following configurations:

1 No trigger
2 Rising edge of external trigger input
3 Falling edge of external trigger input
4 Software trigger

See Also

CTTRGR. Also read about triggering under "Operating Notes."

Example

The following BASIC program first sets up channel 0 for totalizing and sets up this channel's trigger type for software trigger, which disables totalizing. Then the program waits 10 seconds and then re-enables totalizing.

```
100  LINK "DIOLIB"
110  CTTOTL(0%,1%,0.0)
120  CTTRCF(0%,4%)
130  WAIT(10,000)
140  CTTRGR(0%)
150  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1602 Illegal Counter/Totalizer channel number.
1610 (Warning) The function specified has no effect on totalizing.

Usage

BASIC: [CALL] CTTRGR(channel%)

Description

This function is used to trigger a measurement by software. It has no effect unless the software trigger is enabled using the CTTRCF function.

When the Counter/Totalizer is in the totalizing mode, calling this function enables totalizing if totalizing has been stopped using the CTTRCF function.

When the Counter/Totalizer is measuring time or frequency in the continuous measurement mode, calling CTTRGR triggers a new measurement if the software trigger is set by calling the CTTRCF function. Repeated calls to CTTRGR always trigger a new measurement.

When the Counter/Totalizer is measuring time or frequency in the single measurement mode, CTTRGR triggers a new measurement only when the trigger has first been enabled by calling CTTRCF, CTREAD, or CTSCAN. This prevents additional software triggers from overwriting previous measurements when the Counter/Totalizer is in the single measurement mode.

Parameter

channel	The channel parameter is the number of the Counter/Totalizer channel. It must be between 0 and 31, inclusive.

See Also

CTTRCF, CTMODE

Example

The following BASIC program triggers a measurement to be taken on Counter/Totalizer channel 0 if in the frequency or time mode, or enables totalizing if in the totalizing mode.

```
90   LINK "DIOLIB"
100  CTTRGR(0%)
110  END
```

Possible Error Messages

1600 DIOLIB software drivers have not been linked with FDOS.
1601 The Counter/Totalizer channel is not installed.
1610 (Warning) The function specified has no effect on totalizing.

ERROR MESSAGE SUMMARY

This table provides an annotated list of all possible error messages that can be returned by the subroutines that control the Counter/Totalizer. All of these errors are recoverable errors or warnings. See the Fluke BASIC Manual under "Errors and Error Handling" for a description of error types.

1600 DIOLIB software drivers have not been linked with FDOS.

Use the System Configuration Utility program to link in the DIOLIB drivers.

1601 The Counter/Totalizer channel is not installed.

The specified Counter/Totalizer channel has not been assigned by the Address Switch on the module. See "Setting the Board Address" to set the Address Switch.

1602 Illegal Counter/Totalizer channel number.

The value specified for the analog input channel is not in the range of 0 to 31.

1603 The first channel parameter is greater than the last channel parameter.

When reading multiple channels using the CTSCAN function, the first channel being read must be less than or equal to the last channel being read.

1604 Illegal parameter for designating the source.

The value passed to the CTTIME (1 through 3) or CTFREQ (1 or 2) functions to set the source of the signal to be measured is not allowed. Notice that Gate 1 and Gate 2 cannot be the source for a frequency measurement.

1605 Illegal parameter for setting the slope combination for CTTIME.

The value passed to the CTTIME function to select the slopes (1 through 4) or the gate input signals (1 through 6) to start and stop the measurement was not a legal value.

1606 Illegal parameter for setting the gate time for the CTFREQ function.

The value passed to the CTFREQ function to select the gate time was not in the range of 1 through 4.

1607 Illegal parameter for selecting the external gating when totalizing.

The value passed to the CTTOTL function to select the external gating was not in the range of 1 through 3.

1608 The initial value parameter for totalizing was out of range.

The value passed to the CTTOTL function for the initial value was not in the range of -8,388,608 to 8,388,607.

1609 Illegal parameter for selecting the trigger type.

The value passed to the CTTRCF function for selecting the trigger type was not in the range of 1 through 4.

1610 (Warning) The function specified has no effect on totalizing.

The Counter/Totalizer is in the totalizing mode and the function called has no effect on this type of measurement. This could be either the CTTRCF function with the hardware trigger specified or the CTMODE function.

1611 (Warning) The reading for the specified channel is out of range.

The frequency or time measurement was out of range (the counter chain overflowed), or the counter chain has overflowed or underflowed when totalizing.

Section 6
Bit Parallel I/O

CONTENTS

INTRODUCTION

The 17XXA-002 Parallel Interface (PIB) adds two 16-bit parallel interfaces to the 1752A. A maximum of three PIBs may be installed in one 1752A system, for a total of six 16-bit ports. The PIB may be installed in slots 1, 3, 4, or 5.

The PIB can adapt to some of the most unusual interface requirements of connected devices. Using software drivers supplied by Fluke, the PIB provides bidirectional transfer of bits (for monitoring and controlling status), 16-bit words (for communication with BCD instrumentation), or 512-word blocks (for maximum-speed data transfer of 80K words per second). Handshake or strobe protocols may also be selected under user program control.

The PIB is completely controlled by subroutines supplied in the PIBLIB library on the 1752A System Disk when used with Fluke Interpreted BASIC. The PIB may be used with programs written in several programming languages, including Fluke Interpreted BASIC, Compiled BASIC, Extended BASIC, and FORTRAN.

INCLUDED WITH THE OPTION

The next page shows the items included with the 17XXA-002 option. The 17XXA-002 Parallel Interface manual provides complete documentation for the PIB.

The floppy disk supplied with the PIB allows the PIB to operate in the Fluke 1720A Instrument Controller. The disk is not needed when the PIB is used in the 1752A. The PIB library and software drivers are already supplied on the 1752A System Disk.

17XXA-002 PARALLEL INTERFACE OPTION CONTENTS

NUMBER	ITEM	JOHN FLUKE PART NUMBER
1	Parallel Interface Module	611947
2	Instruction Manual	732230
3	(2) Parallel Interface Cables	733907
4	1720A PIB Software Disk	630699

SPECIFICATIONS

HARDWARE SPECIFICATIONS

Ports	Two independent 16-bit parallel ports, 25-pin D-type subminiature female pin connectors.
Logical Interface	Memory mapped, two memory locations per port: data and status/control.
Line Characteristics	Data I/O lines are terminated resistively with diode input protection, 2400 ohms to +5V, 5000 ohms to ground.
Line Sense	Independent jumper-configurable active sense level for each control line, and for input and output data lines.
Data Out	Low: <0.4V @ 48 mA High: >2.4V @ -0.4 mA
Data In	Low: <0.8V. High: >2.0V.
Control Out	Low: <0.4V @ 8 mA. High: >2.4V @ 400 uA
Control In	Low: <0.4V High: >2.4V
Control Lines (each port)	PCTRL (output) PFLAG (input) PDIR (output) POEN (input)
Temperature	0 - 55 C storage 10 - 40 C operating
Dimensions	190.5 mm x 254.0 mm x 1.6 mm (7-1/2" x 10" x 1-1/16")
Supplied Cable	1.98 m (6.5 ft) of 25 conductor 26-gauge stranded copper wire.

SOFTWARE SPECIFICATIONS

Drivers .... Supplied on System Software Disk:
Read/Write Bit
Read/Write Words (16 bits)
Read/Write Blocks (multiple words)

Subroutine Library .... Supplied on System Software Disk:
chkbit - Check a bit
clrbit - Clear a bit
setbit - Set a bit
rdwrd - Read a word
wtwrd - Write a word
rdblk - Read a block
wtblk - Write a block
frdblk - Fast read a block
fwtblk - Fast write a block
popen - Open a port
pclose - Close a port

Control Modes .... Mode 0: No Handshake
Mode 1: Input Handshake
Mode 2: Full Output Handshake
Mode 3: Strobe Output Handshake

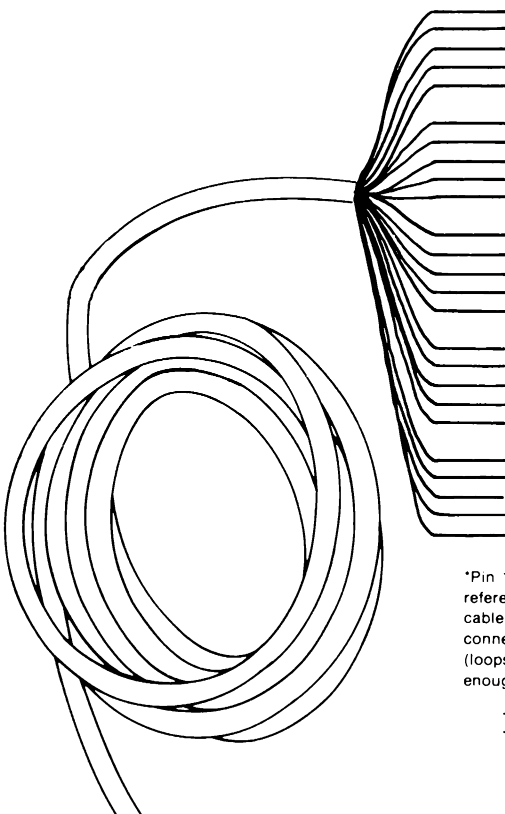
Handshake Modes .... No Handshake

Full Handshake Input
Strobe Input

Handshake Output
Strobe Output

INTERFACE DESCRIPTION

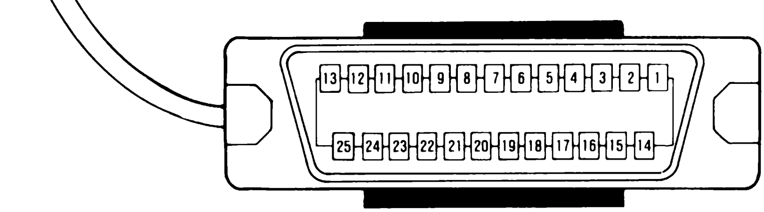
Port lines on the PIB provide bidirectional data transmission between the 1752A and compatible external devices. The drawing of the cable connector (below) names the signals and lists the logic states for each of the lines at the interface.



PIN	MNEMONIC	WIRE COLOR	DIRECTION
1	Shield	Ground*	-
2	DP(13)	Red	←→
3	DP(8)	Yellow	←→
4	DP(11)	Green	←→
5	DP(10)	Violet	←→
6	DP(9)	Grey	←→
7	DP(4)	Red/White	←→
8	DP(7)	Yellow/White	←→
9	DP(6)	Green/White	←→
10	DP(5)	Violet/White	←→
11	DP(0)	Grey/White	←→
12	DP(3)	Yellow/Red	←→
13	DP(2)	Green/Red	←→
14	DP(14)	Violet/Red	←→
15	DP(15)	Grey/Red	←→
16	DP(12)	Red/Green	←→
17	Return	Red/Black	-
18	Return	Yellow/Black	-
19	Return	Green/Black	-
20	Return	Violet/Black	-
21	PFLG	Red/Grey	←
22	PIOE-	Yellow/Grey	←
23	PCTRL	Green/Grey	→
24	PDIR	Violet/Grey	→
25	DP(1)	Grey/Green	→

*Pin 1 is connected to the cable shield. This pin is not a reference point for signals. Its purpose is to connect the cable shield to a system ground. Make sure that use of this connection does not result in circular grounding paths (loops) through the system. Such ground loops can conduct enough current to interfere with data transmission.

←→ indicates bidirectional data lines
← indicates input to PIB
→ indicates output by PIB



SOFTWARE LIBRARY (PIBLIB)

The next few pages summarize the subroutines which control the PIB. The required parameters are described immediately following the descriptions of the routines.

CHKBIT Check bit

Parameters: port, bit, bool

Description: This routine checks a particular bit on a Parallel Interface Port. It is equivalent to reading the port and then isolating the specified bit position.

CLRBIT Clear bit

Parameters: port, bit

Description: This routine clears to zero a particular bit on a selected port. It is equivalent to reading the port, ANDing the bit with 0 in the appropriate position, and then writing the data word back out to the port.

SETBIT Set bit

Parameters: port, bit

Description: This routine sets a particular bit (output = high) on a selected port. It is equivalent to reading the data latched at the port, ORing the bit in the specified position with 1, and then writing the data word back out to the port.

RDWORD Read word

Parameters: port, word

Description: This routine reads a selected port and writes the value into a variable.

WTWORD Write word

Parameters: port, word

Description: This routine writes a word from a variable to a specified port.

RDBLK Read block

Parameters: port, block, count

Description: This routine reads multiple words from a port into an array.

WTBLK Write block

Parameters: port, block, count

Description: This routine writes multiple words to a port from an array.

FRDBLK Fast Read block

Parameters: port, block, count

Description: This routine reads a block of data from a port, as fast as possible. It does not perform the error checking that is done in a normal read of a block using RDBLK.

FWTBLK Fast Write block

Parameters: port, block, count

Description: This routine writes a block of data to a port as fast as possible. It does not perform the error checking that is done in a normal block write using WTBLK.

POPEN Open a port

Parameters: port, mode, mask, timeout

mode = 0: No Handshake
mode = 1: Hndshkin
mode = 2: Hndshkout
mode = 3: Strobeout

$-32767 \leqslant \text{mask} \leqslant +32767$

$0 \leqslant \text{timeout} \leqslant 32767$

Description: POPEN opens a port in preparation for data transfer at the interface. The direction of data flow is set by the mask parameter.

PCLOSE Close a port

Parameters: port

Description: PCLOSE closes the specified port and returns the hardware to a passive state similar to the power-up condition.

Parameters

When the routines are used in a program, one or more parameters are specified by the programmer. All parameters must be specified as integers.

PORT — The port number for the routine to operate on, expressed as an integer in the range 0 - 15.

MODE — The Parallel Interface module operates in one of four modes: No Handshake, Full Handshake, and Strobe Input and Output Handshakes. With the exception of No Handshake, the handshakes synchronize incoming and outgoing data. The table below lists the handshake names and the mode number that the software recognizes.

HANDSHAKE MODES

NAME	DEFINITION	MODE
—	No Handshake	0
HNDSHKIN	Full Handshake Input	1
STROBEIN	Strobe Input	1
HNDSHKOUT	Full Handshake Output	2
STROBEOUT	Strobe Output	3

TIME OUT — The wait time before an incomplete handshake is terminated.

BIT — The bit number to be checked, read, or written to, expressed as an integer.

BOOL — When a bit or word is read or checked, as in the CHKBIT routine, the routine places a value into the variable specified as BOOL.

DIRECTION MASK — An integer that indicates the desired transmission direction of each bit on the port.

BLOCK	This parameter is the array to which data will be transferred using the Block subroutines RDBLK, WRTBLK, FRDBLK, and FWTBLK.
COUNT	Indicates how many array elements to transfer.

CONCLUSION

For complete information about the Parallel Interface, refer to the manual shipped with the PIB. That manual includes:

- Specifications
- Interface timing
- Interface Description
- Software Library Description
- Sample programs
- Performance Testing
- Theory of Operation
- Schematic

Section 9
Options

CONTENTS

P/N 760611
January 1985

INTRODUCTION

This section of the manual gathers into one area all information about options available at the time of printing. Because new options are always being investigated and released throughout the life of the instrument, this section is expected to grow between printings of the manual.

When a new option becomes available, first shipments are supported by "User Information" sheets, which can be incorporated into this section after the option is installed. The next printing of the manual will then include the new sheets in this section. Be sure to contact your local Fluke representative for the latest information about available options.

The items discussed in this section 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.

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
1765A/AB	Winchester Disk Drive, 10M Byte
1780A	InfoTouch Display

ACCESORIES

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 Shileded, 4 meters

RS-232C Interface Cables

Standard (For DCE devices)
Y1707 2 meter
Y1708 10 meter

Null Modem (For other DTE devices)
Y1702 2 meter
Y1703 4 meter
Y1705 0.3 meter

Printer Cable

For connecting a serial printer.

Y1709 2 meter

Rack Mount Kits

Y1790 Rack Mount Kit with 24-inch slides
Y1794 Rack Mount Kit with 18-inch slides

Side Carrying Handle

Y1795

OPTIONS

Options are listed by a unique three-digit number appended to the product family identifier. For example, the -004 option 256K Byte Bubble Memory option is ordered using model number 17XXA-004.

Memory Expansion

Memory Expansion options greatly increase the available on-line storage capabilitites 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 Option Configuration Table later in this section for complete details.

-004 256K Byte Bubble Memory
-005 512 Kbyte Bubble Memory
-006 256 Kbyte RAM Expansion
-007 512 Kbyte RAM Expansion

Interface Additions

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

Configuration Information

Use this table to determine allowable configurations of available hardware options. A dot in a column indicates the slots that the option can be placed in. For example, if all available slots are used for 512K byte RAM expansion memory modules, the system has the maximum memory configuration for this type of memory: 2.6M bytes, but no slots are available for other modules. On the other hand, slots 1, 3, 4, and 6 could be used for additional memory, resulting in 2.1M bytes of additonal memory, and slot 5 would still be available for one of the I/O options.

Option Configuration Table

OPTIONS

Dual Serial Interface	IEEE-488/RS-232C Interface	Parallel Interface	512K byte RAM Expansion	256K byte RAM Expansion	512K byte Bubble Memory	256K byte Bubble Memory	**SLOTS**
●		●	●	●	●	●	**1**
Reserved for Video/Graphics/Keyboard Interface							**2**
●		●	●	●	●	●	**3**
			●	●	●	●	**4**
●	●	●	●	●	●	●	**5**
			●	●	●	●	**6**
Reserved for Single Board Computer							**7**

● = Allowable Slot for Option

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
-205 Extended BASIC Software Development System

1722A USER INFORMATION
Installing Hardware Options

INTRODUCTION

This information is provided to assist you in installing hardware options into a 1722A Instrument Controller. All options are installed in the same way. The instructions here describe how to install options into the Controller's card cage, and give general directions on how to check them out.

Some of the options require some initial set-up. Be sure to refer to the appropriate option User Information for a module's unique requirements before you start the installation.

If a new module fails to perform correctly on first applying power, be sure to recheck your work. It may be that a small but important step was missed, resulting in a failure of the new module to operate.

PRE-INSTALLATION CHECKOUT

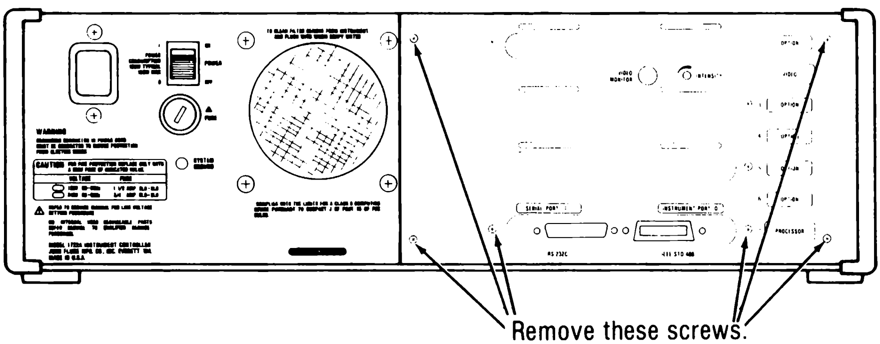
Inspect the shipping carton for damage, and notify the shipper immediately if it appears to have been damaged. Unwrap the module and inspect it for damage. If everything seems to be in order, set any selection switches or jumpers that are unique to the module. This information is available in the individual sections that cover each of the options.

INSTALLATION

1. Refer to the option User Information provided with the module and perform any preliminary set-up steps.

2. Power down the Controller, and remove the AC line cord.

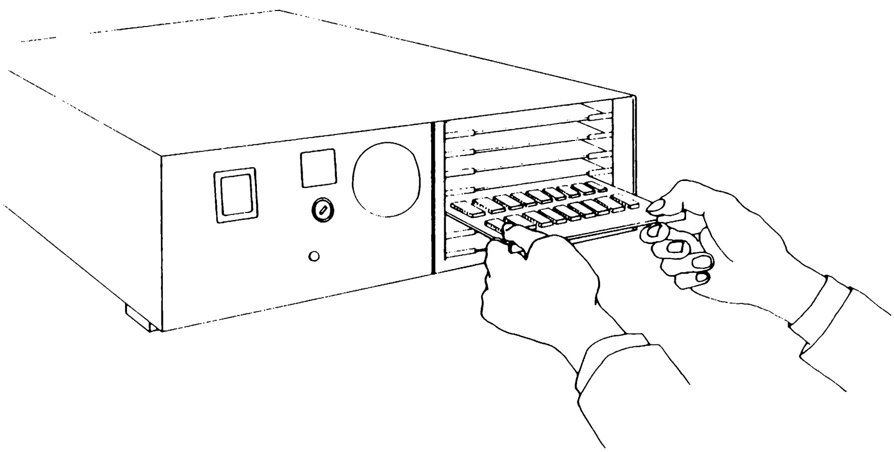
3. Remove the rear card cage cover, illustrated below. Depending on which modules are already installed, more screws than those indicated may also have to be removed. The 6 screws shown here are those that are removed from a new Controller with no options installed.



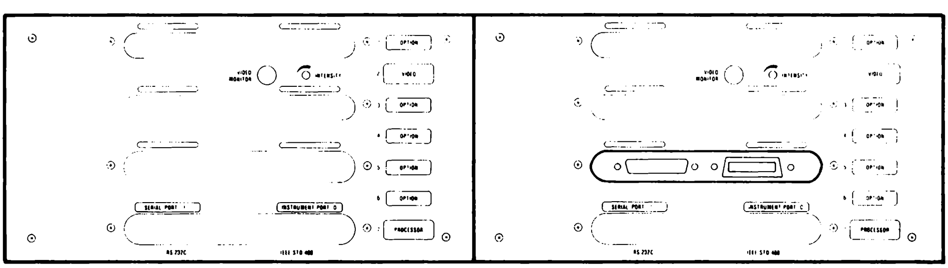
4. Determine which location to use for the option:

Memory Options:	Any open slot
17XX-008 Option:	Slot 5 only
Other Input Output Options:	Slots 1, 3, or 5 only

5. Carefully slide the option module into the card cage. Make sure the module is fully seated in the card cage so that it makes solid contact with the card-edge connector.



6. If an input/output option is being installed, remove the two screws holding the solid oval plate onto the card cage cover. After reinstalling the card cage cover, use the two screws to attach the shield plate supplied with the option, to the card cage cover. Afix the identification sticker to the outlined area on the card cage cover.



7. Reinstall the power cord.

8. Once installation is complete, power up the Controller and test the module. Refer once again to the option User Information provided with the module for any special requirements or procedures.

9. In case of problems with any new option, recheck your work to insure that switches are set properly, and that the correct jumpers are in place. Be sure that the board is fully seated in the card cage. If everything is in order, but the failure continues, refer to Appendix G, System Diagnostics, for troubleshooting information, or call your local Fluke Service Center.

1722A USER INFORMATION

OPTION 17XXA-002

PARALLEL INTERFACE BOARD

INTRODUCTION

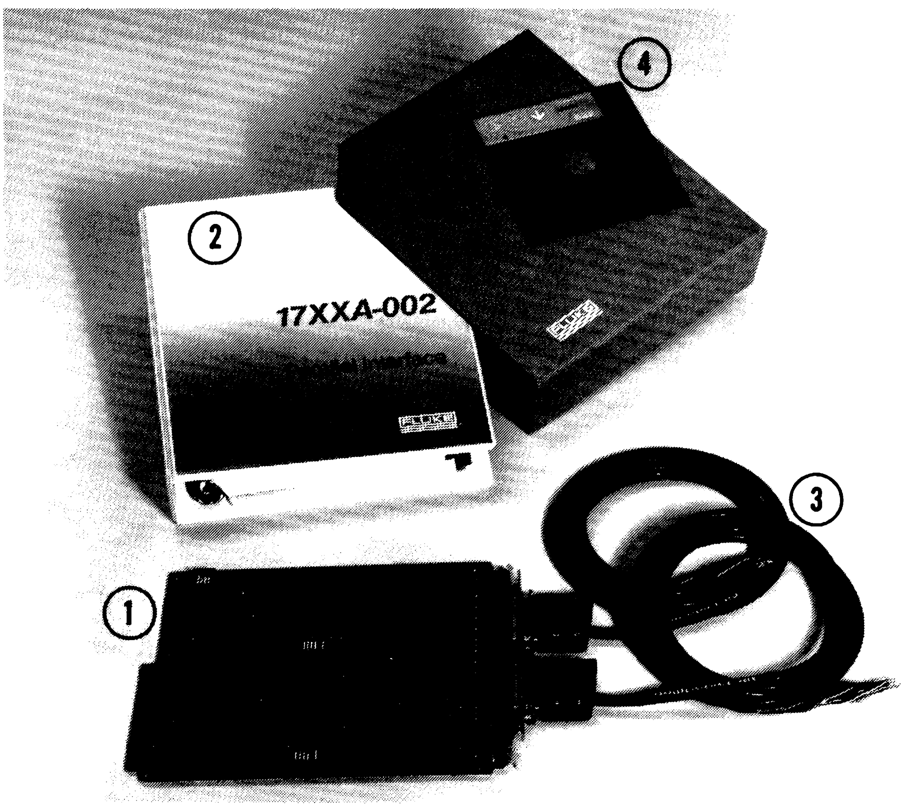
The Option 17XXA-002 Parallel Interface (PIB) is an extremely versatile addition to the Fluke Instrument Controller. The PIB has the built-in ability to adapt to some of the most unusual interface requirements of connected devices.

Option Contents

The photograph and table below show the contents of the 17XXA-002 option. The floppy disk is supplied to support the PIB in 1720A installations. For the 1722A Controller, the PIB support software is supplied on the standard system disk. With minor variations, which are fully explained in the manual, both sets of routines operate the same.

17XXA-002 PARALLEL INTERFACE OPTION CONTENTS

NUMBER	ITEM	JOHN FLUKE PART NUMBER
1	Parallel Interface Module	611947
2	Instruction Manual	732230
3	(2) Parallel Interface Cables	733907
4	1720A PIB Software Disk	630699



INSTALLATION AND CHECKOUT

The instructions that follow describe how to install a Parallel Interface option in a 1722A Instrument Controller.

Configuration Procedure

The operating configuration of the Parallel Interface is set up by a board address switch on the module.

1. Set the address switch for ports PI0 and PI1. Use the table below to ensure that the switch is set properly for port addressability.

SWITCH/ADDRESS OPERATING CONFIGURATION

BOARD	SW4	SW3	SW2	SW1	PORT PI0	ADDRESS PI1RANGE	ADDRESS
1	N	ON	ON	ON	0	1	F340-F346
2	O	ON	ON	OFF	2	3	F348-F34E
3	T	ON	OFF	ON	4	5	F350-F356
4		ON	OFF	OFF	6	7	F358-F35E
5	U	OFF	ON	ON	8	9	F360-F366
6	S	OFF	ON	OFF	10	11	F368-F36E
7	E	OFF	OFF	ON	12	13	F370-F376
8	D	OFF	OFF	OFF	14	15	F378-F37E

2. Once the switch has been set, use the directions in the Options section "Installing Hardware Options" to install the -002 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 -002 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 Parallel Interface module is included in Fluke's Module Exchange Program.

SOFTWARE COMPATIBILITY

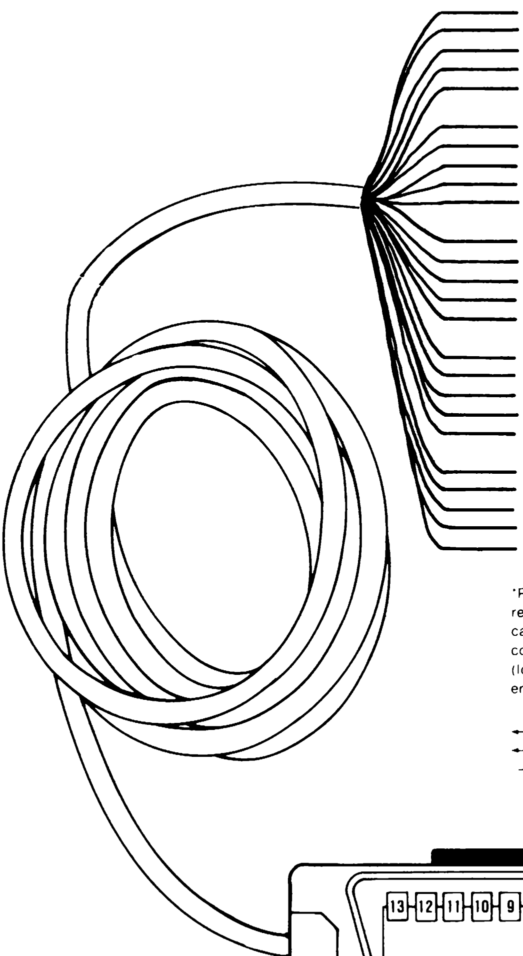
For the 1722A Instrument Controller, the Parallel Interface software is supplied on the 1722A System Disk. These machine language programs are interdependent and are compatible only in the combinations of versions supplied by Fluke and documented in published Fluke manuals. Using incompatible system software modules may give unpredictable results. In this case, Fluke cannot provide software support except for identification of compatible combinations.

NOTE

The floppy disk supplied with the Parallel Interface option contains software for operating the interface when it is installed in a 1720A Instrument Controller ONLY. The same routines for the 1722A Controller are already supplied on the System Disk that is shipped with the instrument.

INTERFACE DESCRIPTION

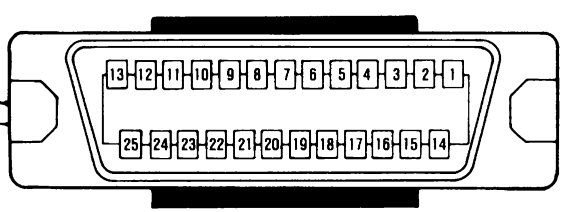
The port lines provide bidirectional data transmission between the Instrument Controller and compatible external devices. The drawing below shows the cable connector and lists the signal definition and logic states for each of the lines at the interface.



PIN	MNEMONIC	WIRE COLOR	DIRECTION
1	Shield	Ground*	
2	DP(13)	Red	↔
3	DP(8)	Yellow	↔
4	DP(11)	Green	↔
5	DP(10)	Violet	↔
6	DP(9)	Grey	↔
7	DP(4)	Red White	↔
8	DP(7)	Yellow White	↔
9	DP(6)	Green White	↔
10	DP(5)	Violet White	↔
11	DP(0)	Grey White	↔
12	DP(3)	Yellow Red	↔
13	DP(2)	Green Red	↔
14	DP(14)	Violet Red	↔
15	DP(15)	Grey Red	↔
16	DP(12)	Red Green	↔
17	RETURN	Red Black	
18	RETURN	Yellow Black	
19	RETURN	Green Black	
20	RETURN	Violet Black	
21	PFLG	Red Grey	←
22	PIOE-	Yellow Grey	←
23	PCTRL	Green Grey	→
24	PDIR	Violet Grey	→
25	DP(1)	Grey Green	↔

*Pin 1 is connected to the cable shield. This pin is not a reference point for signals. Its purpose is to connect the cable shield to a system ground. Make sure that use of this connection does not result in circular grounding paths (loops) through the system. Such ground loops can conduct enough current to interfere with data transmission.

↔ indicates bidirectional data lines
← indicates input to PIB
→ indicates output by PIB

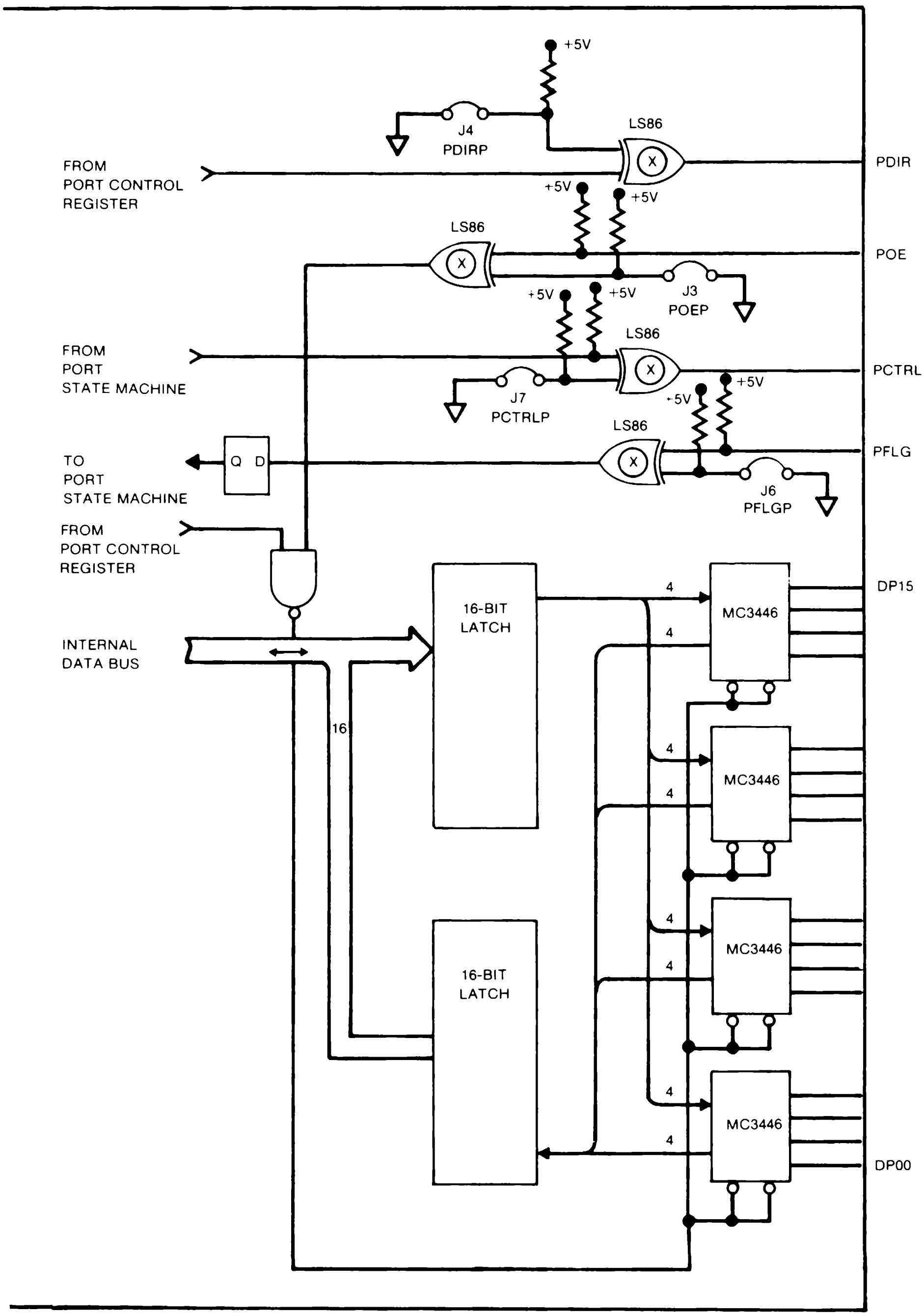


Port Signals

On the Parallel Interface module, several signals control the direction of data and the sense of the handshake lines. These signals are defined in the table below. The jumpers shown on the port schematic permit inverting handshakes.

PORT SIGNAL DEFINITIONS

SIGNAL NAME	DIRECTION	DEFINITION
PDIR	Output	Port Direction: Direction of data on port.
POE	Input	Port Output Enable: Used by external device to disable the output from the ports.
PFLG	Input	Port Flag: One of the two handshake lines; this signal originates with the peripheral device. For input operations (device to port), PFLG, when asserted, indicates that input data is valid. For output operations, PFLG, when asserted, acknowledges that the device is reading the output data from the port.
PCTRL	Output	Port Control: The other handshake line; the signal originates with the Parallel Interface module. For output operations (port to external device), PCTRL, when asserted, indicates that the output data is valid and the device may read it. For input operations, PCTRL, when asserted, indicates that the port is reading the incoming data from the device.
Data	Bidirectional	Each data line can be used either as an input or as an output.


+5V
J4
PDIRP
LS86
FROM
PORT CONTROL
REGISTER
PDIR
+5V
+5V
LS86
POE
+5V
+5V
J3
POEP
LS86
FROM
PORT
STATE MACHINE
PCTRL
J7
PCTRLP
+5V
+5V
LS86
TO
PORT
STATE MACHINE
Q D
PFLG
J6
PFLGP
FROM
PORT CONTROL
REGISTER
16-BIT
LATCH
4
MC3446
DP15
4
INTERNAL
DATA BUS
16
MC3446
MC3446
16-BIT
LATCH
MC3446
DP00

SOFTWARE LIBRARY (PIBLIB.OBJ)

The next few pages summarize the available software routines. The parameters are described immediately following the descriptions of the routines.

CHKBIT Check bit

Parameters: port, bit, bool

Description: This routine checks a particular bit on a Parallel Interface Port. It is equivalent to reading the port and then isolating the specified bit position.

CLRBIT Clear bit

Parameters: port, bit

Description: This routine clears to zero a particular bit on a selected port. It is equivalent to reading the port, ANDing the bit with 0 in the appropriate position, and then writing the data word back out to the port.

SETBIT Set bit

Parameters: port, bit

Description: This routine sets a particular bit (output = high) on a selected port. It is equivalent to reading the data latched at the port, ORing the bit in the specified position with 1, and then writing the data word back out to the port.

RDWORD Read word

Parameters: port, word

Description: This routine reads a selected port and writes the value into a variable.

WTWORD Write word

Parameters: port, word

Description: This routine writes a word from a variable to a specified port.

RDBLK Read block

Parameters: port, block, count

Description: This routine reads multiple words from a port into an array.

WTBLK Write block

Parameters: port, block, count

Description: This routine writes multiple words to a port from an array.

FRDBLK Fast Read block

Parameters: port, block, count

Description: This routine reads a block of data from a port, as fast as possible. It does not perform the error checking that is done in a normal read of a block using RDBLK.

FWTBLK Fast Write block

Parameters: port, block, count

Description: This routine writes a block of data to a port as fast as possible. It does not perform the error checking that is done in a normal block write using WTBLK.

POPEN Open a port

Parameters: port, mode, mask, timeout

Description: POPEN opens a port in preparation for data transfer at the interface.

PCLOSE Close a port

Parameters: port

Description: PCLOSE closes the specified port and returns the hardware to a passive state similar to the power-up condition.

Parameters

When the routines are used in a program, one or more parameters are specified by the programmer. All parameters must be specified as integers.

PORT — The port number for the routine to operate on, expressed as an integer in the range 0 - 15.

MODE — The Parallel Interface module operates in one of four modes: No Handshake, Full Handshake, and Strobe Input and Output Handshakes. With the exception of No Handshake, the handshakes synchronize incoming and outgoing data. The table below lists the handshake names and the mode number that the software recognizes.

HANDSHAKE MODES

NAME	DEFINITION	MODE
—	No Handshake	0
HNDSHKIN	Full Handshake Input	1
STROBEIN	Strobe Input	1
HNDSHKOUT	Full Handshake Output	2
STROBEOUT	Strobe Output	3

TIME OUT — The wait time before an incomplete handshake is terminated.

BIT — The bit number to be checked, read, or written to, expressed as an integer.

BOOL — When a bit or word is read or checked, as in the CHKBIT routine, the routine places a value into the variable specified as BOOL.

DIRECTION MASK — An integer that indicates the desired transmission direction of each bit on the port.

BLOCK	This parameter is the array to which data will be transferred using the Block subroutines RDBLK, WRTBLK, FRDBLK, and FWTBLK.
COUNT	Indicates how many array elements to transfer.

CONCLUSION

This information has been taken from the manual supplied with the PIB. Besides being the definitive source of information about the topics presented here,the PIB manual includes a great deal more information, including:

- Specifications
- Interface timing
- Sample programs
- Performance Testing
- Theory of Operation
- Schematic

1722A USER INFORMATION

Option 17XXA-004/005

Magnetic Bubble Memory

INTRODUCTION

The Option 17XXA-004/-005 Bubble Memory Modules provide additional memory for the 1722A.

Like a floppy disk, the Bubble Memory is treated by FDOS as a file-structured device. Information is retained in the device when the power is turned off.

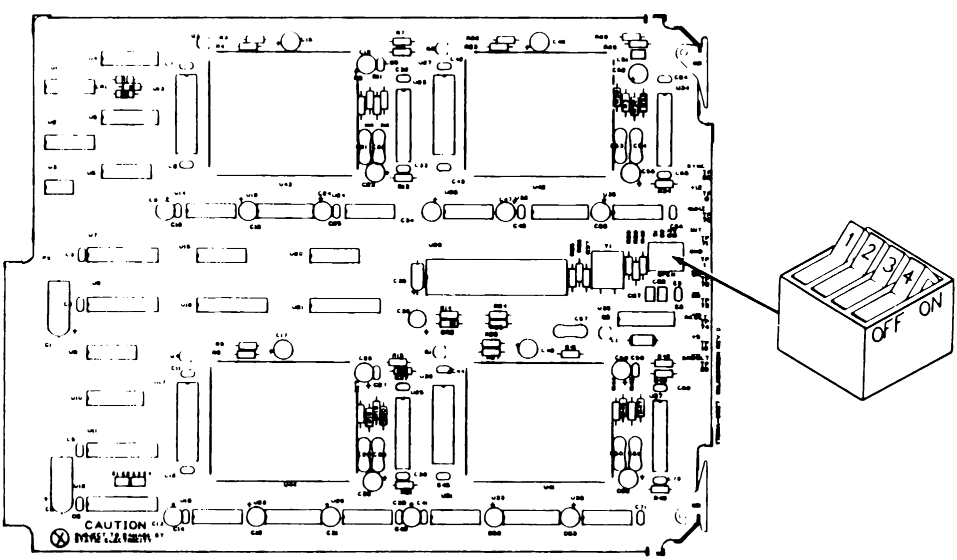
The 17XXA-004 Bubble Memory Module contains 256K bytes of memory; the 17XXA-005 module contains 512K bytes. The maximum amount that can be installed in a system is 1.5M bytes (any combination of three modules).

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 (FDOS) to operate properly using bubble memory, there must be a unique address associated with each Bubble Memory Module installed. Use the drawing below to locate the board address switch (SW1).



The 1722A has five slots available for options. Bubble Memory Modules can be installed into any three of them. The SW1 address switch settings determine the device names, and are identical for Option -004 (256K bytes) or Option -005 (512K bytes).

DEVICE NAME	ADDRESS CODE	SWITCH POSITIONS 1	2	3	4
MB0:	111X	on	on	on	X
MB1:	110X	on	on	off	X
MB2:	101X	on	off	on	X
MB3:	100X	on	off	off	X

NOTES: 1. "1" = on, "0" = off, "X" = don't care.

2. Four device names are available. However, only three are used at a time because only three modules can be installed at one time.

INSTALLATION AND CHECKOUT

1. Once address switch SW1 has been set, follow the directions in the Options Section "Installing Hardware Options" to install the module into the Controller's card cage. Be sure to turn the power off before beginning.

2. Power up the Controller and insert the 1722A System Software disk. If required, use the System Generation Utility program (SYSGEN) to make a new System Software disk that includes the Bubble Memory driver. Refer to Section 3 of the System Guide for instructions.

3. When a new System Disk has been generated, press the RESTART button and let the disk load the new FDOS.

4. Use the File Utility Program (FUP) to format the Bubble Memory Module. Type MBx: / F, where x is the device number given the module by its address switch setting. See Section 4 of the System Guide for complete details about using FUP.

5. Test the new memory board by running the Bubble Memory diagnostic, as described in Appendix G, "System Diagnostic Software", or by transferring files to and from the bubble memory device using FUP.

6. If the diagnostic test executes successfully, your Bubble Memory Module is now available for use.

7. If any trouble develops, first make sure that the address selection switch is set properly, and that the module is seated firmly in the card cage. If everything seems to be in order, but the failure continues, refer to Appendix G, "System Diagnostic Software", or call your Fluke Technical Service Center for assistance in tracking down the problem. The Bubble Memory Module is included in Fluke's Module Exchange Program.

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.

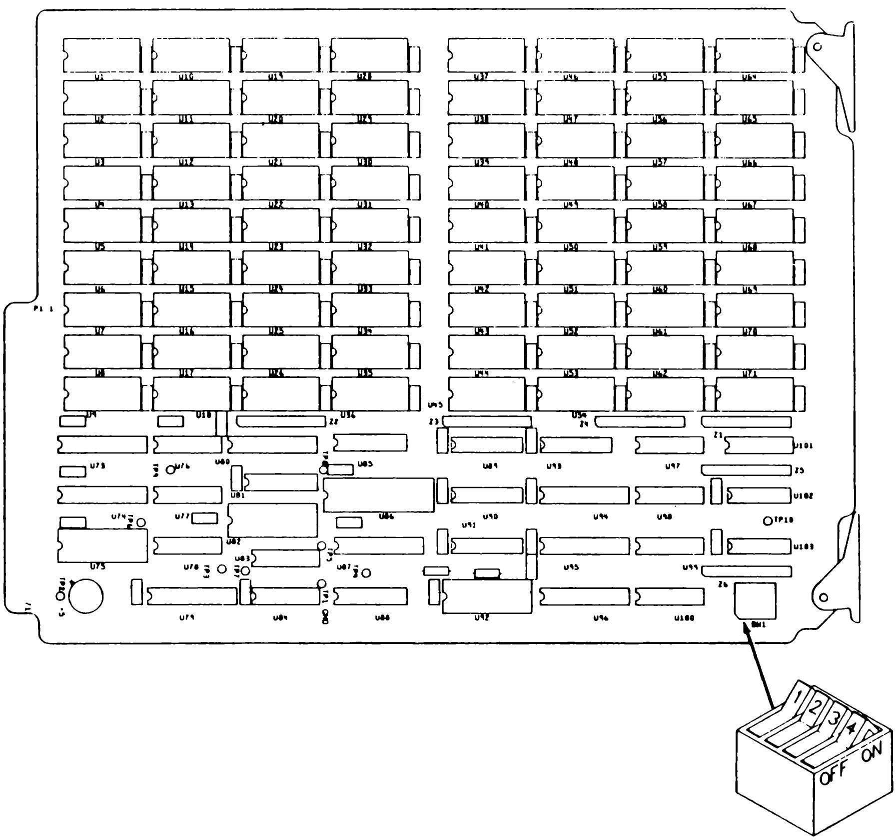
The 17XX-006 Memory Expansion Module contains 256K bytes of dynamic RAM; the 17XX-007 module contains 512K bytes. Any combination of up to five modules can be installed in a 1722A at a time. If all of the slots are filled with 17XX-007 boards, then the total expansion memory added to the 1722A would 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	1110	off	off	off	on
2	1100	off	off	on	on
3	1010	off	on	off	on
4	1000	off	on	on	on
5	0110	on	off	off	on

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 1110 and 1100. Next, the first -006 option's switches are set to 1010, and the second one to 1000.

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

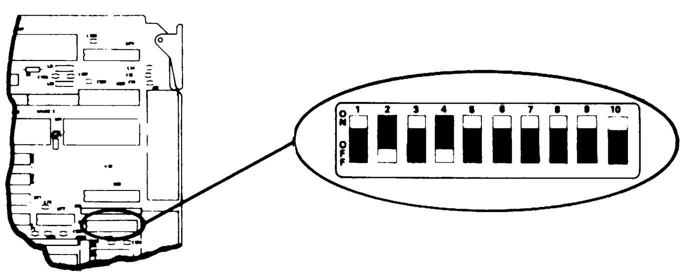
Inspect the shipping carton for damage. Notify the shipper immediately if the carton appears to have been damaged in shipping. Unwrap the module and inspect it for damage. If everything seems to be in order, go on to the next step, Installation.

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 "idle controller".



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 USER INFORMATION
OPTION 17XXA-009
DUAL SERIAL INTERFACE

INTRODUCTION

The 17XXA-009 Dual Serial Interface (DSI) provides the 1722A Instrument Controller with two additional serial communications ports. The ports are addressed as SP0: - SP9: through the Set Utility program and high level languages. They are treated similarly to KB0: and KB1: on the Single Board Computer (SBC), and KB2: on the IEEE/RS-232 Option (-008).

Up to three DSI modules can be installed in the 1722A. Each port may be configured for these electrical interfaces:

- RS-232-C
- RS-422
- 20 mA Current Loop

Each port buffers incoming and outgoing data and signals the external device when the buffers are nearly full to prevent loss of data. The signaling method or protocol may be selected as discussed below. The ports are controlled by a microprocessor which reduces the overhead on the Single Board Computer (SBC). System throughput is a function of the data being transferred at the floppy disk and the IEEE-488 and KBx: ports. If the load from these devices is heavy, external devices will be held off more frequently regardless of the data rate selected.

The Operating System (FDOS) which is supplied on the 1722A System Disk includes a device driver for the -009 option. This operating system must be used in order for your software to be able to access the Dual Serial Interface. If necessary, you can reconfigure the operating system by using this disk and following the instructions in Section 3 of the 1722A System Guide.

The disk also includes the Serial Port Software Driver (SPIO.OBJ). This driver allows a BASIC program to directly monitor and control the various lines of the serial interface, including RS-422 ENABLE, which some users may require. Information later in this section describes the operation of the driver.

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.

INSTALLATION

The Option has been configured at the factory as follows:

Electrical Interface	RS-232-C
Data rate	4800 Baud
Data Bits	7
Parity	none
Stop Bits	2
Flow Control	off
Board Address	0 (SP0: and SP1:)

The jumpers and switches are set at the factory as shown in the figure on the next page. Jumpers JPR1, 2, 3, 4, 5, 6, 29, and 35 are not user-configurable and must remain in the positions shown. Check all jumpers and switches to be sure they match the factory configuration.

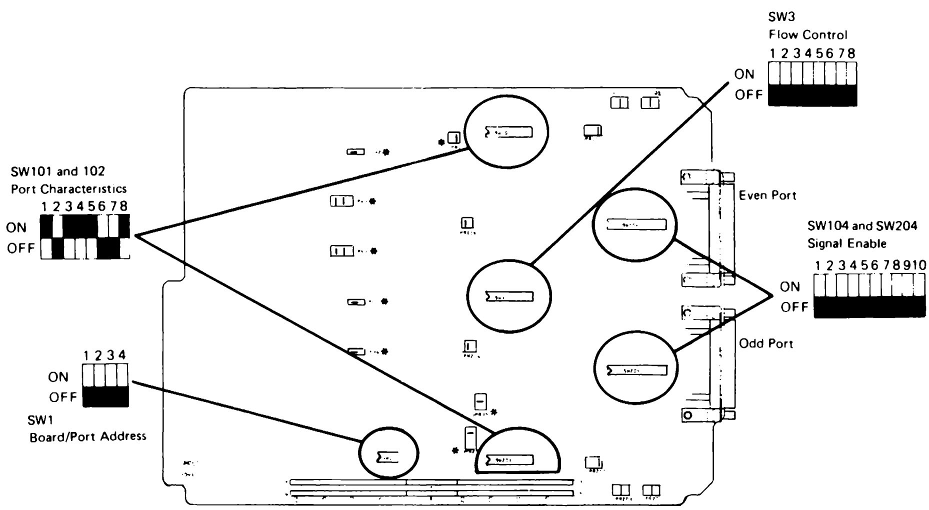
Use the directions in the Options Section of the System Guide "Installing Hardware Options" to install the -009 option into the 1722A.

If you have reconfigured the Operating System with the SYSGEN Program, make sure that the Dual Serial Interface Driver has been included. You can check this by re-booting the controller with your version of the Operating System and then running the CONFIG Program supplied on the standard System Disk.

The signals for all three interface types are available on each of the port connectors. Since this is a modification of the RS-232-C standard, the redefined pins can be switched off using SW104 and SW204 when RS-232-C is desired. This allows using cables with connections for signals defined by the standard to be used. Refer to the section "Electrical Interfaces" for connections to external devices.

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 the port connectors, jumper positions, and switch settings are correct. If the failure continues, refer to Appendix G for troubleshooting information, or call your local Fluke Service Center. The Dual Serial Interface is included in Fluke's Module Exchange Program.

FACTORY CONFIGURATION



Note: * indicates jumpers that are not user-configurable. Do not move these jumpers.

POWER ON CONFIGURATION

When the Dual Serial Interface is powered on, these things take place:

- The configuration switches are read.
- The RS-422 drivers are enabled.
- The DSI waits for input or output.

The initial states of the control lines are shown later. See "Electrical Interfaces - RS-232-C".

PROTOCOLS

XON/XOFF

The ASCII Standard defines two codes that may be used to control data transfer between devices. If the input buffer of the device receiving data is full or nearly full, XOFF is sent to the transmitting device to request the transmission be stopped. When the receiver can accept more data, the XON code is sent to resume the transmission. The Set Utility program can be used to enable or disable this protocol, and refers to the protocol as "stall input" and "stall output".

Secondary Request to Send (RS-232)

SRTS is a handshake line that is used for flow control with external devices that cannot respond to XON/XOFF codes. The polarity of SRTS is set by the Flow Control configuration switch (SW3).

RECONFIGURATION

The electrical interfaces and power-up configuration can be changed using the switches and jumpers described in the following tables. After the tables, the next sections discuss each interface and typical setups. The Set Utility program can also be used to change port characteristics. See Section 5 of the System Guide for details.

NOTE

The Port Characteristics and Flow Control switches are read only at power-up.

Board/Port Addresses (SW1)

BOARD	PORT	1 2 3 4
1	1, 0	0 0 0 0
2	3, 2	0 0 0 1
3	5, 4	0 0 1 0
4	7, 6	0 0 1 1
5	9, 8	0 1 0 0

ON = 1 = closed = enabled
OFF = 0 = open = disabled

J1 = EVEN Port
J2 = ODD Port

Port Characteristics (SW101 AND SW201)

1 2 3 4		5 6 7 8	
1 1 1 1	19200 Baud	1	Data Bits: 7
1 1 1 0	19200	0	8
1 1 0 1	9600		
1 1 0 0	7200	1 1	Parity: even
1 0 1 1	4800	1 0	odd
1 0 1 0	3600	0 1	none
1 0 0 1	2400	0 0	none
1 0 0 0	2000		
0 1 1 1	1800	1	Stop Bits: 2
0 1 1 0	1200	0	1
0 1 0 1	600		
0 1 0 0	300		
0 0 1 1	150		
0 0 1 0	134		
0 0 0 1	110		
0 0 0 0	75		

Flow Control (SW3)

1	2	3	4	5	6	7	8	
								Odd Port
1								enable
0								disable
	1							active high
	0							active low
		x	x					not used
								Even Port
				1				enable
				0				disable
					1			active high
					0			active low
						x	x	not used

Port Connector Signal Disable Switches (SW104 and SW204)

1	RS-422	Rx+
2		Rx-
3	20mA	Rx+
4		Rx-
5		I1-/-12v
6		I2-/-12v
7	RS-422	Tx+
8		Tx-
9	20mA	Tx+
10		Tx-

Clear To Send (CTS) Input to UART (JPR116 and JPR216)

Left	CTS
Right	CTS and SRLSD

UART Receive Input (JPR117 and JPR217)

Left	20mA loop
Middle	RS-422
Right	RS-232-C

Voltage/Current Sources (JPR102, 103, 202, 203)

Left	20mA
Middle	OFF
Right	+12v

ELECTRICAL INTERFACES

RS-232-C

Maximums

Distance	50ft
Data Rate	19200 Baud

Typical Applications

Data Communications Equipment (DCE)
(Use RS-232-C Cable)

Modems

Data Terminal Equipment (DTE)
(Use "Null Modem Cable")

1780A
VT100
Printers

Port Connections

To DCE / **From DCE**

Pin		Circuit Function	Pin		Circuit Function
1	AA	Shield			
7	AB	Signal Common			
2	BB	Transmitted Data	3	BA	Received Data
4	CA	Request to Send	5	CB	Clear to Send
20	CD	Data Terminal Ready	6	CC	Data Set Ready
19	SCA	Secondary Request to Send			
11	UND	RS-232-B			
			22	CE	Ring Indicator
			12	SCF	Secondary Received Line Signal Detector
			8	CF	Received Line Signal Detector

The Clear To Send jumpers (JPR116 and 216) allow the CTS input to the UART to be either the CB circuit or the logical AND of CB and SCF. This feature is useful for external devices that use the SCF circuit as a "busy" indicator.

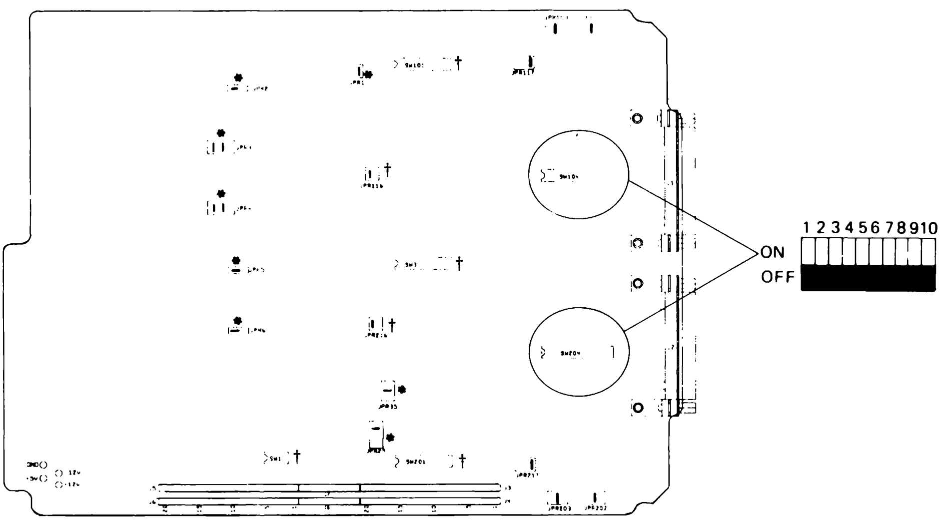
Power-on States of the Control Lines

SIGNAL	PIN	STATE
BB	2	MARK
CA	4	ON
SCA	11, 19	OFF
CD	20	ON

NOTE

Clear To Send (Pin 5) controls the transmission from the port. When it is ON, the corresponding UART is permitted to transmit. When it is OFF, the UART stops transmitting, beginning at the next character boundary. This behavior is a function of the UART hardware, and always applies. It cannot be disabled. Leave Pin 5 unterminated if not used by the receiving device.

RS-232-C CONFIGURATION



Notes: * *indicates jumpers that are not user-configurable. Do not move these jumpers.*

† *indicates switches or jumpers that can be set as desired. Refer to tables in the text for settings.*

RS-422

Maximums

Distance	4000 feet
Data Rate	19200 Baud

Typical Applications

2400B
1780A/AU

Protection Networks

The circuitry incorporates protection networks on the drivers and receivers to reduce susceptibility to high voltage transients and faults.

Port Connections

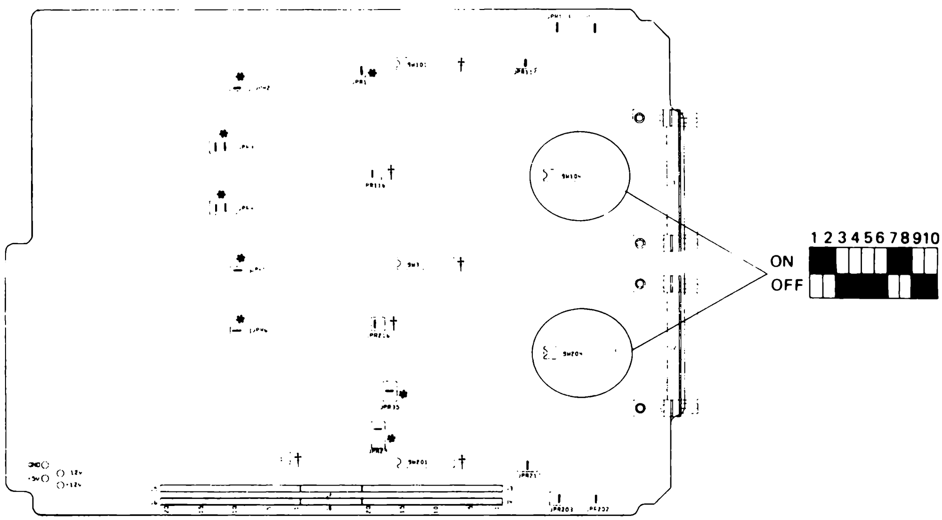
To External Device

PIN	SWITCH	SIGNAL
9	7	Tx+
10	8	Tx-
7		Signal Ground

From External Device

PIN	SWITCH	SIGNAL
14	1	Rx+
15	2	Rx-

RS-422 CONFIGURATION



Notes: * *indicates jumpers that are not user-configurable. Do not move these jumpers.*

† *indicates switches or jumpers that can be set as desired. Refer to tables in the text for settings.*

20 MA LOOP

Maximums

Distance	1000 feet
Data Rate	4800 Baud
Voltage	30 Vdc

Typical Application

TTY

Port Connections

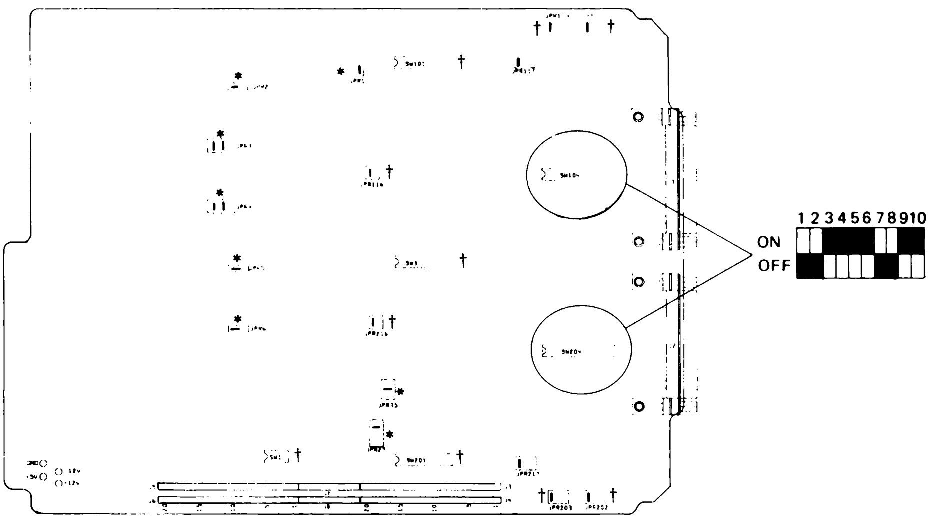
To External Device

PIN	SWITCH	SIGNAL
12	9	Tx+
23	10	Tx-
18	5	I1-/-12v
16	6	I2-/-12v

From External Device

PIN	SWITCH	SIGNAL
24	3	Rx+
25	4	Rx-
17	JPRx02	I1+/+12v
13	JPRx03	I2+/+12v

20 MA CURRENT LOOP CONFIGURATION



Notes: * *indicates jumpers that are not user-configurable. Do not move these jumpers.*

† *indicates switches or jumpers that can be set as desired. Refer to tables in the text for settings.*

USING THE DUAL SERIAL INTERFACE

The -009 device driver in FDOS allows the programmer to use the DSI from all languages and utility programs just as any other serial device. The ports are specified as SP0: through SP9: depending on the board address selected.

Two additional routines are provided to gain more direct control of the interface lines. The user can read the current state of all the input and output lines and can set the output lines to any state he desires. The user can also enable and disable the RS-422 drivers. These routines are supplied in the following files for each programming language:

LANGUAGE	FILENAME	SUPPLIED WITH
Interpreted BASIC	SPIO.OBJ	1722A System Disk
Compiled BASIC	BASIC.LIB	17XXA-203 Compiled BASIC
Extended BASIC	BASIC.LIB	17XXA-205 Extended BASIC
FORTRAN	FLUK22.LIB	17XXA-202 FORTRAN

PROGRAMMING IN BASIC

The routines can be used from Interpreted BASIC, by using the LINK statement as follows:

LINK "SPIO" ⟨RETURN⟩

To use the routines in Compiled BASIC, use the FIND command in the Linking Loader, as follows:

F BASIC ⟨RETURN⟩

Description

The module consists of two routines: SPGETS and SPSETS. SPGETS is called to get a "snapshot" of the inputs and outputs. A port number between 0 and 9 is specified, along with an integer word into which the status is to be stored by SPGETS. When it is called, SPGETS retrieves the current input and output status and returns the value to the caller in the specified integer variable. The state of each line is represented by a corresponding bit in the status word. The bit assignments are illustrated below.

SPSETS sets the state of the output lines. A port number between 0 and 9 is specified, along with an integer word which contains the control data to be output to the control lines. The bit assignments in the control word are identical to the assignments in the status word. The input portion of the status/control word is ignored by this function.

Usage

```
CALL SPGETS(port%, status%)
        INTEGER port%          ! 0 for SP0:
                               ! 1 for SP1:
                               ! ........
                               ! 9 for SP9:
                               !
                 status%       ! RS-232 input/output line status
                               ! bit
                               ! value  pin      description
                               ! -----  ---  -------------------------
                               !    1    20  Data Terminal Ready
                               !    2    19  Secondary Request To Send
                               !    4    11  Undefined
                               !    8     4  Request To Send
                               !  128     -  RS-422 Output Enable
                               !  ----   --  --------------------------
                               !  256    12  Sec Rcv Line Sig Detector
                               !  512    22  Ring Indicator
                               ! 1024     8  Rcv Line Signal Detector
                               ! 2048     6  Data Set Ready
                               ! 4096     5  Clear To Send
------------------------------------------------------------
CALL SPSETS(port%, status%)
        INTEGER port%          ! 0 for SP0:
                               ! 1 for SP1:
                               ! ........
                               ! 9 for SP9:
                               !
                 status%       ! RS-232 output line control
                               ! bit
                               ! value  pin      description
                               ! -----  ---  -------------------------
                               !    1    20  Data Terminal Ready
                               !    2    19  Secondary Request To Send
                               !    4    11  Undefined
                               !    8     4  Request To Send
                               !  128     -  RS-422 Output Enable
```

Errors

All errors are recoverable:

5100 FDOS function call failed (usually means option missing or faulty)

5101 invalid port number

External Effects

The RS-232 output lines may be changed. Turning off Request To Send inhibits transmission on the corresponding port.

FORTRAN PROGRAMMING

From FORTRAN, the routines are called in the same manner as they are in BASIC, except that an error parameter is passed as follows:

```
CALL SPGETS (port, status, error)

CALL SPSETS (port, status, error)
```

If the error value returned is non-zero, then one of the following has occurred:

No device driver in FDOS
Option missing or faulty
Illegal port number specified

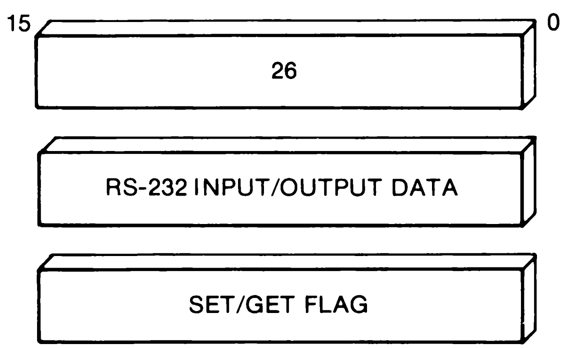
ASSEMBLY LANGUAGE PROGRAMMING

The FDOS driver for the option supports all the applicable functions, which are listed below. For a description of the call conventions, refer to the FDOS direct I/O functions for KBx: ports in the Assembly Language Manual. The functions are:

0	Read a Record
2	Write a Record
4	(unused)
6	Initialize Driver
8	Get Port Configuration
10	Set Port Configuration
12	Return Number of characters/lines in Input Buffer
14	Get a Character
16	Put a Character
18	Send a Break
20	(unused)
22	(unused)
24	Return Number of Characters in Output Buffer

Full control of the UARTs on the Dual Serial Interface option requires one additional FDOS call, described below.

26 READ/WRITE RS-232 LINES



Description

This function either sets or gets the the current state of the RS-232 signal lines. When the Set/Get flag is non-zero, the lower byte of the RS-232 data word is loaded into the latches that drive the RS-232 lines. When the set/get flag is zero, the entire RS-232 data word is returned with the current state of the RS-232 interface, including both input and output lines.

In addition, this word also controls the RS-422 data driver. When the 422EN bit is set to one (1), the RS-422 driver is active. When 422EN is set to zero (0), the RS-422 output drivers are tri-stated.

The set function has no effect on the input signal lines. They are always sampled directly during a get function.

Format of RS-232 Data Word

	[READ ONLY]								[READ/WRITE]							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
				CTS	DSR	RLSD	RI	SRLSD	422EN				RTS	SRTS	SRTS	DTR
CIRCUIT NAME				CB	CC	CF	CE	SCF					CA	—	SCA	CD
PIN NUMBER				5	6	8	22	12					4	11	19	20
				CLEAR TO SEND	DATA SET READY	RECEIVED LINE SIGNAL DETECT	RING INDICATOR	SECONDARY REC'D LINE SIG. DET.	RS-422 DRIVER ENABLE				REQUEST TO SEND	UNDEFINED	SECONDARY REQUEST TO SEND	DATA TERMINAL READY

1722A USER INFORMATION

1760A and 1761A DISK DRIVE SYSTEMS

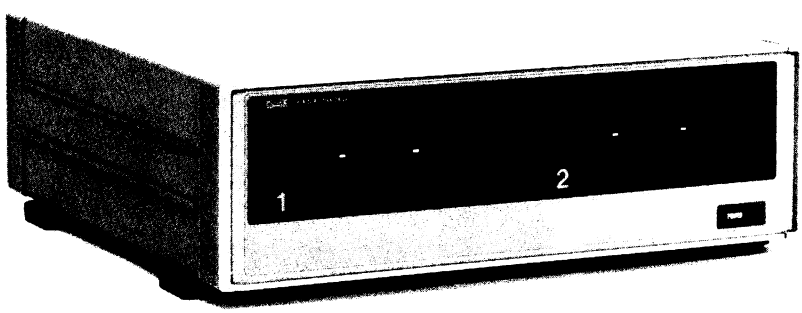
WARNING

This equipment generates and uses radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio and television reception. It has been tested and found to comply with the limits for a Class B computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. If this equipment does cause interference, which can be determined by turning the the equipment off and on, the user is encouraged to try to correct the interference by relocating the equipment with respect to the receiver or plugging the computer into a different outlet so that the computer and receiver are on separate branch circuits.

INTRODUCTION

The Fluke 1760A and 1761A Disk Drive Systems provide additional floppy disk mass storage for the 1722A Instrument Controller. They connect to the Controller's IEEE-488 connector, and are recognized and addressed as additional logical devices MF1: - MF4:.

In addition to the internally mounted floppy disk drive (MF0:), up to four other drives can be connected to the Controller. The Fluke model 1760A is a single 5-1/4' unit, and the 1761A has two drives. When they are installed, they act similar to the internal drive; operation over the IEEE-488 bus is transparent to the user.



PRE-INSTALLATION CHECKOUT

The Disk Drive System is carefully inspected at the factory before shipment. Remove it from the shipping carton and inspect it for any signs of physical damage that might have occurred during shipment. If you find anything wrong, notify the nearest Fluke Service Center immediately and file a claim with the carrier.

INSTALLATION

These procedures describe how to install the Disk Drive System. There are two main steps:

- Setting the proper line voltage.
- Setting the IEEE-488 address.

Setting the Line Voltage

The Disk Drive System is shipped configured to the line voltage specified on the order form. If no voltage is specified, the factory ships the drive to operate on 120V ac, 47 to 63 Hz. If that is the voltage you will be using, skip this procedure, and go on to the next step, setting the IEEE-488 address. This procedure is only required if the voltage setting is different than that required, but it just takes a moment to check, so we recommend that you check the voltage as part of the incoming inspection.

1. Place the drive on a suitable work surface with the rear facing you, and with the line cord disconnected.

2. Slide the clear plastic cover (A) to the side, so that it covers the line plug connector.

3. Look at the wafer (B) at the top of the AC line connector. It shows the voltage for which the drive is configured. If the number shown differs from the voltage at the installation site, remove the wafer from its slot, and re-install it so that the correct number shows. This may be either 100, 120, 200, or 240.

4. Slide the cover back over the wafer, and double check that the correct voltage is still visible.

NOTE

Changing the wafer's position changes the voltage configuration. No frequency conversion is needed.

5. Check the fuse (C) against this table, and replace it for the correct value if needed.

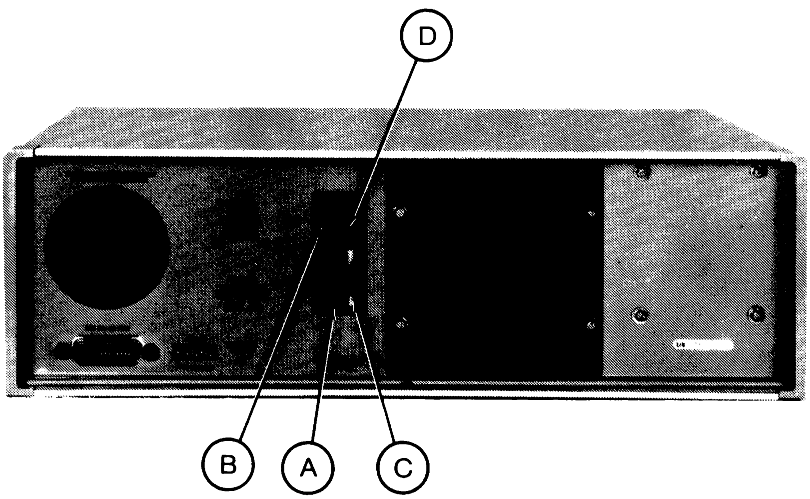
Voltage Setting	Fuse Rating
100 to 120	1 ampere, 250 volt, slow blow
200 to 240	1/2 ampere, 250 volt, slow blow

6. Check the power cord supplied with the Disk Drive System to ensure that it matches the receptacle. If it does not match, contact your sales representative to obtain the correct cord.

WARNING

If it is necessary to replace the power cord, the replacement must have the same polarity as the original. If it does not, a shock hazard exists, and the Disk Drive System may be damaged.

7. Plug the AC line plug into the connector (D) at the rear of the Disk Drive System. Do not apply power until the complete installation procedures have been done.



Selecting the IEEE-488 Address

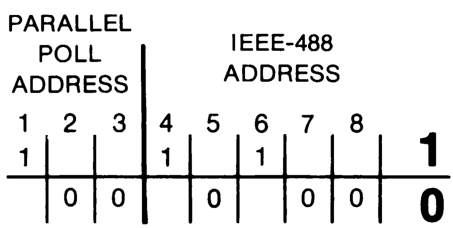
After the power requirements have been taken care of, the next step is to connect the Disk Drive System to the Controller's IEEE-488 port.

1. Disconnect power from the Controller and the Disk Drive System.

2. Remove the Single Board Computer module from the Controller (slot 7). Check configuration switch S1 to be sure that position 5 and 6 are set to the OFF position. Doing so makes the Controller the System Controller rather than an idle controller. Only a System Controller can manipulate the bus control lines to initialize the disk drive.

3. Replace the Single Board Computer Module into slot 7, and reattach the Controller's rear cover.

4. Locate the switch labeled "Device Address" on the back of the Disk Drive System. Set it to IEEE-488 Address 20, Parallel Poll Address 4.



NOTE

If the Controller is installed in a system, make sure that no other connected equipment is set to Address 20, because bus contention problems might occur, in which case neither the drive nor the other device will operate properly. Also make sure that the Controller itself is not set to address 20.

If a second Disk Drive System is connected to the Controller, it must be set to Device Address 21, Parallel Poll Address 5. (Switches ON: 1, 3, 4, 6, and 8.)

5. Attach the Disk Drive System IEEE-488 connector to the IEEE-488 connector on the Controller's Single Board Computer module. If you need to order the cable, see the table below:

Fluke P/N	Length
Y8021	1 meter
Y8022	2 meters
Y8023	4 meters

TESTING THE DISK DRIVE SYSTEM

At this point, all the steps have been completed to prepare for using the new Disk Drive System. To begin using it, remember that it provides new logical devices: MF1:, and so on. Also be sure to format floppy disks prior to use, as they are not formatted at the factory prior to shipment.

WARNING

Whenever the Controller is accessing the floppy disk drive, do not press the RESTART or ABORT buttons or enter ⟨CTRL⟩/P. Doing so may damage the directory or data files on the disk. The disk is being accessed any time the red LED indicator is lit.

1. Connect the Disk Drive System to the Controller's IEEE-488 Port 0 connector, and power up both units.

2. Follow the instructions in Appendix G of the System Guide to run the diagnostic *MFXTST*. This test will check the disk drive speed and media detection logic, then seek, format, write, and read data back from a disk installed in each drive.

USING THE DISK DRIVE SYSTEM

There is a software device driver for the 1760A and 1761A that can be linked into the 1722A operating system (FDOS). The device driver allows the system software and applications programs to treat the Disk Drive System as another logical device in the system. The device names are MF1: and MF2: for a Disk Drive System at IEEE-488 Address 20, and MF3: and MF4: for a Disk Drive System at Address 21.

The operating system (FDOS2.SYS) supplied on the 1722A System Disk does not contain the device driver for the 1760A and 1761A. You must run the SYSGEN program to create a new operating system which includes this driver before you can use the Disk Drive System. Follow the instructions in Section 3 of the 1722A System Guide to reconfigure the operating system.

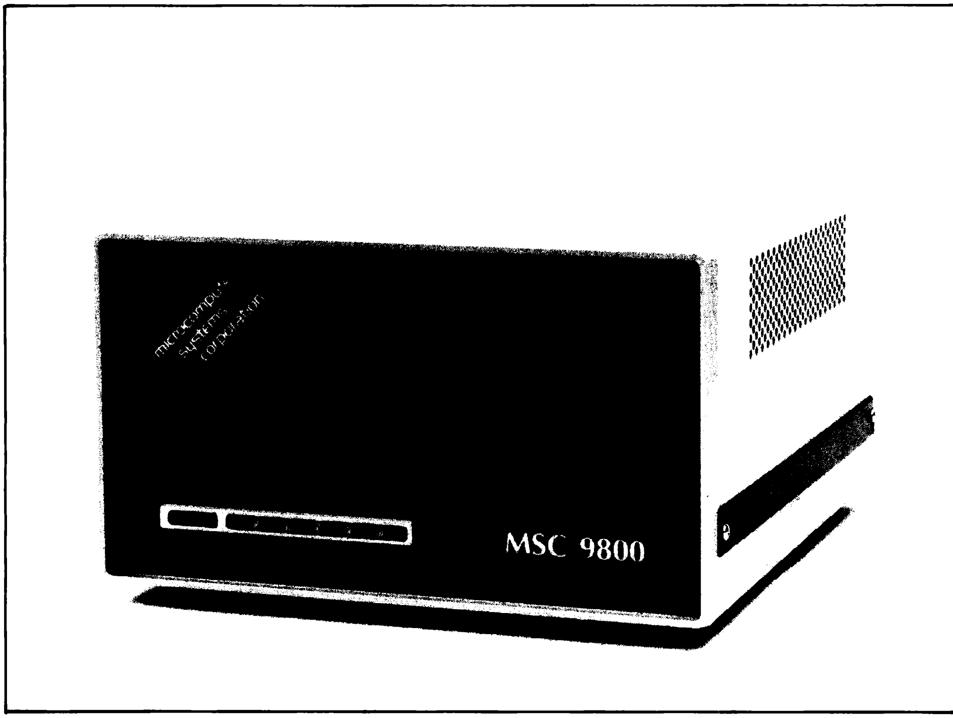
1722A USER INFORMATION
1765A/AB WINCHESTER DISK DRIVE

WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

INTRODUCTION

The Fluke 1765A/AB Winchester Disk Storage System provides 10 megabytes of mass storage for the 1722A Instrument Controller. It connects to the Controller's IEEE-488 connector, and is recognized and addressed as four logical devices: WD0:, WD1:, WD2:, and WD3:.



PRE-INSTALLATION CHECKOUT

The disk drive is carefully inspected at the factory before shipment. Remove it from the shipping carton and carefully inspect it for any signs of physical damage that might have occurred during shipment. If you find any damage, notify the nearest Fluke Service Center immediately and file a claim with the carrier.

These procedures describe how to install the disk drive. There are two main steps:

- Setting the proper line voltage.
- Setting the IEEE-488 address.

Setting the Line Voltage

The 1765A/AB is shipped configured to the line voltage specified on the order form. If no voltage is specified, the factory ships the drive to operate on 120V ac, 47 to 63 Hz. If that is the voltage you will be using, skip this procedure, and go on to the next step, setting the IEEE-488 address. This procedure is only required if the voltage setting is different than that required, but it just takes a moment to check, so we recommend that you check the voltage as part of the incoming inspection.

1. Place the drive on a suitable work surface with the rear facing you, and with the line cord disconnected.

2. Look at the wafer (A) at the top of the AC line connector. It shows the voltage for which the drive is configured. If the number shown differs from the voltage at the installation site, remove the wafer from its slot, and re-install it so that the correct number shows. This may be either 100, 120, 200, or 240.

   NOTE
   Changing the wafer's position changes the voltage configuration. No frequency conversion is needed.

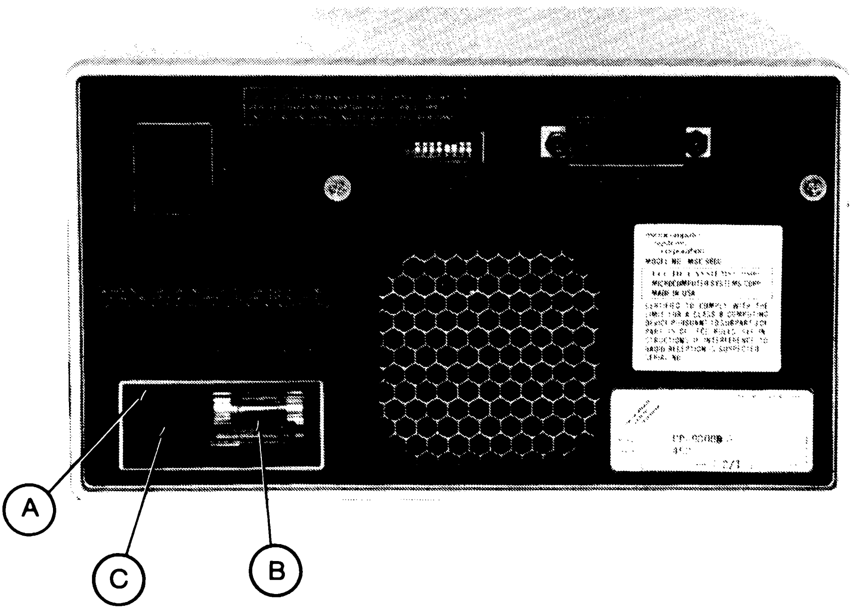
3. Check the fuse (B) against this table, and replace it for the correct value if needed.

Voltage Setting	Fuse Rating
100 to 120	2 ampere, 250 volt, slow blow
200 to 240	1 ampere, 250 volt, slow blow

4. Check the power cord supplied with the disk drive to ensure that it matches the receptacle. If it does not match, contact your sales representative to obtain the correct cord.

   WARNING
   If it is necessary to replace the power cord, the replacement must have the same polarity as the original. If it does not, a shock hazard exists, and the disk drive may be damaged.

5. Plug the AC line plug into the connector (C) at the rear of the disk drive. Do not apply power until the complete installation procedures have been done.


A
C
B

Selecting the IEEE-488 Address

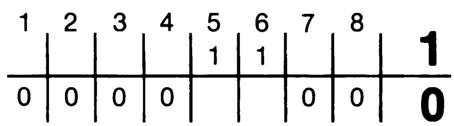
After the power requirements have been taken care of, the next step is to connect the 1765A/AB to the Controller's IEEE-488 port.

1. Disconnect power from the Controller and the disk drive.

2. Remove the Single Board Computer module from the Controller (slot 7). Check configuration switch S1 to be sure that positions 5 and 6 are set to the OFF position. Doing so makes the Controller the System Controller rather than a Controller in Charge. Only a System Controller can manipulate the bus control lines to initialize the disk drive.

3. Replace the Single Board Computer Module into slot 7, and reattach the Controller's rear cover.

4. Locate the switch labeled "Device Address" on the back of the 1765A/AB. Set it to IEEE-488 Address 12. The orientation of the switch differs between revisions of the Disk Drive System, but the back panel makes clear the required direction to place a switch ON switch settings. When a switch is set to 1, it is ON (closed). For Address 12, switches 5 and 6 should be ON, and all others OFF as shown:



NOTE

If the Controller is installed in a system, make sure that no other connected equipment is set to Address 12, because bus contention problems may occur, in which case neither the drive nor the other device will operate properly. Also make sure that the Controller itself is not set to address 12.

5. Attach the disk drive IEEE-488 connector to the IEEE-488 connector on the Controller's Single Board Computer module. If you need to order a cable, see the table below:

Fluke P/N	Length
Y8021	1 meter
Y8022	2 meters
Y8023	4 meters

Testing the Hard Disk Drive

At this point, all the steps have been completed to prepare for using the new hard disk. To begin using it, remember that it provides four new logical devices: WD0: - WD3:. There is no need to format the disk prior to use, as it has been formatted at the factory prior to shipment.

WARNING

Whenever the Controller is accessing the Winchester disk drive, do not press the RESTART or ABORT buttons or enter ⟨CTRL⟩/P. Doing so may damage the directory or data files on the disk. The disk is being accessed any time the red LED indicator is lit.

1. Connect the drive to the Controller's IEEE-488 Port 0 connector, and power up both units.

2. Follow the instructions in Appendix G of the System Guide to run the diagnostic WDXTST. This test program performs two functions:

   Self Test — This program sends a self-test command to the disk controller inside the 1765A/AB. When it receives this command, the 1765A/AB performs an internal disk controller test and communications test.

   Verify — This program checks each sector on the disk for errors, and reports any errors to the display.

3. When the program has been selected, four options will be presented on the screen:

   Option 1 - Self Test

   Option 2 - Verify

   Option 3 - Self Test and Verify

   Option 4 - Exit (Exits to FDOS.)

4. Select the option desired. For new installations, Option 3 is probably the most useful. If the message "correctable ECC error" is displayed during the Verify operation, press ⟨RETURN⟩ to continue the test. This indicates that a software correctable error occured. Any other errors indicate a faulty unit, and should be reported to the local Fluke Service Center.

Using the Winchester Disk Drive

There is a software device driver for the 1765A/AB that can be linked into the 1722A operating system (FDOS). The device driver allows the system software and applications programs to treat the Winchester Disk Drive as four additional logical devices in the system. The device names are WD1:, WD2:, WD3: and WD4:.

The operating system (FDOS2.SYS) supplied on the 1722A System Disk does not contain the device driver for the 1765A/AB. You must run the SYSGEN program to create a new operating system which includes this driver before you can use the Winchester Disk Drive. Follow the instructions in Section 3 of the 1722A System Guide to reconfigure the operating system.

Appendix A
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U.S. Sales for all Fluke Products

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Tucson
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Irvine, CA 92713
16969 Von Karman
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(714) 863-9031

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Carson, CA 90746
(213) 538-3900

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Santa Clara, CA 95051
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Hinditron Services Pvt. Ltd.
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Euro House
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Kuwait, Arabian Gulf
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