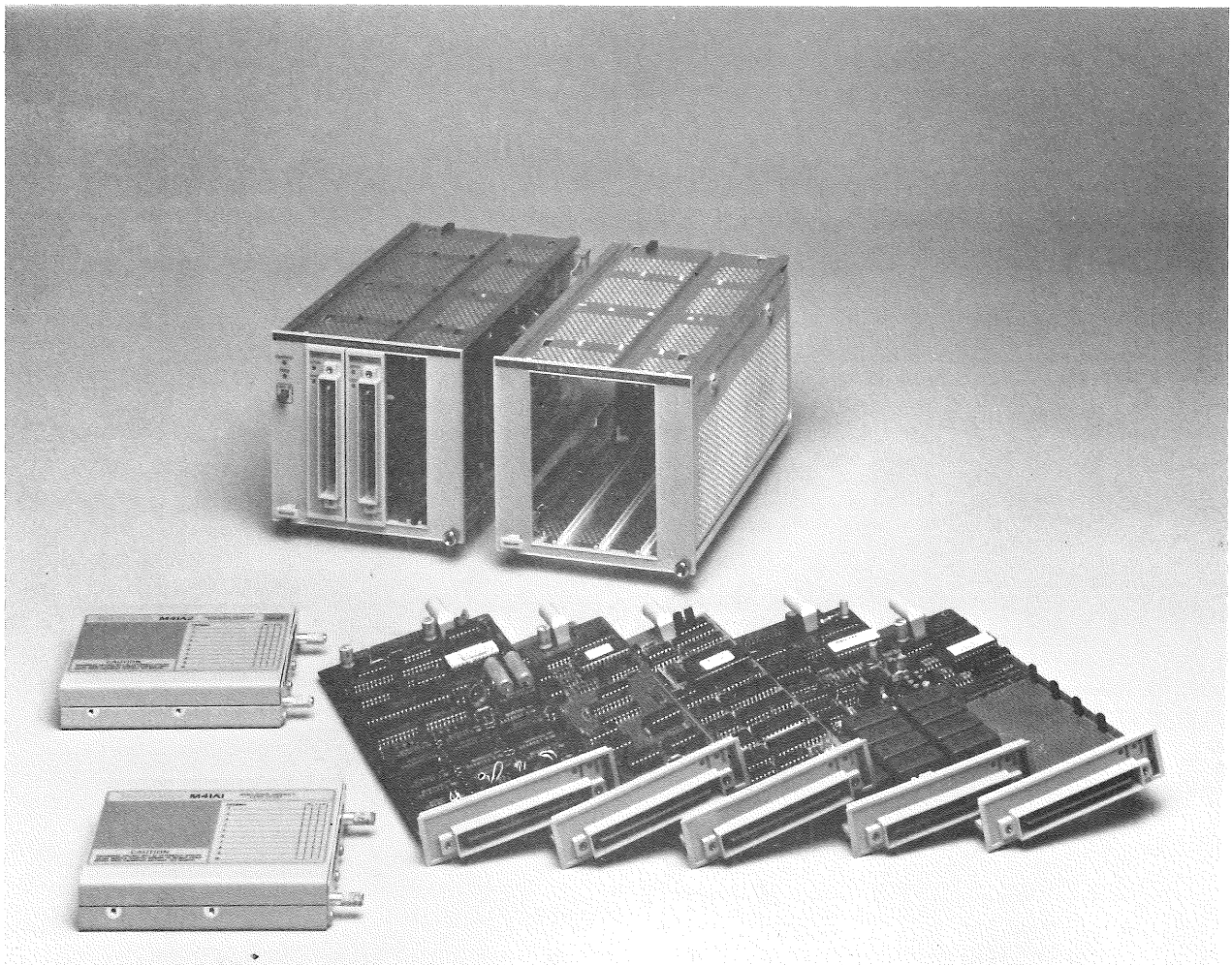
MI 5010 Multifunction Interfacing System User's Guide



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Introduction

This user's guide is designed to help you get started using the Tektronix MI 5010 Multifunction Interfacing System. It is intended to supplement, rather than take the place of, the operator's manuals and other documentation supplied with the elements of the system. Please refer to the other documents for further details on its operation.

The MI 5010 Multifunction Interfacing system consists of the MI 5010 Multifunction Interface, the MX 5010 Multifunction Interface Extender, and, at present, seven function cards capable of a variety of functions typically required in automated testing system interfacing, data acquisition and generation, and process control.

The MI 5010 and MX 5010 each house up to three of the function cards, in any combination. The MI 5010 provides the means of communication between the system controller and the function cards. The MX 5010 is always used in connection with an MI 5010, extending its control to six function cards at one GPIB address.

As of this printing, the function cards available for use in the MI/MX system are:

50M10 Analog-to-Digital Converter Card
50M20 Digital-to-Analog Converter Card
50M30 Digital Input/Output Card
50M40 Relay Scanner Card
50M41 Low-Level Relay Scanner Card
50M50 Memory Card
50M70 Development Card

Section 1
MI 5010 Operation

Setting up the MI 5010 for GPIB Operation

The MI 5010 communicates on the GPIB via the GPIB connector on the rear of the TM 5000 power module in which it is installed. Each GPIB instrument within a given power module will have its own address; the power module itself does not have an address. Power to the power module should be turned off when inserting or removing plug-in instruments or cards.

The MI 5010 primary address and message terminator are set by means of a bank of six switches on the rear of the MI 5010. A label similar to that shown in Figure 1 identifies the switches and their meanings. The MI 5010 is shipped from the factory with the switches set to an address of 23 and to EOI-only for the message terminator.

Valid primary addresses include the range of 0 to 30 (address 31 effectively disables the MI 5010 from communicating on the GPIB). If your controller reserves an address for itself, do not set the MI 5010 to that address. The Tektronix 4050-series controllers reserve address 0 for themselves. The Tektronix 4041 defaults to address 30 on power-on, but may be programmed to use any primary address. The MI 5010 ignores secondary addresses.

EOI-only is recommended as the message terminator for use with Tektronix controllers. LF/EOI is recommended for use with a Hewlett-Packard controller. (In the latter position, the MI 5010 still recognizes EOI as a terminator and transmits EOI concurrently with the line-feed character to terminate the message.)

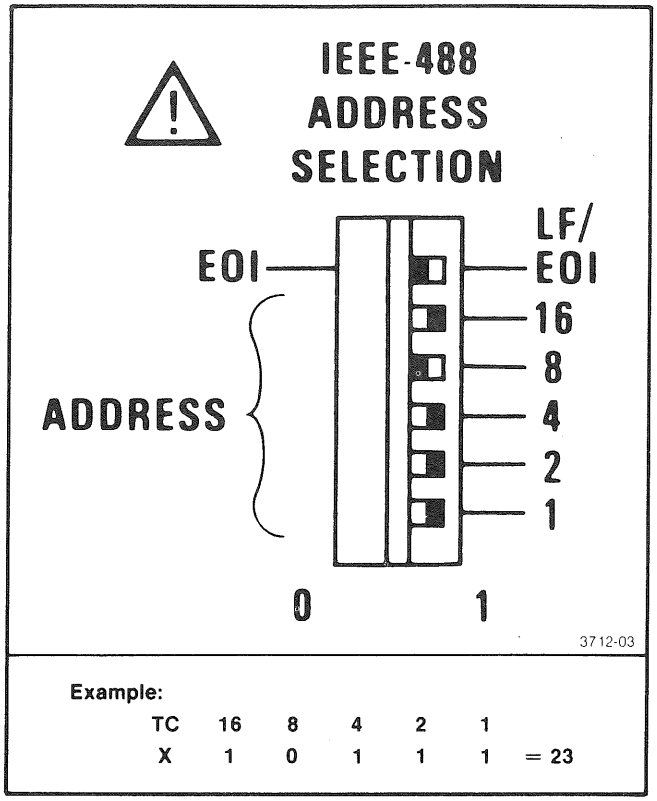


Fig. 1-1. *MI 5010 address and terminator switches.*

MI 5010 Power-On

The MI 5010/MX 5010 performs a self-test at power-up. During the self-test, all front-panel indicators (the ADDRESSED and ERROR lights on the front of the MI 5010 and the ACTIVE and ERROR lights on the front of each of the installed function cards) are lighted. If an internal error is detected, the ERROR light on the MI 5010 and/or one or more of the function cards will remain lighted after the self-test has been completed. See the operator's manual for the proper procedure to follow in the case of a failed self-test.

Following a successful self-test, the MI 5010 and the installed function cards go to the default states shown in Section 4 of this guide.

The MI 5010 asserts SRQ to report power-on status after completing the self-test. This SRQ can be handled by a serial poll, although the MI 5010 communicates normally on the GPIB and executes commands whether or not the SRQ is serviced. Some controllers, such as the Tektronix 4051 and 4052 when used without the 405XR14 GPIB rompack, require that the program contain an SRQ handler and begin by enabling the handler; otherwise the power-on SRQ will cause the program to halt. The 4051 and 4052 indicate this condition by displaying the message, "NO SRQ ON UNIT."

Sending Messages to the MI 5010

Most GPIB controllers provide a high-level statement that allows you to transfer device-dependent messages to the MI 5010. In the 4041, it's the PRINT statement.

```
150 Print #23:"TIME 09:11:00"
```

A useful variation assigns the MI 5010 address to a variable and inserts that variable in the PRINT statement in place of the number for the address. This allows you to change the program to work with the MI 5010 set to other addresses by changing only the statement that assigns the variable.

```
170 Mi=23
180 Print #mi:"TIME 09:11:00"
```

Notice that the MI 5010 message (what's inside the quote marks) is the same in both of the above examples. The rest of each example varies to match the PRINT statement syntax designed into each controller. This suggests that once you understand your controller's output and input statements, it's just a matter of plugging in the MI 5010 commands you need.

Getting MI 5010 Current Settings

MI 5010 queries or output commands (such as SET? or TIME?) prepare the instrument for bus data output, but do not start such output. The MI 5010 waits until it sees its talk address to begin sending the requested data. This is accomplished by the INPUT statement in the 4052A or the INPUT PROMPT statement in the 4041.

```
220 Input #23 prompt "ID?":id$
```

In each of the above examples the MI 5010 will respond by sending back its identification followed by the version number of its firmware.

All instrument settings can be obtained in one message with the following commands:

```
260 Input #23 prompt "SET?":setting$
```

You can later restore the MI 5010 to those same settings simply by sending that setting string back to the MI 5010 as follows:

```
300 Print #23:setting$
```

Talking to the Cards

To send a message to a card in the MI 5010, select the card and then send the card commands as you would any other message to the MI 5010. Here is a message that asks for and inputs the name of the card in slot 1 of the MI 5010:

```
340 Print #23:"SELECT 1"
350 Input #23 prompt "NAME?":name$
```

A card's function settings can be acquired into a single string if the string is dimensioned large enough.

```
370 Dim fsettng$ to 150
380 Input #23 prompt "FSET?":fsettng$
```

MI 5010 Command Buffer

The MI 5010/MX 5010 system has two operating modes, "immediate" and "buffered." In the immediate mode, commands are executed immediately upon receipt of the message terminator (EOI-only or LF/EOI). In the buffered mode, commands are stored in a command buffer within the MI 5010 for later execution. The command buffer is loaded by sending the BUFFER ON command, followed by the commands to be buffered, then followed by the BUFFER OFF command. The commands in the buffer are executed when the MI 5010 receives the EXEC <num> command where the argument <num> determines how many times the buffer is to be executed. A negative argument causes continuous operation. The commands STOP, INIT, or EXEC <num> cause buffered execution to end. The buffer is erased by sending the INIT command or by opening the buffer again with the BUFFER ON command.

An entire test sequence can be put into the buffer and executed repetitively for as long as the test needs to be performed. The advantage of the buffered mode is that it reduces GPIB traffic for repetitive functions.

Three commands control execution in the buffered mode: EXECUTE, STOP, and WAIT. The EXECUTE command determines the number of times that the buffered commands will be executed. The argument for the EXECUTE command ranges from -255 to +254. Any negative number means continuous operation until a new EXECUTE command or a STOP command is sent to the instrument. An EXECUTE 0 command produces no executions if none is occurring; if any are occurring, buffered mode execution stops at the completion of the one in progress.

The WAIT command is used to suspend execution of the buffer while waiting for some event to occur. The event may be any of the following:

WAIT <num>—a time duration from 0 to 655.35 seconds in 0.01-second steps.

WAIT UNTIL—a selected time reading of the time-of-day clock.

WAIT TRIG—receipt of the <GET> interface message or TRIGGER command.

WAIT COND—an EXT TRIG, IDV, or ODR signal received at any of the resident cards.

WAIT OFF—execution resumed.

The WAIT <num> provides for a delay in execution of the buffer. This delay can be used to allow for settling time of an external circuit. The WAIT UNTIL command can be used to interrupt the controller at a given time-of-day. The WAIT TRIG command can be used with the GET interface message to synchronize operation of the MI 5010 and its cards to other instruments on the GPIB. The WAIT COND command allows the synchronization of the MI 5010 and its cards to external trigger signals coming from other devices in the test system. Other instruments on the bus can be synchronized to this external trigger by the use of the ARM SRQ command. ARM SRQ instructs the MI 5010 to assert SRQ upon receipt of an EXTERNAL TRIGGER, IDV, or ODR signal at a selected function card. The controller can then synchronize other instruments on the bus as a response to this SRQ.

MI 5010 Response to Interface Messages

The following program sequences show various interface messages transmitted to the MI 5010.

```
130      Pri_addr=23 !    MI primary bus address
140    !
150    !
160 Listen:      wbyte atn(pri_addr+32) !     Send Listen Address (MLA)
170    !
180 Unlisten:      wbyte atn(unl) !           Send Unlisten (UNL)
190    !
200 Talk:      wbyte atn(pri_addr+64) !       Send Talk Address
210    !
220 Untalk:      wbyte atn(unt) !             Send Untalk
230    !
240 Devclear:      wbyte dcl !                Send Device Clear
250    !
260 Selctclr:      wbyte sdc(pri_addr),atn(unl) ! Send MLA, Selected Device
270    !                                          Clear, UNL
280 Trigger:      wbyte get(pri_addr),atn(unl) ! Send MLA, Group Execute
290    !                                         Trigger, UNL
```

The MI 5010 responds to DCL (and SDC if listen addressed) by clearing its Input and Output Buffers and any unexecuted setting commands in its Pending Settings Buffer, along with any errors or events waiting to be reported (except power-on).

GET satisfies the WAIT TRIG condition when the MI 5010 is executing buffered settings (and the instrument is listen addressed). GET also provides a trigger for MI 5010 card functions: if a function card is in the DT SET mode, decoded settings are executed only on receipt of GET; if a function card is in the DT TRIG mode, inputs or outputs do not change until receipt of GET.

See the MI 5010 Operators Manual for a full discussion of how the instrument responds to interface messages.

Section 2
Operating the MI 5010 System Function Cards

This section describes the operation of each of the function cards presently available for use with the MI 5010 Multifunction Interfacing System. The hand-shaking lines on each card are summarized in Section 3 of this guide, and the programming commands for each card are listed in Section 4. Greater detail on the specifications, theory of operation, and maintenance and calibration of the cards is given in their respective instruction manuals.

50M10 A-D Converter Card

The 50M10 is a 12-bit analog-to-digital converter with four ranges selectable by means of internal jumpers:

Range	Resolution
−102.40 to +102.35 mV	50 μV
−1.0240 to +1.0235 V	500 μV
−10.240 to +10.235 V	5 mV
−102.40 to ±102.35 V	50 mV

Figures 2-1 and 2-2 show the 50M10 front-panel interface connector pin assignments and the 50M10 on-board jumper locations, respectively.

The voltage to be measured is applied to pin 6A with the analog ground or common applied to pins 5B, 6B, and/or 7B. Any of these pins may be elevated to ±350 volts (dc plus peak ac) from earth ground.

The 50M10 range is selected by means of J3051 and J2051. J3051 sets the gain of the 50M10 input amplifier to select a basic range of ±100 mV, ±1 V,

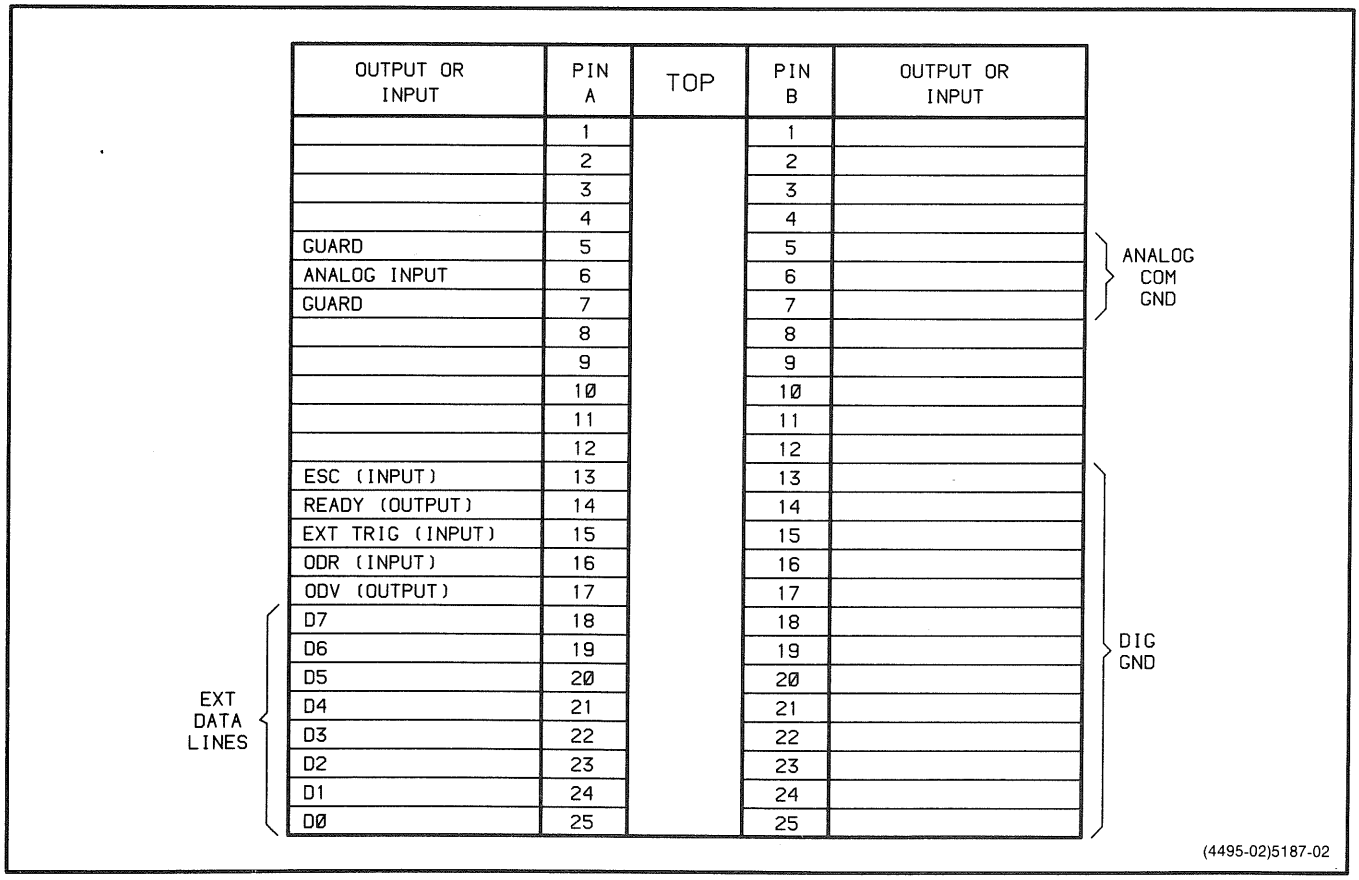


Fig. 2-1. *50M10 front panel interface connector, front view.*

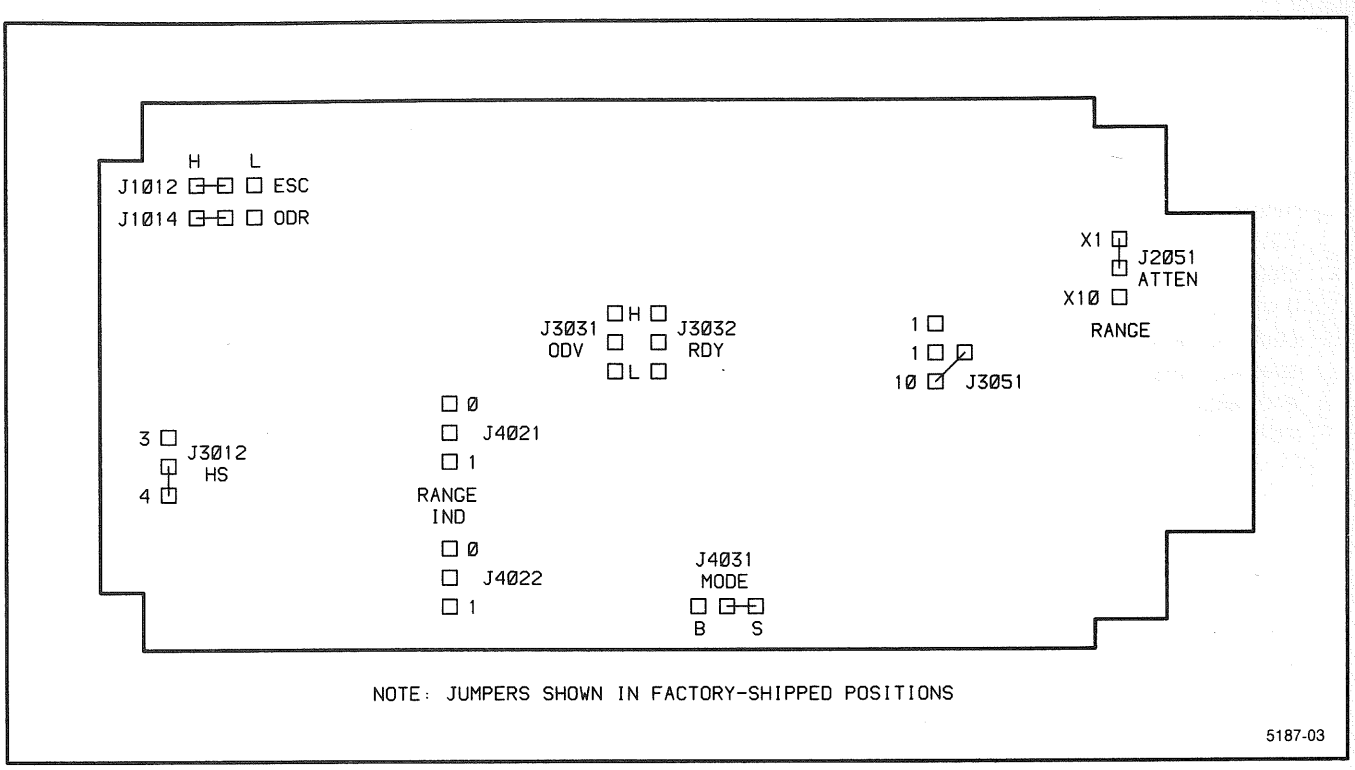


Fig. 2-2. *50M10 on-board jumper locations.*

or ±10 V; J2051 inserts a 10X attenuator ahead of the input amplifier to obtain a range of ±100 V. J4021 and J4022 set the logic to provide the proper response to the settings queries from the GPIB system controller.

Internally generated guard voltages are available at pins A5 and A7. In the three lower ranges of operation, these guard voltages are approximately equal to the voltage applied to pin A6; in the highest range of operation, the guard voltage is approximately equal to one tenth of the voltage applied to pin A6.

The 50M10 takes less than 32 microseconds to convert an analog voltage to a digital value. This converted value is available over the GPIB in binary, decimal, or hex format, and/or in digital format at the External Data Lines of the 50M10 front panel connector. If the 50M10 has previously been sent the command EXT ON, then the digital word is available both over the GPIB and at the front panel connector. If the 50M10 has previously been sent the command EXT OFF, then the digital word is available only over the GPIB; it is not available at the front panel connector.

With EXT ON, the 12-bit digitized value is sent to the eight external data lines in two 6-bit bytes, high byte first. Within each byte, the most significant bit is on pin 20A and the least significant bit is on pin 25A. Pin 19A carries the high-byte/low-byte indicator. When the high byte of a given conversion is present on the external data lines, pin 19A is high; when the low byte is present, pin 19A is low. Pin 18A is not used, and is connected internally to a low logic level.

Two modes of conversion are available, Burst Mode and Step Mode, selectable by means of jumper J4031. In the Burst Mode, conversions occur continuously as long as the ESC line is held in the true state by the receiving device. In the Step Mode, one conversion occurs each time the ESC line is changed from the false state to the true state.

Conversions may also be initiated by means of the CONVERT command or SEND command over the GPIB. The CONVERT command causes a conversion to occur; the SEND command causes a conversion to take place and returns the value in volts over the GPIB.

The ODR (Output Data Received) and ODV (Output Data Valid) lines are used to handshake the converted digital value at the 50M10 front panel connector out to some external receiving device, such as the 50M50 Memory Card. In general, the 50M10 asserts ODV when it has placed a valid data byte on its

output lines, and the receiving device asserts ODR when it has accepted that data byte.

Two modes of handshaking are available, the 4-state handshake mode and the 3-state handshake mode. The 4-state handshake mode is generally used to communicate with devices which are slower than the 50M10. The 3-state handshake mode is generally used to communicate with devices which are faster than the 50M10.

In either mode, when the 50M10 places a byte of data on its external data lines, it asserts its ODV line. In the 4-state handshake mode, the 50M10 requires that the ODR line go from an false level to a true level and back to a false level before it will place another byte of data on its external data lines and assert ODV again. Thus, the 50M10 will wait until the receiving device has received a data byte and signaled via the ODR line that it is ready for the next before placing another data byte on its external data lines. Since there are two bytes of data for each conversion, there will be two ODV/ODR handshakes per conversion.

In the 3-state handshake mode, the 50M10 will continue to place data on its external data lines as long as the ODR line is held true by the receiving device and as long as conversions are occurring. The 50M10 will assert ODV each time a new byte is put onto the external data lines, but the 50M10 does not have to wait for an external signal before placing subsequent bytes on the external data lines. When the receiving device places the ODR line in the false state, the data handshaking will stop, although conversions may continue to take place, depending upon the state of the ESC line. With the 50M10 in the Burst Mode and with the ESC and ODR lines held in their true state, the 50M10 is capable of making conversions and transmitting the converted digital values at the rate of 30,000 conversions per second.

The READY line is an output line which is in the true state except during the time that the 50M10 is in the process of making a conversion. It may be used to signal other parts of the measurement system when a conversion is in process and/or when it has been completed.

50M20 D-A Converter Card

The 50M20 is a 12-bit digital-to-analog converter with either voltage or current output, selectable by means of an on-board switch. In the voltage mode, the output range is −10.240 volts to +10.235 volts with 5 mV resolution and 5 mA current capability. In the current mode, the output range is −20.48 mA to +20.47 mA, with 10 μA resolution and 11 volts compliance.

The digital value to be converted may be sent to the 50M20 over the GPIB (via the MI 5010) or through the 50M20's front panel connector from an external word generator, such as the 50M50 Memory Card. The argument of the SOURCE command determines which of these sources of digital data the 50M20 will pay attention to. Total conversion time for data sent to the 50M20 through its front panel connector is 20 microseconds or less.

Figures 2-3 and 2-4 show the 50M20 front-panel interface connector pin assignments and the 50M20 on-board jumper locations, respectively.

The Data Input lines at the 50M20 front panel connector are pins 19A through 25A. The analog output of the 50M20 appears between pins 7&8A and 7&8B.

Over the GPIB, the value of the desired analog output is sent either as a voltage or current expressed in decimal, or as the digital equivalent of that value expressed in binary, decimal, or hex. Through the data input lines of the front panel connector, the value of the desired analog output is expressed digitally in two 6-bit bytes. Within each byte, the most significant bit is on pin 20A and the least significant bit is on pin 25A. Pin 19A is used for the high-byte/low-byte indicator. A high state applied to pin 19A indicates that a high byte is present; a low state applied to pin 19A indicates that a low byte is present. Pin 18A is not used; it has no internal connection within the 50M20.

Pins 14A through 17A are handshake lines which permit synchronization with other devices. The READY line is an output line which is true except while the 50M20 is in the process of making a conversion. The signal on this line may be used to signal other parts of the measurement system when a con-

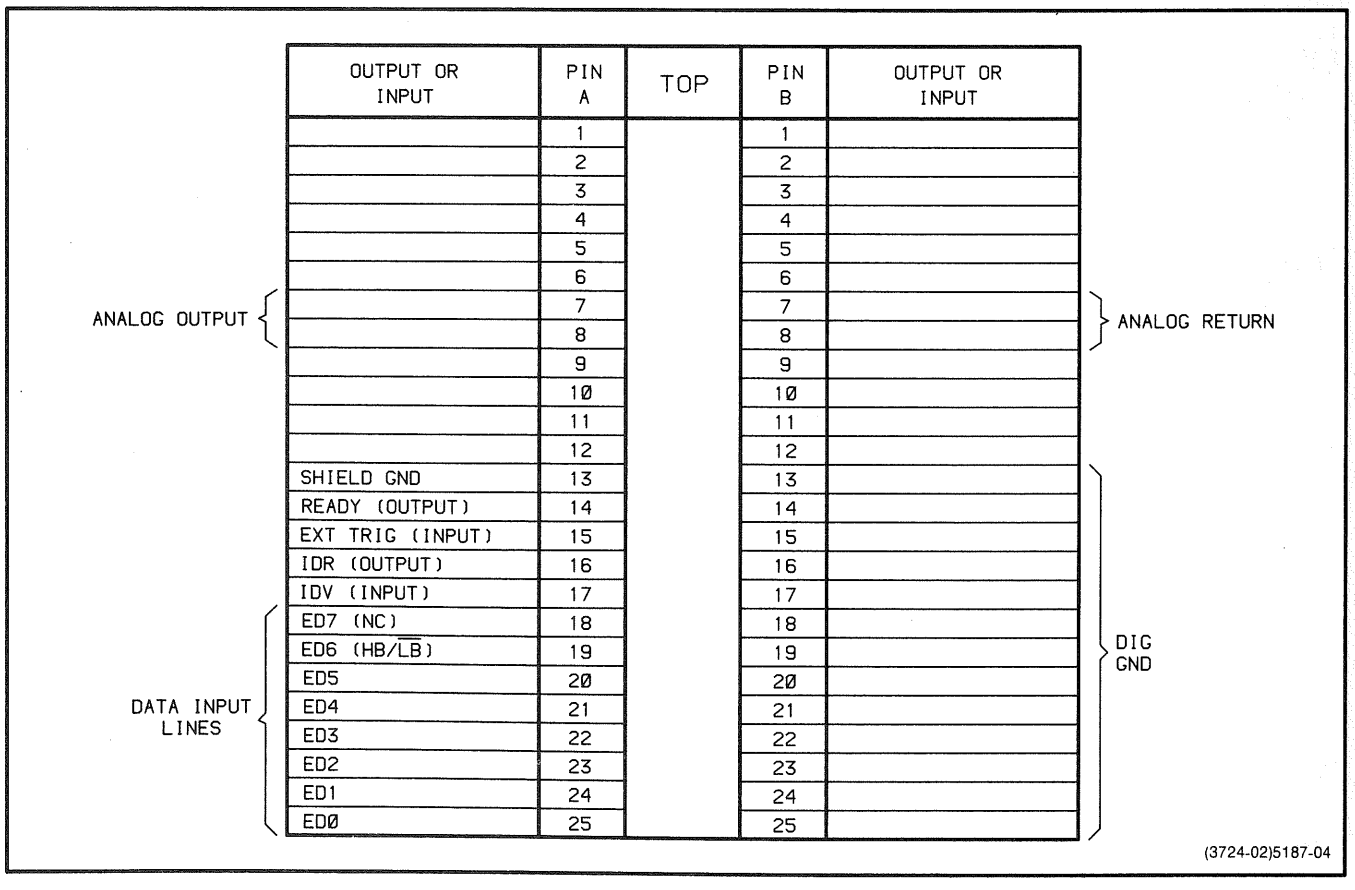


Fig. 2-3. *50M20 front panel interface connector, front view.*

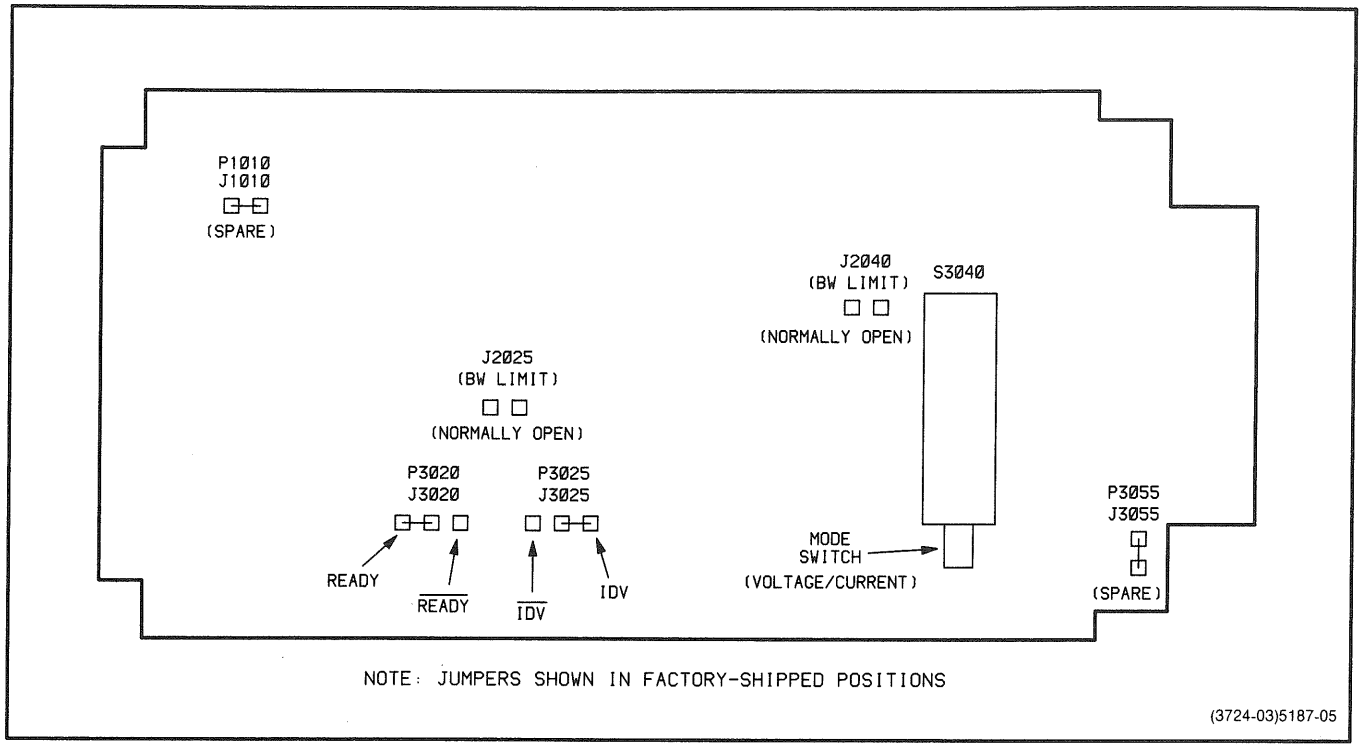


Fig. 2-4. *50M20 on-board jumper locations.*

version is in process and/or when it has been completed.

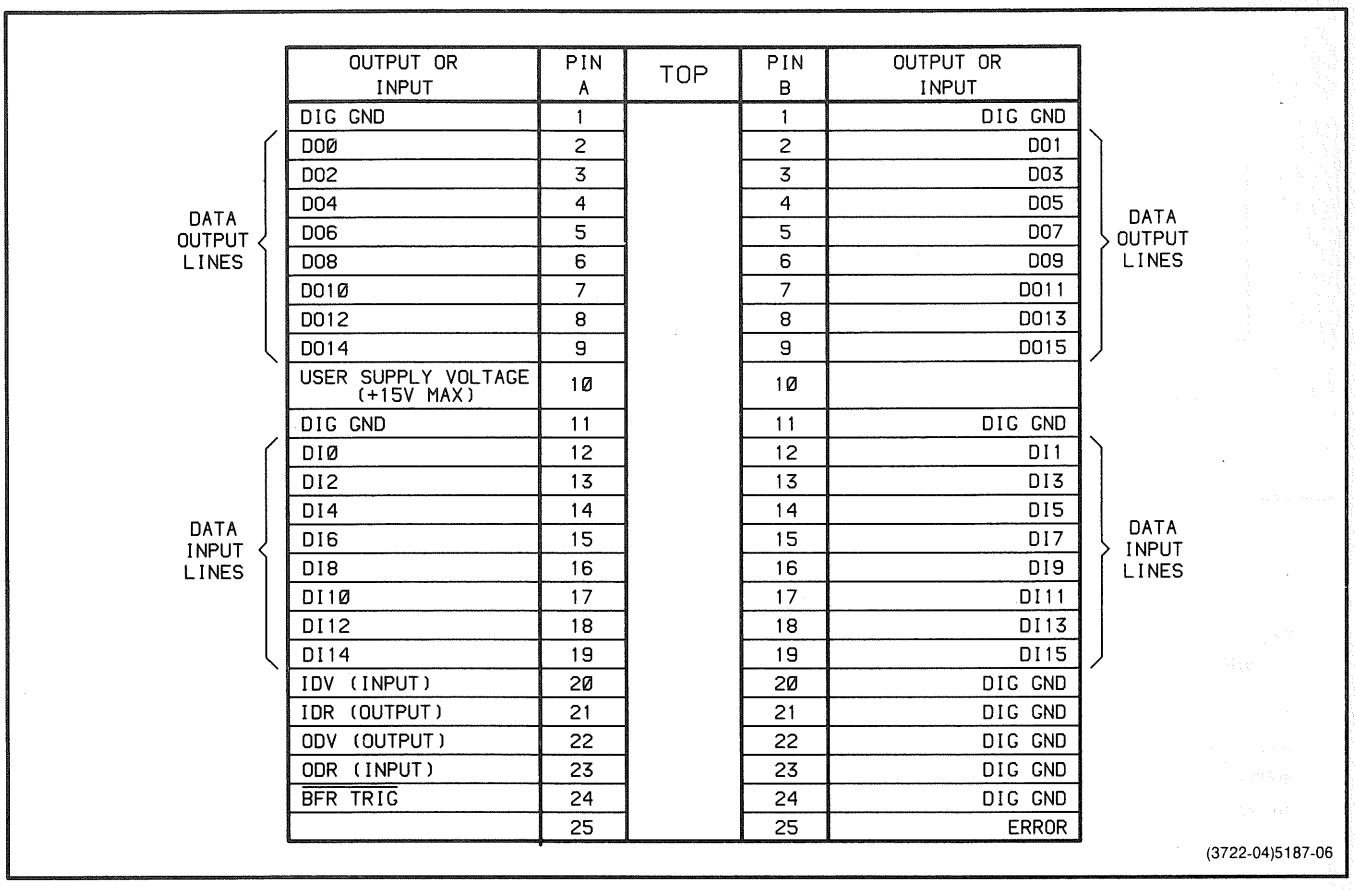
The EXT TRIG line is an input line which allows the external system to cause selected actions to occur within the measurement system. (See ARM command, Section 4.)

The IDR (Input Data Received) and IDV (Input Data Valid) lines are used to synchronize the receipt of input data on the Data Input lines. When the external sending device has placed a valid data byte on the Data Input lines, it must assert IDV to signal the 50M20 that it may accept the byte. When the 50M20 has accepted the data, it asserts IDR to signal the external sending device that it may send the next byte. Once it goes true, IDR remains true until reset by the trailing edge of the IDV signal.

In the normal bandwidth mode of operation, the 50M20 output settles to within one least significant bit of its final value within 20 microseconds. Smoothing of the output signal can be accomplished by placing a shorting jumper on J2040. This places a bandwidth filter in the signal output line and stretches the settling time to about 250 microseconds. At the same time that this is done, a shorting jumper should also be placed on J2025 which stretches the READY signal's false state to 250 microseconds to coincide with the lengthened settling time of the output signal. Two spare shorting jumpers are supplied with the 50M20 at J1010 and J3055.

50M30 Digital I/O Card

The 50M30 provides sixteen digital output lines and sixteen digital input lines. The sixteen output lines provide TTL levels to control various types of test and measurement instruments, relays, indicators, etc. The sixteen input lines accept data from pushbuttons, switches, contact closures, and most digital devices capable of supplying TTL output levels. Figures 2-5 and 2-6 show the 50M30 front-panel interface connector pin assignments and the 50M30 on-board jumper locations, respectively.



OUTPUT OR INPUT	PIN A	TOP	PIN B	OUTPUT OR INPUT
DIG GND	1		1	DIG GND
DØØ	2		2	DØ1
DØ2	3		3	DØ3
DØ4	4		4	DØ5
DØ6	5		5	DØ7
DØ8	6		6	DØ9
DØ1Ø	7		7	DØ11
DØ12	8		8	DØ13
DØ14	9		9	DØ15
USER SUPPLY VOLTAGE (+15V MAX)	1Ø		1Ø	
DIG GND	11		11	DIG GND
DIØ	12		12	DI1
DI2	13		13	DI3
DI4	14		14	DI5
DI6	15		15	DI7
DI8	16		16	DI9
DI1Ø	17		17	DI11
DI12	18		18	DI13
DI14	19		19	DI15
IDV (INPUT)	2Ø		2Ø	DIG GND
IDR (OUTPUT)	21		21	DIG GND
ODV (OUTPUT)	22		22	DIG GND
ODR (INPUT)	23		23	DIG GND
$\overline{\text{BFR TRIG}}$	24		24	DIG GND
	25		25	ERROR

Fig. 2-5. *50M30 front panel interface connector, front view.*

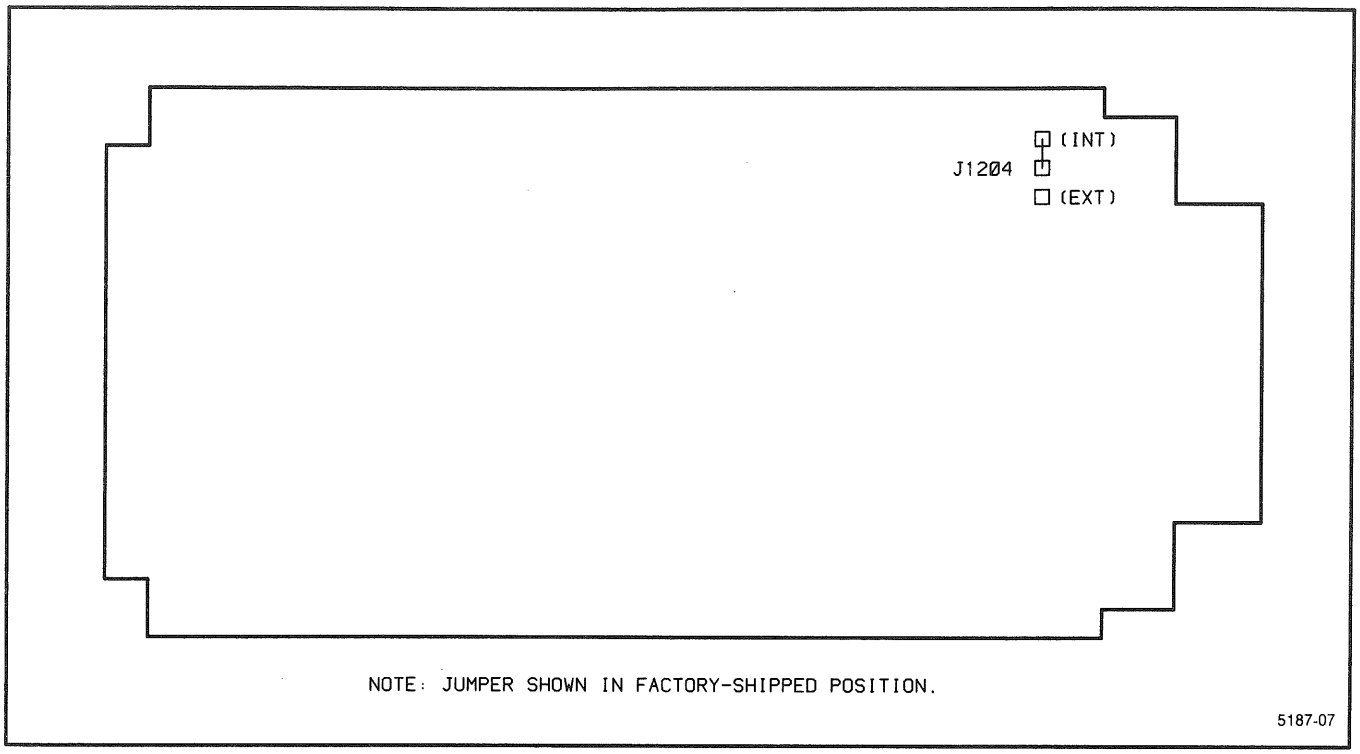


Fig. 2-6. *50M30 on-board jumper location.*

As shipped from the factory the output lines are tied through 2 kohm resistors to an internal +5 volt supply. J1201 allows the output lines to be connected through the same 2 kohm resistors to an external supply as high as +15 volts, or as open-collector outputs to an external supply as high as +30 volts. The three modes of operation are diagrammed in Figure 2-7.

The sixteen input lines are tied through approximately 22 kohms to an internal +5 volt supply, and are therefore normally in the high state.

For programming the 50M30, the output channel is designated Channel 1 and the input channel is designated Channel 2. The digital word to be placed on the output channel may be sent over the GPIB or loaded from the command buffer in the MI 5010 in binary, decimal, or hex format. Likewise, the digital word present on the input channel may be returned over the GPIB or transferred to the MI 5010 input buffer in binary, decimal, or hex format as desired. There is no way in the 50M30 to move a word from the input channel to the output channel without going through the controller.

Four handshake lines—IDV, IDR, ODV and ODR (pins 20A through 23A)—at the 50M30 front panel connector permit synchronization of input and output signals with external devices. In normal handshaking of input data, the sending device initiates the handshake by placing a valid data word on the 50M30's input lines and asserting IDV. When the 50M30 has received that word, it asserts IDR to signal the sending device that it is ready for the next word. The 50M30 automatically resets IDR to its false level after about two microseconds.

In normal handshaking of output data, the 50M30 asserts ODV to signal the receiving device that a valid word is present on its output lines. When the receiving device has received and accepted that digital word, it asserts the ODR line to signal the 50M30 that it may place another word on its output lines. The 50M30 does not require that the receiving device assert ODR before placing a subsequent data word on its output lines; however, once asserted, the ODV line will remain true until it is reset by an ODR signal.

It takes the 50M30/MI 5010 combination about 2 milliseconds to respond to an ODR from the external system and about 3 milliseconds to respond to an IDV from the external system. Thus, with handshaking, the 50M30 can place words on its output lines at a maximum rate of about 500 words per second. It can receive words on its input lines at a maximum rate of about 333 words per second. (If input or output speed

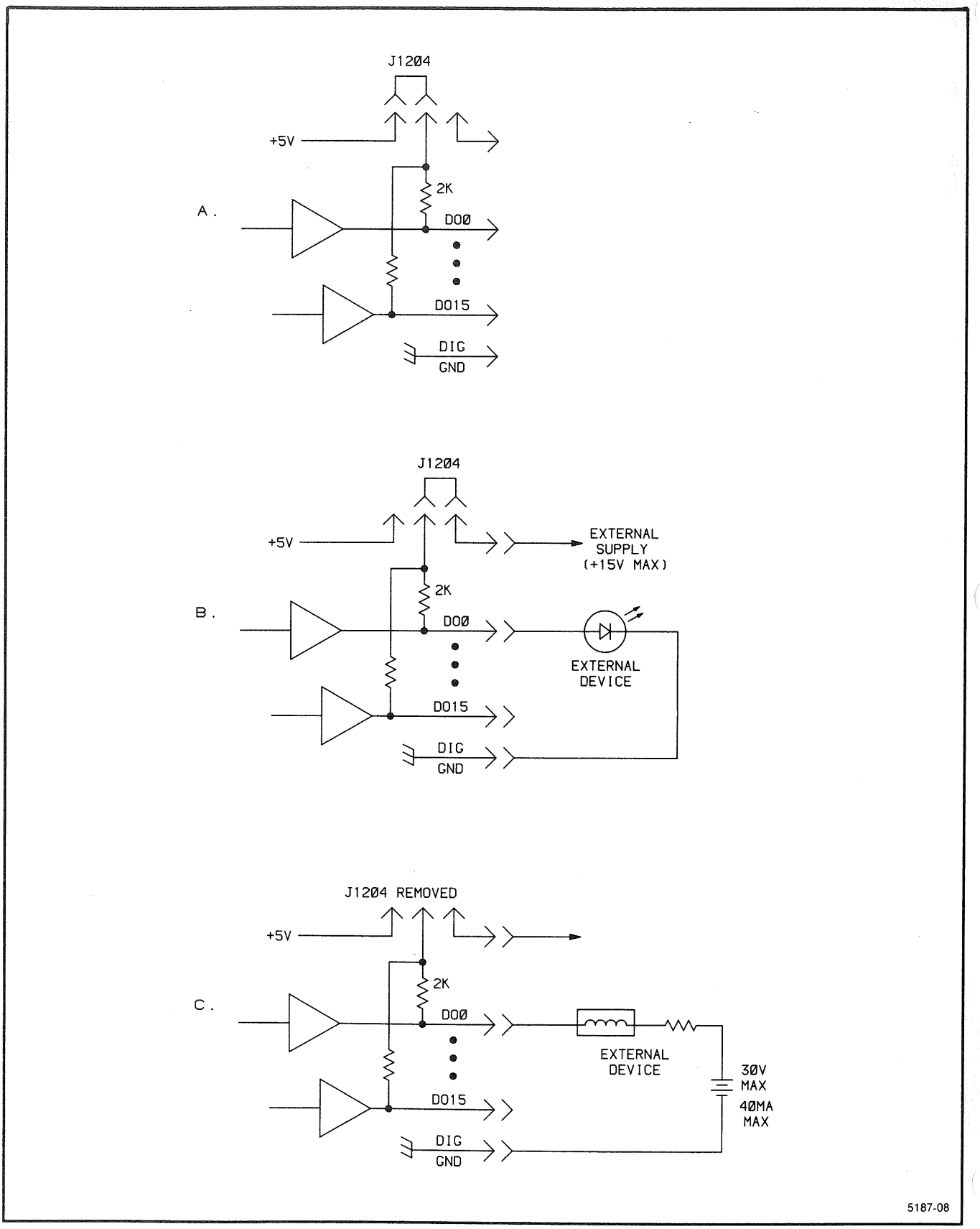


Fig. 2-7. *Typical 50M30 output line configurations.*

is critical, then the 50M50 memory card with its 200,000 words per second speed should be used instead of the 50M30.)

There is also a limitation in the number of different words that the 50M30 can generate or acquire at the above rates. The number of different words which can be generated is limited by the size of the command buffer. The command buffer can hold about 300 commands, including the data words to be generated and the wait commands between words. So the practical limit on the number of words which can be generated by means of the command buffer is 100 to 150, depending upon the size of the words and the number of intervening commands.

When the 50M30 "reads" a word on the input lines, it stores that word in an input buffer in the MI 5010. This buffer has a limit of about 48 words before it becomes full. When the buffer becomes full, its contents must be transmitted over the GPIB before it can accept any further words. So the maximum number of words which the 50M30 can read at 3 milliseconds per word is about 48. Then there will be some time, determined primarily by the speed of the controller, before further words can be accepted.

Of course, there is no limit to the number of words that can be input or output if each word is transmitted individually over the GPIB from the controller. In this case, the data rate is primarily a function of the speed of the controller.

50M40 Relay Scanner Card

The 50M40 contains 16 independent, single-pole, single-throw mercury-wetted relays which are wired in four groups of four relays, with each group tied to a separate common. The groups of four may also be configured, by means of internal jumpers, into groups of eight, twelve, or sixteen—each group with its own common connection. Individual switch closures are controlled by commands over the GPIB or by commands from the command buffer in the MI 5010. Each switch may be individually closed or opened without regard to the state of the other switches. Or a special scanning mode of operation may be programmed wherein the switches are closed one at a time in a user-selectable sequence, in a break-before-make fashion.

Figures 2-8 and 2-9 show the 50M40 front panel interface connector pin assignments and the 50M40 on-board jumper locations, respectively.

	OUTPUT OR INPUT	PIN A	TOP	PIN B	OUTPUT OR INPUT
	EXT TRIG (INPUT)	1		1	GND
	READY (OUTPUT)	2		2	GND
INPUT/OUTPUT GROUP A	(1) K1300	3		3	
	(2) K1301	4		4	
	(3) K1400	5		5	
	(4) K1401	6		6	GROUP A COM
		7		7	
	GND	8		8	
INPUT/OUTPUT GROUP B	(5) K1500	9		9	
	(6) K1501	10		10	
	(7) K1310	11		11	
	(8) K1410	12		12	GROUP B COM
		13		13	
	GND	14		14	
INPUT/OUTPUT GROUP C	(9) K1411	15		15	
	(10) K1510	16		16	
	(11) K1511	17		17	
	(12) K1320	18		18	GROUP C COM
		19		19	
	GND	20		20	
INPUT/OUTPUT GROUP D	(13) K1420	21		21	
	(14) K1421	22		22	
	(15) K1520	23		23	
	(16) K1521	24		24	GROUP D COM
	GND	25		25	

(3723-08)5187-09

Fig. 2-8. *50M40 front panel interface connector, front view.*

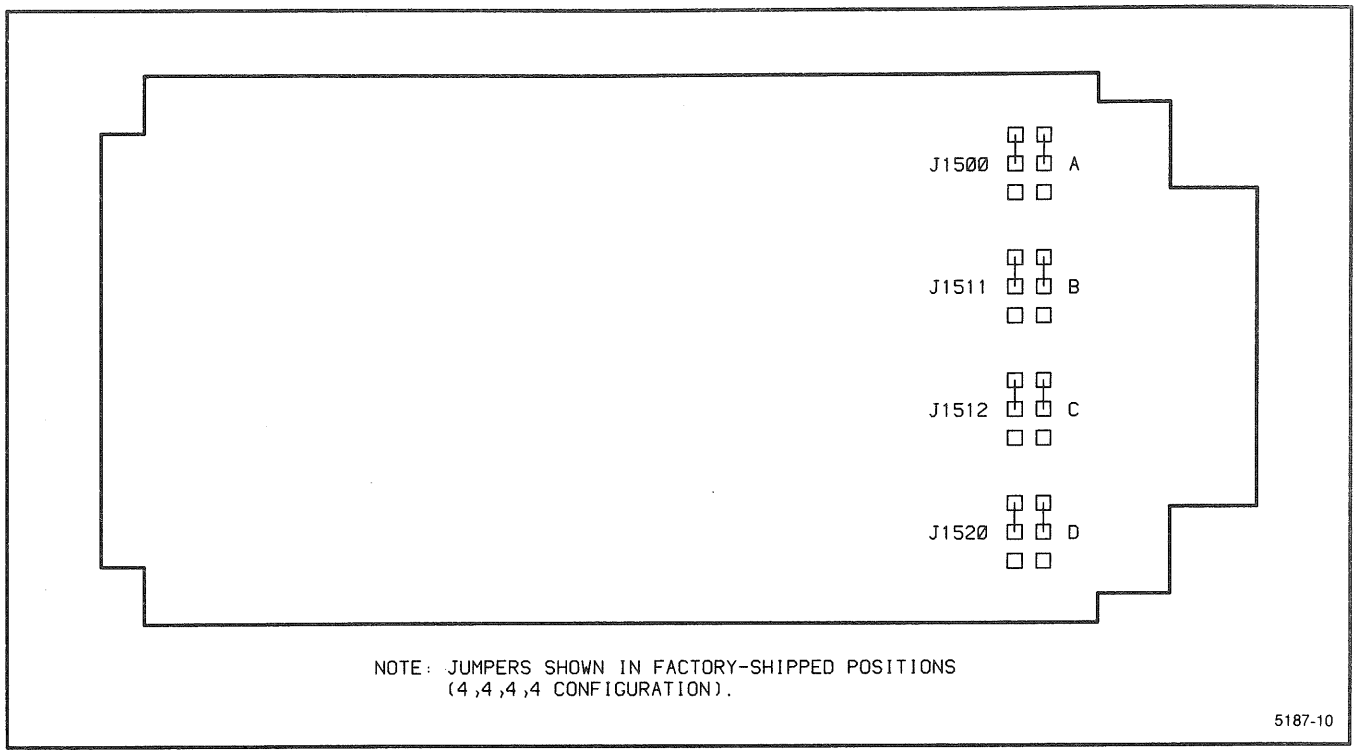


Fig. 2-9. *50M40 on-board jumper locations.*

Figure 2-10 is a schematic diagram of the 50M40 switching matrix showing how the jumpers configure the matrix into groups of 8, 12, and 16. As diagrammed, moving the jumpers to the left connects the bank of four switches to the next lower common line. The jumpers are actually dual jumpers; the second portion of each one activates the logic which tells the controller what the configuration is, in answer to a configuration query from the controller.

Two handshake lines, EXT TRIG and READY (Pins 1A and 2A), provide the means of synchronizing the operation of the 50M40 with the external system. The READY line is an output line which is normally high. Whenever the 50M40 receives a command to open or close any relay, the READY line goes low and stays low for about five milliseconds to notify the rest of the measurement system that the relays are changing state and no measurements should be taken during this time. The EXT TRIG line is an external trigger input line which allows the external system to cause selected actions to occur within the measurement system. (See ARM command, Section 4.)

If the switch closure commands to the 50M40 are coming from the MI 5010 command buffer, it takes the 50M40/MI 5010 combination about two milliseconds to respond to an external trigger signal, so the maximum rate of switch operations is typically be about one operation every seven milliseconds. If the switch closure commands are coming from the controller, the period of time between operations is increased by the amount of time that it takes the controller to service the SRQ initiated by the external trigger signal and to place the next command on the GPIB.

50M41 Low-Level Relay Scanner Card

The 50M41 contains ten independent pairs of guarded, normally open, low-thermal relay contacts which are wired in two groups of five, with each group tied to a separate common. The two groups of five may be configured, by means of internal jumpers, into one group of ten with one common connection. Individual switch pair closures are controlled by commands over the GPIB or by commands from the command buffer in the MI 5010. Each switch pair may be individually closed or opened without regard to the state of the other switch pairs. Or a special scanning mode of operation may be programmed wherein the switch pairs are closed one at a time in a user-selectable sequence, in a break-before-make fashion.

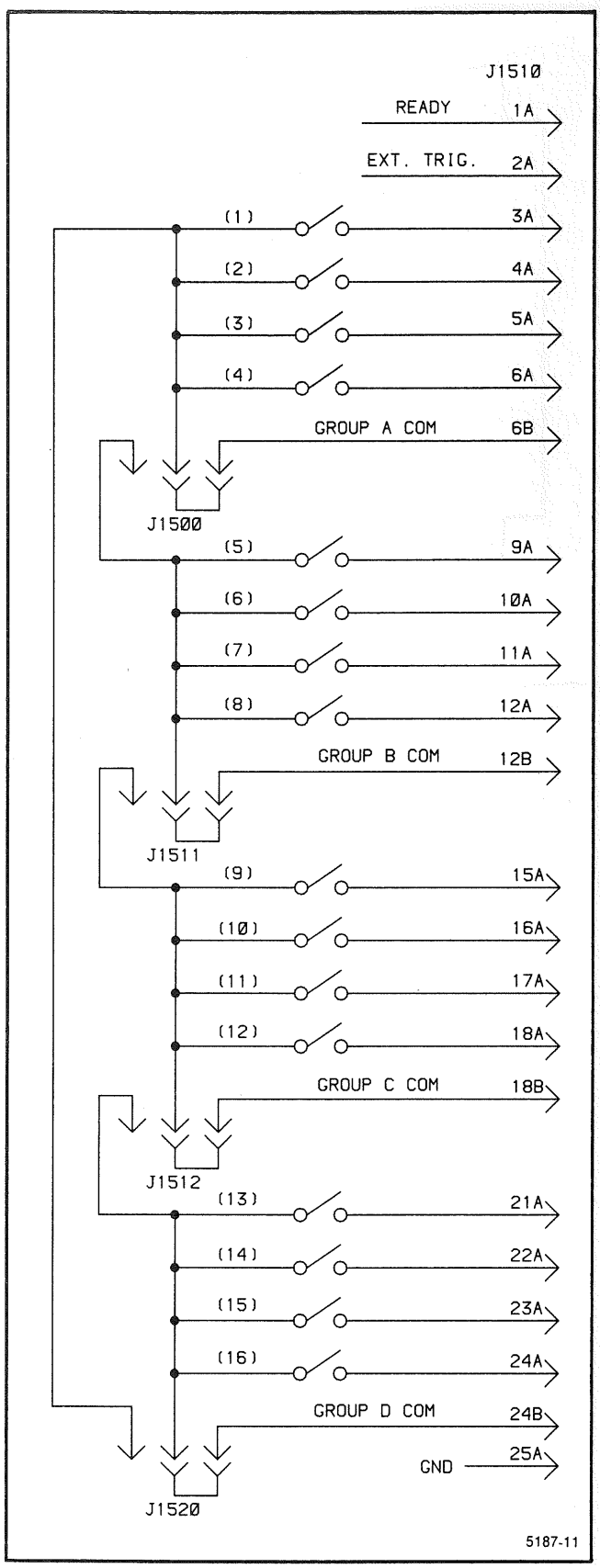


Fig. 2-10. *50M40 Relay Schematic.*

Each differential pair of contacts has less than one microvolt of thermal offset, low to high, and each pair is accompanied by a third set of contacts to switch shields or guards. The guard voltage must be applied by the external system; the 50M41 does not supply a guard signal.

Figures 2-11 and 2-12 show the 50M41 front-panel interface connector pin assignments and the 50M41 on-board jumper locations, respectively.

Figure 2-13 is a schematic diagram of the 50M41 switching matrix. As diagrammed, moving J3090ABC to the left changes the configuration from two 1-to-5 switches to one 1-to-10 switch. J3095 enables and disables the tree relay in the Group A common lead.

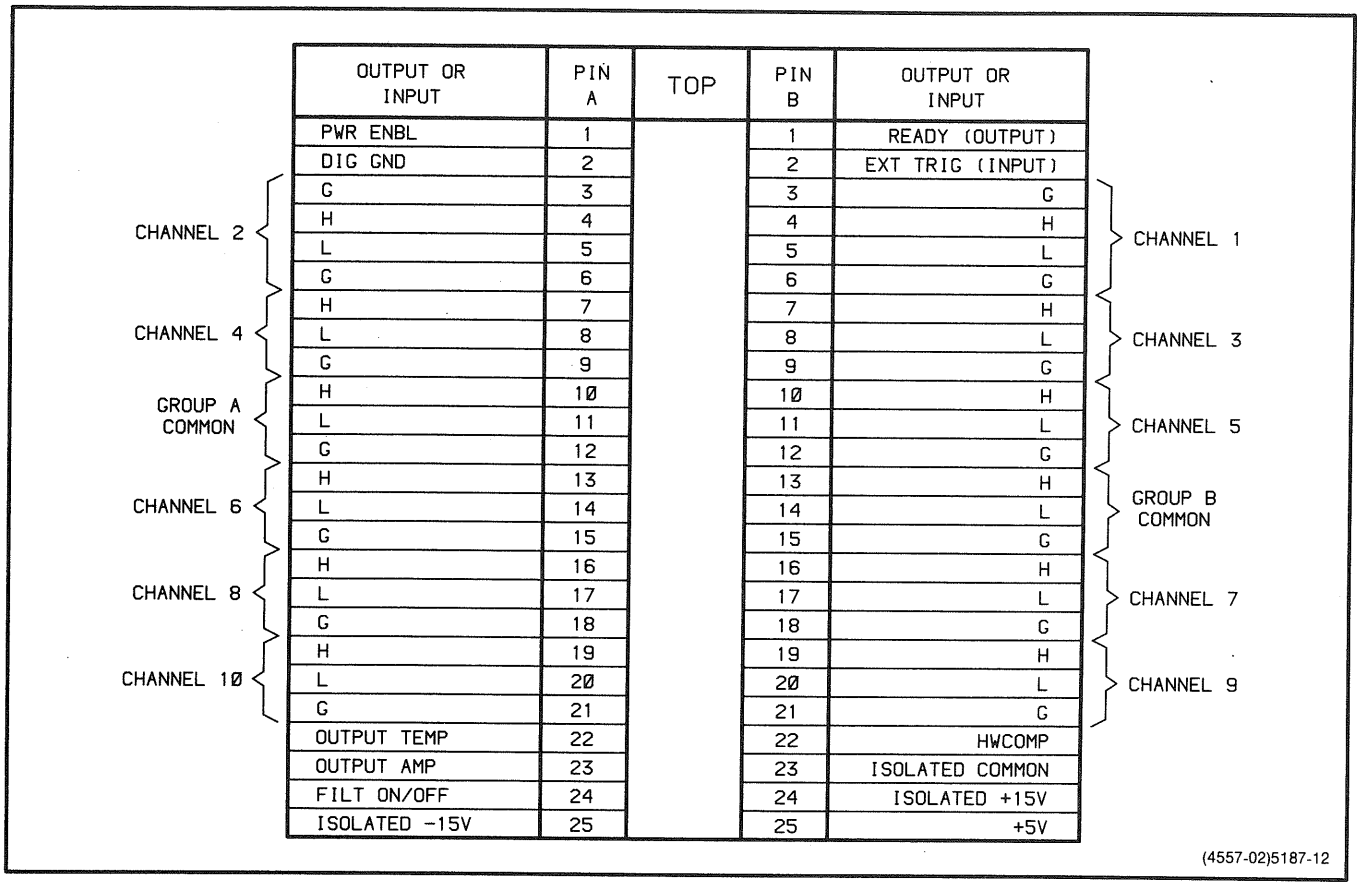


Fig. 2-11. *50M41 front panel interface connector, front view.*

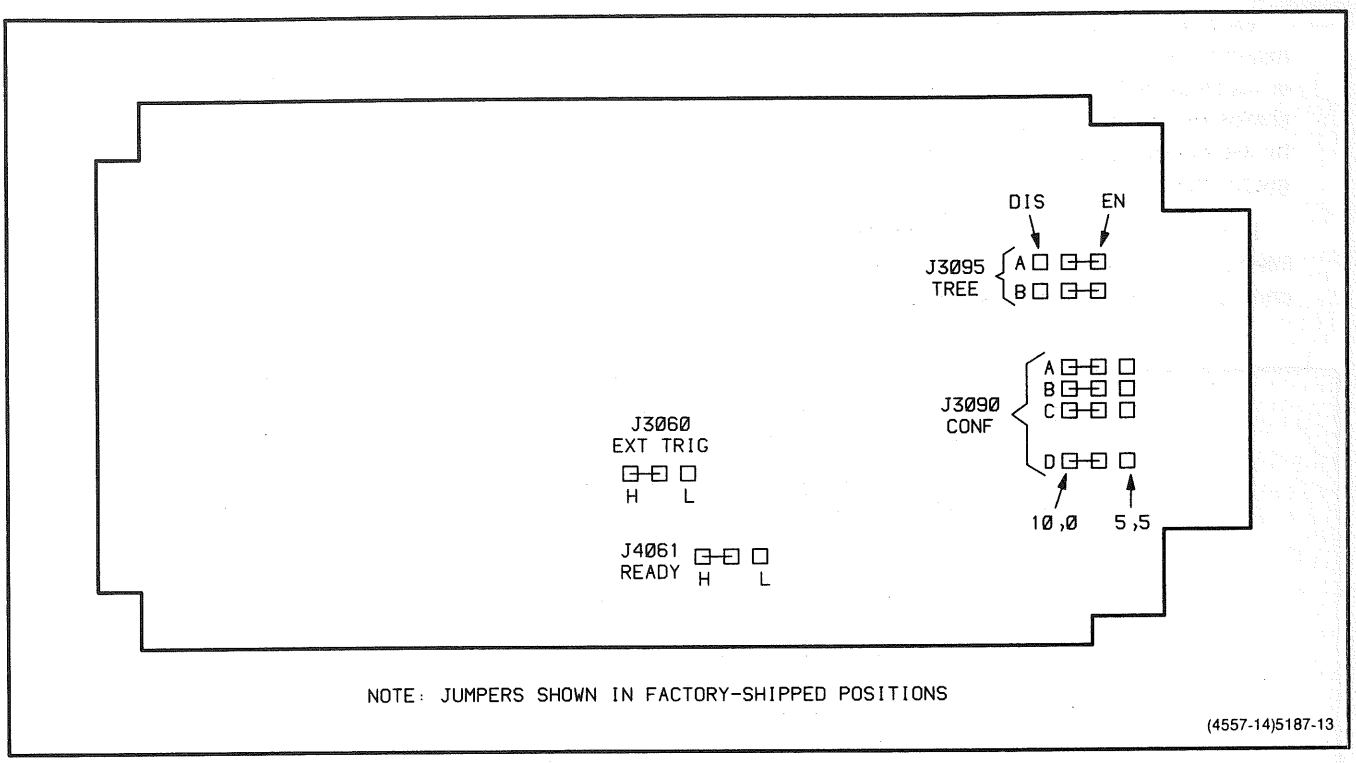


Fig. 2-12. *50M41 on-board jumper locations.*

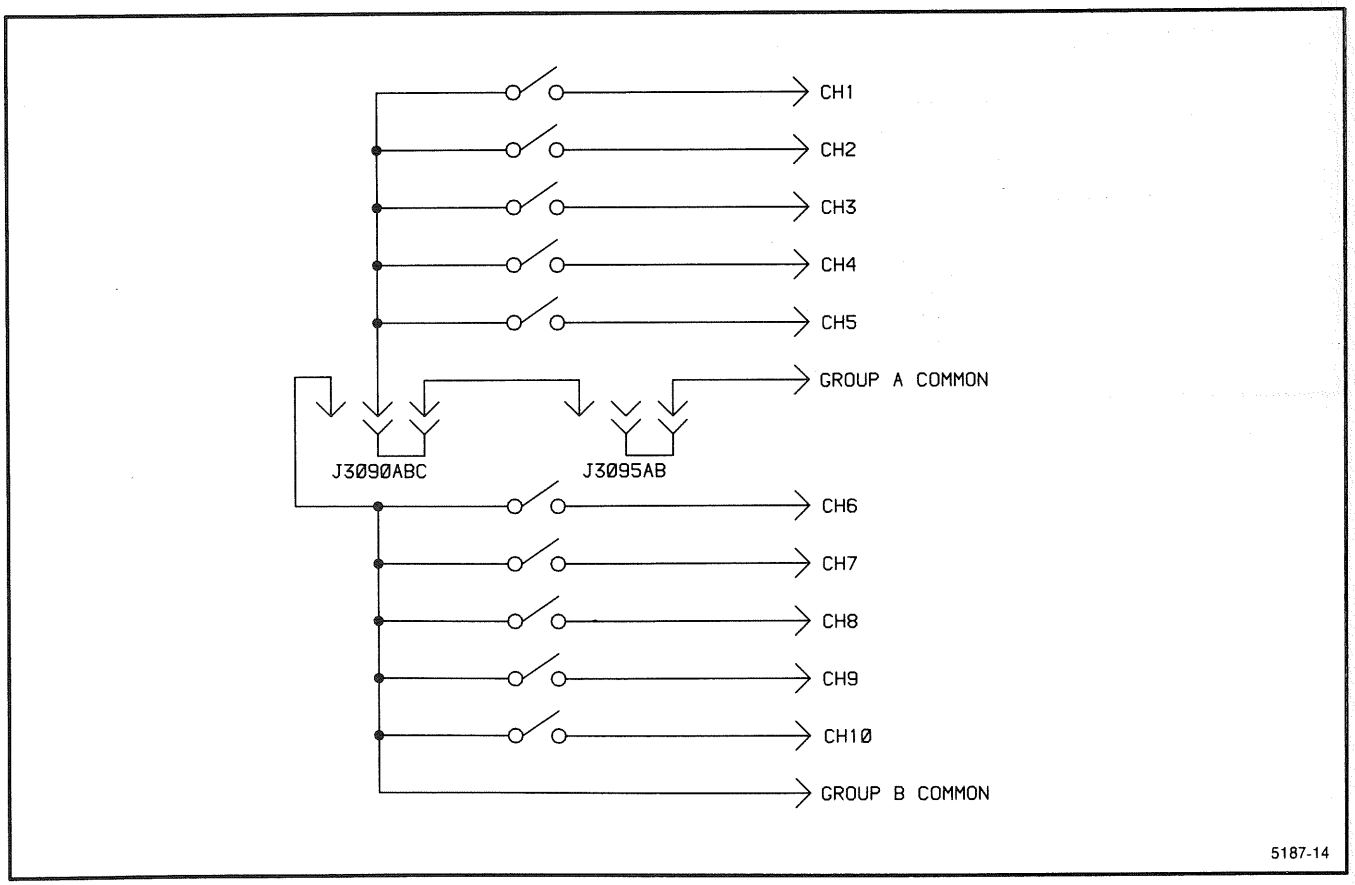


Fig. 2-13. *50M41 Switching Schematic.*

Two handshake lines, EXT TRIG and READY, provide the means of synchronizing the operation of the 50M41 with the external system. The READY line is an output line which is normally in its true state. Whenever the 50M41 receives a command to open or close any relay, the READY line goes to its false state and stays false for about three milliseconds to notify the rest of the measurement system that the relays are changing state. The EXT TRIG line is an input line which allows the external system to cause selected actions to occur within the measurement system. (See ARM command, Section 4.)

If the switching commands to the 50M41 are coming from the MI 5010 command buffer, it takes the 50M41/MI 5010 combination about three milliseconds to respond to an external trigger signal, so the maximum rate of switch operations will typically be about one operation every six milliseconds. If the switching commands are coming from the controller, the period of time between switch operations is increased by the amount of time that it takes the controller to service the SRQ initiated by the external trigger signal and to place the next command on the GPIB.

Tektronix provides a family of high-gain, low-noise signal conditioning modules, designated M41A1 through M41A8, for use with the 50M41. These modules mount onto the front panel connector of the 50M41 and make use of the switching of the 50M41 to switch the input to the module among multiple sources.

The M41A1 is a general purpose amplifier with switchable gain in decade steps from 1 to 1000. A software-selectable, low-pass filter with a corner frequency of approximately 6 Hz provides more than 60 dB of normal mode rejection at 60 Hz. The frequency response of the amplifier with the filter turned off is approximately 10 kHz.

Signal conditioning modules M41A2 through M41A8 are thermocouple amplifiers, each designed to operate with a specific thermocouple type (J, K, E, T, S, R, and B, respectively). They are virtually identical to the M41A1 except that each contains an isothermal block with a temperature sensor, and the gain and offset of each module are fixed at values appropriate for its thermocouple type.

Pins 25A and 23B through 25B of the 50M41 front panel connector provide voltages for powering the signal-conditioning modules. Grounding pin 1A to pin 2A turns on the isolated supply; this grounding occurs automatically whenever one of the signal conditioning modules is mounted onto the front panel connector of the 50M41. The +5 volt supply is on continuously.

The FILT ON/OFF, OUTPUT AMP, and OUTPUT TEMP lines control the operation of the signal conditioning modules. They are activated by commands to the 50M41 from the system controller. The HARDWARE COMP line permits the user's software to determine if hardware cold-junction compensation is enabled or not; hardware compensation is activated by means of a jumper within the signal conditioner module.

50M50 Memory Card

The 50M50 is a buffer memory input/output device which can be used either as a high-speed digital word generator or as a high-speed data acquisition buffer. Its 16 k bytes of memory can be compartmentalized under program control into as many as sixteen separately addressable variable-length data buffers. The sixteen input/output lines can be configured under program control as two independent 8-bit input/output ports or as a single 16-bit input/output port. These ports can be connected separately under program control to any of the sixteen addressable data buffers. These buffers are created, named, and sized by means of the CREATE command to the 50M50, and are connected to the input/output ports by means of the ATTACH command.

Figures 2-14 and 2-15 show the 50M50 front-panel interface connector pin assignments and the 50M50 on-board jumper locations, respectively.

The 50M50 can be programmed to input or output data via the two 8-bit ports simultaneously, or to input data via one 8-bit port while outputting data via the other 8-bit port. Each of the two 8-bit ports has its own set of handshake lines; therefore, synchronizing of data input and output on the two channels can be done completely separately from one another. When the two 8-bit channels are used as a single 16-bit channel, the Channel 1 handshake lines are used.

Pins 9A, 10A, 16A, and 17A are either Input Data Valid and Input Data Received or Output Data Received and Output Data Valid lines, depending upon whether the corresponding channel is programmed for

	OUTPUT OR INPUT	PIN A	TOP	PIN B	OUTPUT OR INPUT	
CHAN 2	I/Ø0	1		1		
	I/01	2		2		
	I/02	3		3		
	I/03	4		4		
	I/04	5		5		
	I/05	6		6		
	I/06	7		7		
	I/07	8		8		
	IDV-ODR (INPUT)	9		9		
	IDR/ODV (OUTPUT)	1Ø		1Ø		
	PACE2 (INPUT)	11		11		
	DEND2 (OUTPUT)	12		12		
	EOP (INPUT)	13		13		DIGITAL GND
CHAN 1	DEND1 (OUTPUT)	14		14		
	PACE1 (INPUT)	15		15		
	IDR-ODV (OUTPUT)	16		16		
	IDV-ODR (INPUT)	17		17		
	I/07	18		18		
	I/06	19		19		
	I/05	2Ø		2Ø		
	I/04	21		21		
	I/03	22		22		
	I/02	23		23		
	I/01	24		24		
	I/Ø0	25		25		

CHAN 3 (16-BITS INPUT/OUTPUT DATA LINES)

USES CHAN 1 I/O DATA LINES TO FORM A LOW ORDER BYTE (I/Ø0-I/07) AND CHAN 2 I/O LINES TO FORM A HIGH ORDER BYTE (I/08-I/015).

USES CHAN 1 HANDSHAKE LINES.

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Fig. 2-14. *50M50 front panel interface connector, front view.*

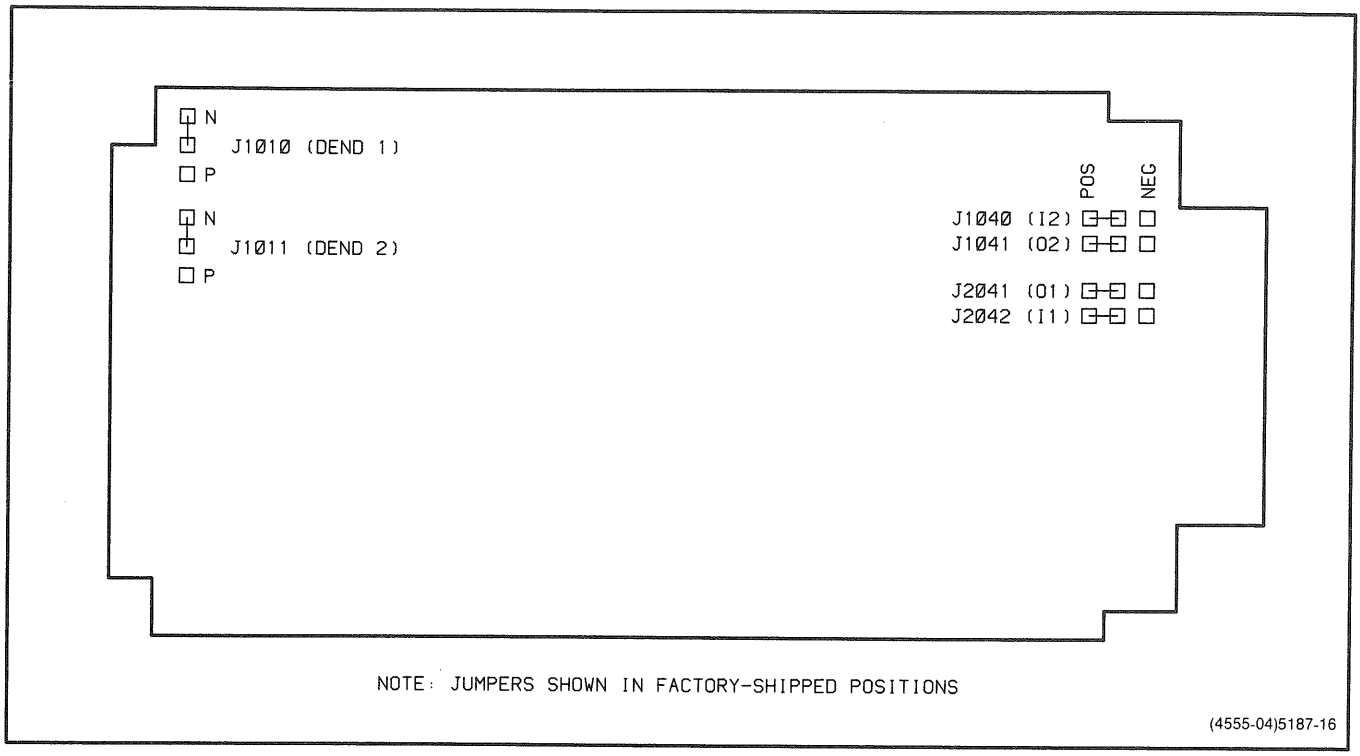

Fig. 2-15. *50M50 on-board jumper locations.*

input or output. In normal handshaking of output data, the 50M50 asserts ODV to signal the receiving device that a valid word is present on its output lines. When the receiving device has received and accepted that word, it asserts the ODR line to signal the 50M50 that it may place another word on its output lines. The 50M50 does not require that the receiving device assert ODR before placing a subsequent word on its output lines; however, once asserted, the ODV line will remain true until it is reset by an ODR signal.

In normal handshaking of input data, the sending device initiates the handshake by placing a valid data word on the 50M50's input lines and asserting IDV. When the 50M50 has received that word (clocked it into the attached buffer), it asserts IDR to signal the sending device that it is ready for the next word. The 50M50 automatically resets IDR to its false level after about two microseconds.

The PACE lines are used to clock or gate data out in the output mode. The PACE line is quiescently high, and as long as it is allowed by the external device to remain high, the 50M50 will make conversions (subject to other programming and handshake conditions). When the external device pulls the PACE line low, the 50M50 will stop its operation immediately following the next ODV. The purpose of the PACE line is to allow the external device to control the rate of data transmission from the 50M50. By pulsing the PACE high for more than one microsecond and less than one handshake cycle, the external device can clock data out of the 50M50 one byte at a time.

In the input mode, the 50M50 asserts the DEND (Data End) line when the attached buffer is full. In the output mode, the 50M50 asserts DEND when it has transmitted the last data byte in the attached buffer.

The EOP (End of Process) line is an input line which the external device asserts to signal the end of a data transmission. Assertion of this line detaches any attached buffers to prohibit further transmission to or from those particular buffers. Assertion of the EOP line also satisfies the ON, SRQ, and COND arguments of the ARM and WAIT commands.

50M70 Development Card

The 50M70 provides the user with the means of developing his own unique circuit and interfacing it to the GPIB without the need for designing and building the GPIB interface itself. Interface between the 50M70 and the builder's circuit is through two 16-bit 68B21 interface registers (PIAs) which provide 32 data input/output lines, three sets of handshake lines, and several other lines for synchronizing the system with the device under test. Figure 2-16 shows the PIA pin assignments of the 50M70.

Each of the 32 data lines may be individually set for either input or output by means of the DIR command over the GPIB. The functions of the handshake and control lines are described in Section 3 of this guide.

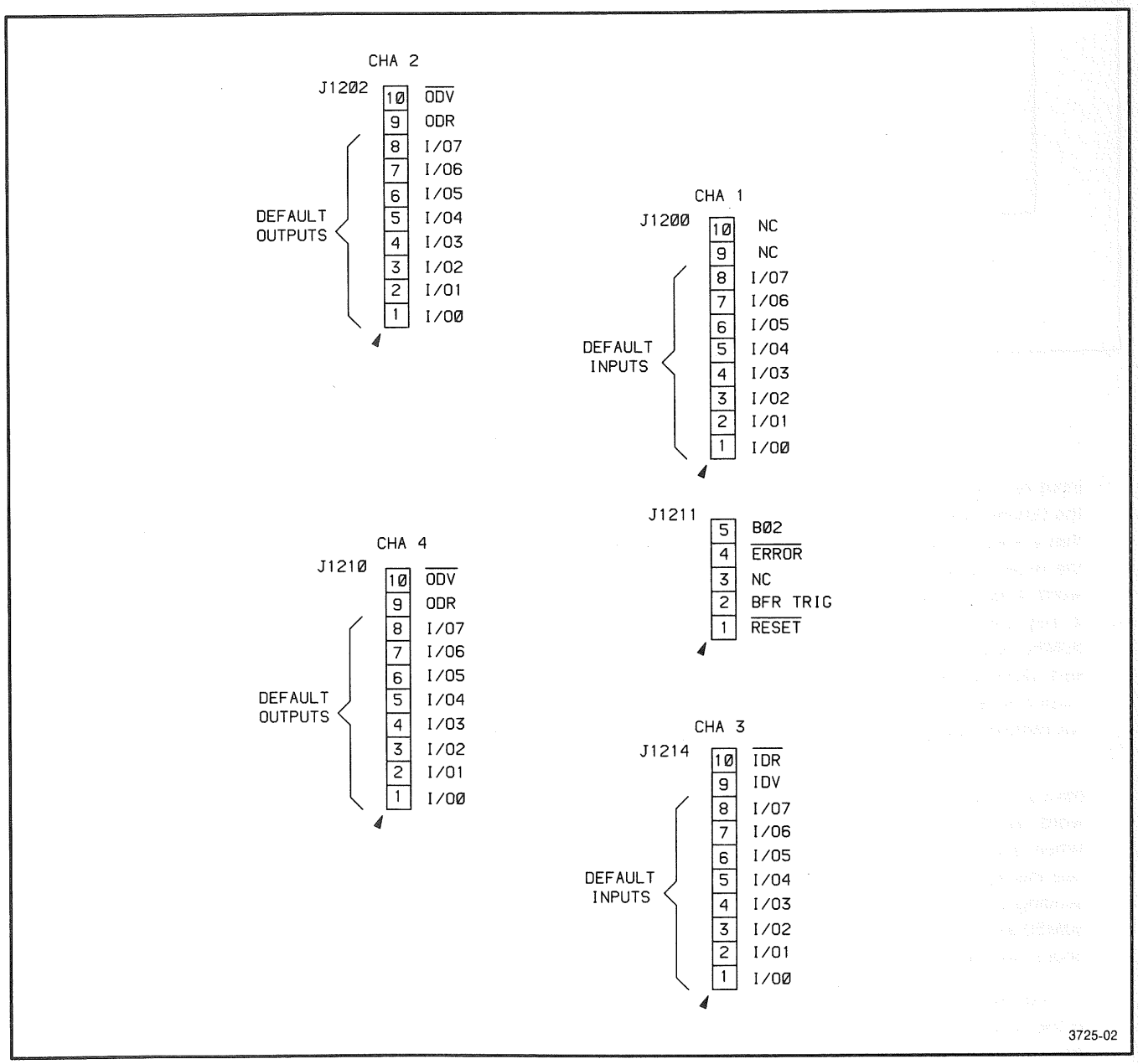

Fig. 2-16. *50M70 PIA pin assignments.*

Section 3
MI 5010 System Function Card Handshake Line Summary

This section summarizes the handshake lines available on each of the function cards in the MI 5010 Multifunction Interfacing System. The word "Select" in the True State column indicates that the true state (high or low) of that line is selectable by means of a jumper on the card. "Prog." indicates that the true state is programmable over the GPIB. All handshake lines use TTL logic levels.

More detail on the use of the handshake lines is given in Section 2 of this guide and in the respective function card instruction manuals.

50M10 Handshaking Lines

Line Name	Input or Output	True State	Function
ESC	Input	Select	Initiates a conversion by the 50M10. This line must be enabled by EXT ON command to 50M10.
READY	Output	Select	Goes false while a conversion is taking place.
EXT TRIG	Input	High	Satisfies the ON, SRQ, and COND arguments of the ARM and WAIT commands.
ODR	Input	Select	In 4-state handshake mode, indicates to 50M10 that an output data word has been accepted, and resets ODV. In 3-state handshake mode, allows continuous output of data, subject to operation of ESC line. This line must be enabled by EXT ON command to 50M10.
ODV	Output	Select	Indicates that a valid data word is available on 50M10 external data lines. This line must be enabled by EXT ON command to 50M10.

50M20 Handshaking Lines

Line Name	Input or Output	True State	Function
READY	Output	Select	Goes false while a conversion is taking place (approximately 20 microseconds in normal bandwidth mode; approximately 250 microseconds in limited bandwidth mode).
EXT TRIG	Input	High	Satisfies the ON, SRQ, and COND arguments of the ARM and WAIT commands.
IDR	Output	Select	Indicates to the sending device that a data word has been received. Once asserted, IDR remains true until reset by trailing edge of IDV.
IDV	Input	Select	Indicates to the 50M20 that the sending device has placed a valid data word on the 50M20 data input lines.

50M30 Handshaking Lines

Line Name	Input or Output	True State	Function
IDV	Input	High	Indicates to the 50M30 that the sending device has placed a valid data word on the 50M30 data input lines. Satisfies the ON, SRQ, and COND arguments of the ARM and WAIT commands.
IDR	Output	High	Indicates that the 50M30 has received the data word on its data input lines and is ready for the next.
ODV	Output	High	Indicates that a valid data word is present on the 50M30 data output lines. Reset by ODR.
ODR	Input	High	Indicates to the 50M30 that the receiving device has received the output data word and is ready for the next. Satisfies ON, SRQ, and COND arguments of ARM and WAIT commands. Resets ODV. (50M30 will ignore ODR if ODV is low.)
BFR TRIG	Output	Low	Occurs on receipt of Group Execute Trigger (GET) by MI 5010.

50M40 Handshaking Lines

Line Name	Input or Output	True State	Function
EXT TRIG	Input	High	Satisfies ON, SRQ, and COND arguments of ARM and WAIT commands.
READY	Output	High	Indicates that relays have settled after a CLOSE, OPEN, or NEXT command.

50M41 Handshaking Lines

Line Name	Input or Output	True State	Function
PWR ENBL	Control	Low	Enables isolated supplies when connected to digital ground. (Attachment of signal conditioning module automatically makes this connection.)
OUTPUT TEMP	Control	Low	Programs signal conditioning module to output the thermal block temperature voltage.
OUTPUT AMP	Control	Low	Programs signal conditioning module to output the thermocouple temperature voltage.
FILT ON/OFF	Control	Low	Enables low-pass filter in signal conditioning module.
HW COMP	Control	Low	Programs signal conditioning module to enable hardware temperature compensation.
READY	Output	Select	Indicates that relays have settled after a CLOSE, OPEN, or NEXT command.
EXT TRIG	Input	Select	Satisfies ON, SRQ, and COND arguments of ARM and WAIT commands.

50M50 Handshaking Lines

Operation in Data Input Mode

Line Name	Input or Output	True State	Function
IDV	Input	Select	Indicates to the 50M50 that the sending device has placed a valid data word on the 50M50 data lines.
IDR	Output	Select	Indicates that the 50M50 has received the data word on its data lines and is ready for the next.
DEND	Output	Select	Indicates that the attached buffer is full.
EOP	Input	High	Detaches all attached buffers, and satisfies the ON, SRQ, and COND arguments of the ARM and WAIT commands.

Operation in Data Output Mode

Line Name	Input or Output	True State	Function
ODR	Input	Select	Indicates to the 50M50 that the receiving device has received the output data word and is ready for the next. Resets ODV. (50M50 will ignore ODR if ODV is false.)
ODV	Output	Select	Indicates that a valid output data word is present on the 50M50 data lines. Reset by ODR.
DEND	Output	Select	Indicates that the last data byte in the attached buffer is present on the 50M50 data lines.
EOP	Input	Select	Detaches all attached buffers, and satisfies the ON, SRQ, and COND arguments of the ARM and WAIT commands.
PACE	Input	High	Holds off ODV when held low by external device.

50M70 Handshaking Lines

Line Name	Input or Output	True State	Function
ODV	Output	Prog.	Indicates that a valid output data word is present on the selected channel.
ODR	Input	Prog.	Indicates to the 50M70 that the receiving device has received the output data word on the selected channel and is ready for the next. Satisfies ON, SRQ, and COND arguments of ARM and WAIT commands.
IDR	Output	Prog.	Indicates to the sending device that the 50M70 has received the data word on the selected channel and is ready for the next word.
IDV	Input	Prog.	Indicates to the 50M70 that a valid input data word is present on the selected channel. Satisfies ON, SRQ, and COND arguments of ARM and WAIT commands.
B02	Output	NA	Buffered 1-MHz clock out (derived from MI 5010 clock).
ERROR	Output	Low	Goes low during power-up self-test. Stays low if a hardware error exists in 50M70.
BFR TRIG	Output	Low	Occurs on receipt of Group Execute Trigger (GET) by MI 5010.
RESET	Output	Low	Indicates that power-up self-test is occurring (see ERROR line).

Section 4
Programming Commands

This section lists the commands which may be sent to the MI 5010/MX 5010 and the function cards. Each command begins with a header -- a word or abbreviation that describes the function to be implemented. A command may include one or more arguments, which are separated from the header by a space and from each other by commas. Multiple commands may be combined in a message by separating the commands with semi-colons.

As an example, the following multiple command message sent to the MI 5010 initializes the MI 5010 (sets it to its power-up settings), directs the subsequent commands to the card in the first slot of the MI 5010, and closes relays 4 and 7 on that card (this assumes a 50M40 or 50M41 in the first slot of the MI 5010):

INIT;SEL 1;CLO 4,7

Most of the MI 5010 commands and all of the function card commands are executable in either immediate or buffered mode. In the MI 5010 command list, the commands which are executable in the immediate mode are indicated by the letter "I" in the mode column; those that are executable in the buffered mode are indicated by the letter "B" in the mode column. Commands that are executable in both modes are indicated by "I/B."

Following the list of commands for each instrument is a listing of the power-up settings for that instrument.

MI 5010 Programming Commands

System/Status Commands

Header	Argument(s)	Mode	Description
ERR?		I/B	Error query. With RQS ON returns error code for most recent event reported when serial polled. With RQS OFF it returns the highest priority status.
ID?		I/B	Identify instrument query.
INIT		I	Initializes system to its power-up state.
OPC	**ON**	I/B	OPeration Complete SRQ. Buffered commands executed on completion of EXECUTE command.
	OFF	I/B	Disables OPeration Complete function.

MI 5010 Programming Commands (cont)

System/Status Commands (cont)

Header	Argument(s)	Mode	Description
OPC?		I/B	OPeration Complete query.
RQS	**ON**	I/B	Enables SRQ assertion.
	OFF	I/B	Disables SRQ assertion (except power-on).
RQS?		I/B	Request for service query.
SET?		I/B	MI 5010 settings query.
TEST		I	Self-test command.
USER	**ON**	I/B	Enables user SRQ function (INST ID button).
	OFF	I/B	Disables user function.
USER?		I/B	User function query.

Card Control Commands

Header	Argument(s)	Mode	Description
BUF	**ON**	I	Opens command storage buffer.
	OFF	I	Closes command storage buffer.
COND	**1**	I/B	Sets flag for WAIT COND command.
	0	I/B	Resets flag for WAIT COND command.
COND?			Condition query.
EXEC	**<num>**	I	Closes command storage buffer, if open, and executes the number of times designated by the argument. Argument values 0 to 254. 0 causes no executions, but an SRQ is generated if OPC ON has been received.
	<−num>	I	Buffered commands executed indefinitely (always). Execution ceases on receipt of a STOP, EXEC <num>, INIT, or TEST command.
EXEC?		I/B	Execute query.
SEL	**<slot num> [,card name]**	I/B	Selects function card defined by argument(s).
SEL?		I/B	Card select query.
STOP		I	Stops execution of buffered command sequence.
TIME	**<hh>: <mm>: <ss> [,50 or 60 or 400]**	I/B	Initializes time-of-day clock. Second argument equals power line frequency; default = 60 Hz.
TIME?		I/B	Time-of-day clock query.

Card Control Commands (cont)

Header	Argument(s)	Mode	Description
TRIG		I/B	Performs same function as <GET> interface message. See IEEE 488 Interface Messages, and Detailed Command List.
UNTI	**<hh>: <mm>: <ss>**	I/B	Sets the time comparison value for the WAIT UNTIL command.
UNTI?		I/B	Time comparison value query.
WAI	**TRIG**	B	Suspends execution of the command storage buffer until receipt of the TRIG command or <GET>.
	COND	B	Suspends execution of the command storage buffer until an armed function card receives a condition defined for the selected card.
	UNTI	B	Suspends execution of the command storage buffer until the time-of-day clock equals the argument value specified in the UNTIL command.
	<num>	B	Suspends execution of the command storage buffer until <num> of seconds has passed.
	OFF	B	No waiting period for buffered mode execution.
WAI?		I/B	Wait status query.

MI 5010 Power-On Settings

OPC	OFF
RQS	OFF
SEL	0 (or lowest slot filled, 1-6)
USER	OFF

50M10 Programming Commands

Header	Argument(s)	Description
ARM	**ON**	Causes 50M10 to generate both a logical condition and an SRQ when an external trigger (EXT TRIG) occurs.
	COND	Causes 50M10 to generate only a logical condition when EXT TRIG occurs.
	SRQ	Causes 50M10 to generate only an SRQ when EXT TRIG occurs.
	OFF	No action is generated when EXT TRIG occurs.
ARM?		Returns arming status.
BDAT?		Returns binary formatted conversion data.
CONVERT		Causes a conversion to be made.
DAT?		Returns decimal formatted conversion data.
DT	**TRIG**	With EXT OFF enabled, causes a conversion whenever a <GET> interface message or MI 5010 TRIG command is received.
	OFF	Causes the 50M10 to ignore the <GET> interface message and MI 5010 TRIG command.
DT?		Returns the device trigger setting.
EXT	**ON**	Enables the 50M10 external port to communicate with other devices via the front connector and enables the ESC (External Start Conversion) line.
	OFF	Disables the external port and ESC line.

50M10 Programming Commands (cont)

Header	Argument(s)	Description
EXT?		Returns EXT setting.
FLAG?		Returns 1 if EXT TRIG has occurred since last FLAG query.
		Returns 0 if EXT TRIG has not occurred since last FLAG query.
FSET?		Returns 50M10 ARM, DT, and EXT command settings.
HDAT?		Returns hexadecimal formatted conversion data.
NAM?		Returns the card name.
RANGE?		Returns the 50M10 range (.1, 1, 10, and 100) configurations.
SEND		Initiates a conversion and returns the value in volts. Does not return a header.
VOLT?		Returns the last conversion value in volts. Does not cause a conversion.

50M10 Power-On Settings

ARM	OFF
DT	OFF
EXT	OFF

50M20 Programming Commands

Header	Argument(s)	Description
ARM	**ON**	Causes 50M20 to generate both a logical condition and an SRQ when an external trigger (EXT TRIG) occurs.
	COND	Causes 50M20 to generate only a logical condition when EXT TRIG occurs.
	SRQ	Causes 50M20 to generate only an SRQ when EXT TRIG occurs.
	OFF	No action is generated when EXT TRIG occurs.
ARM?		Armed status query.
CURR	**<num>**	Sets 50M20 to output the current specified by the argument. <num> is assumed to be in milliamperes with a range of −20.48 to +20.47.
CURR?		Output current setting query.
DAT	**<num>** **B<num>** **H<num>**	Puts binary equivalent defined by the selected argument into the digital inputs of the digital-to-analog converter. <num> can be decimal, binary, or hexadecimal. Decimal range, 0 to 4095.
DAT?		Decimal data format query.
BDAT?		Binary data format query.
HDAT?		Hexadecimal data format query.

50M20 Programming Commands (cont)

Header	Argument(s)	Description
DT	**SET**	Causes 50M20 to wait for the <GET> interface message or MI 5010 TRIG command before executing any setting command previous to <GET> interface message or MI5010 TRIG command.
	TRIG	The DATA, VOLT, and CURRENT commands preceded by DT TRIG are executed on receipt of the <GET> interface message or MI 5010 TRIG command.
	OFF	Causes 50M20 to ignore the <GET> interface message or MI 5010 TRIG command.
DT?		Device trigger setting query.
FLAG?		Flag query for EXT TRIG interrupt.
FSET?		50M20 settings query.
MODE?		Voltage or current mode query.
NAM?		Card name query.
SOUR	**INT**	Causes 50M20 to accept data from MI 5010 data port.
	EXT	Causes 50M20 to accept data from its external data port (front panel connector).
SOUR?		Data source query.
VOLT	**<num>**	Sets 50M20 to output the voltage specified by the argument. <num> is assumed to be in volts with a range of −10.24 to +10.235.
VOLT?		Output voltage setting query.

50M20 Programming Commands (cont)

Header	Argument(s)	Description
	50M20 Power-On Settings	
Voltage Mode:		
VOLT	0.000	
ARM	OFF	
DAT	2048	
SOUR	INT	
DT	OFF	
Current Mode:		
CURR	0.00	
ARM	OFF	
DAT	2048	
SOUR	INT	
DT	OFF	

50M30 Programming Commands

Header	Argument(s)	Description
ARM	**ON**	Handshake lines generate both a logical condition and SRQ when ODR or IDV signal occurs.
	COND	Handshake lines generate only a logical condition when an ODR or IDV signal occurs.
	SRQ	Handshake lines generate only an SRQ when an ODR or IDV signal occurs.
	OFF	No action is generated by the handshake lines.
ARM?		Armed status query.
CHA	**<num>**	Accesses channel defined by argument. <num> = 1 for data output channel. = 2 for data input channel.
CHA?		Accessed channel query.
DAT	**<num>** **B<num>** **H<num>**	Puts binary equivalent of <num> into Channel 1 data output register. <num> can be decimal binary or hexadecimal
DAT?		Decimal data format query (Channel 1 or 2).

50M30 Programming Commands (cont)

Header	Argument(s)	Description
BDAT?		Binary data format query (Channel 1 or 2).
HDAT?		Hexadecimal data format query (Channel 1 or 2).
DT	**SET**	Alter settings after receipt of <GET> interface message or MI5010 TRIG command.
	TRIG	Change input/output data after receipt of <GET> interface message or MI5010 TRIG command.
	OFF	<GET> interface message or MI5010 TRIG command has no effect.
DT?		Device trigger status query.
FLAG?		Flag query for ODV or IDV interrupts.
FSET?		50M30 current settings query.
NAM?		Function card name query.

50M30 Power-On Settings

CHA	1
DT	OFF
CHA 1:	
DAT	0
ARM	OFF
CHA 2:	
ARM	OFF

50M40 Programming Commands

Header	Argument(s)	Description
ARM	**ON**	Causes 50M40 to generate both a logical condition and SRQ when an external trigger (EXT TRIG) occurs.
	COND	Only the logical condition is generated for EXT TRIG. The logical condition is defined as the satisfaction of the WAIT COND command.
	SRQ	Only an SRQ is generated for an EXT TRIG signal.
	OFF	No action is generated for an EXT TRIG signal.
ARM?		Armed status query.
CLO	**<num> [,num...]**	Closes relay(s) defined by argument(s), up to 16 total numbers (1—16).
CLO?		Closed relay status query.
CONF?		Hardwired configuration status query.
DT	**SET**	Causes 50M40 to wait for <GET> interface message before altering its settings.
	TRIG	Causes 50M40 to wait for the MI5010 TRIG command before altering its settings.
	OFF	<GET> interface message or MI 5010 TRIG command have no effect on 50M40.
DT?		Device trigger setting query.

50M40 Programming Commands (cont)

Header	Argument(s)	Description
FLAG?		Flag query for occurrence of EXT TRIG signal (interrupt).
FSET?		50M40 current settings query. Use CONF? query to obtain hardwired relay configuration.
NAM?		Card name query.
NEXT		Closes next relay in the defined scanning sequence. Scanning sequence defined by SCAN command arguments.
OPE	**<num> [,num...]**	Opens relay(s) defined by the argument(s), up to 16 total numbers.
	ALL	Opens all relays.
OPE?		Open relay query.
SCAN	**<num> [,num...]**	Relay scanning sequence specified by the order of the arguments, up to 16 numbers.
SCAN?		Relay scanning sequence query.

50M40 Power-On Settings

DT	OFF
ARM	OFF
OPE	1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15,16
CLO	0
SCAN	0

50M41 Programming Commands

Header	Argument(s)	Description
ARM	**ON**	Causes the 50M41 to generate a logical condition and assert SRQ when the external trigger (EXT TRIG) is asserted.
	COND	Causes the 50M41 to generate only a logical condition when EXT TRIG is asserted.
	SRQ	Causes the 50M41 to assert only an SRQ when EXT TRIG is true.
	OFF	No action is generated when EXT TRIG is asserted.
ARM?		Returns current ARM command setting.
CLO	**<num>** [,**<num>**...]	Causes the 50M41 to close specified relays (integers 1 through 10) and pulses the READY line.
	0	Pulses READY line; does not affect the relays.
CLO?		Returns the number(s) of the currently closed relay(s).
CONF?		Returns card relay jumper configuration.
DT	**SET**	Causes the 50M41 to wait for a Group Execute Trigger <GET> interface message before executing previously received setting commands.
	TRIG	Allows the <GET> interface message to strobe previously received relay setting changes defined by the OPEN, CLOSE, or SCAN commands.
	OFF	Causes the 50M41 to ignore the <GET> interface message.

50M41 Programming Commands (cont)

Header	Argument(s)	Description
DT?		Returns the current DT setting.
FLAG?		Returns FLAG 1, if an EXT TRIG has occurred since the last flag query; otherwise returns FLAG 0.
FSET?		Returns the 50M41 current setting. Use CONF? query to obtain hardwired relay configuration.
MOD?		Returns type of module connected to the 50M41.
NAM?		Returns 50M41 card identification.
NEXT		Causes the 50M41 to go to the next relay closure defined by the SCAN command.
OPE	**<num>** [,**<num>**...]	Causes the specified relay(s) (integers 1 through 10) to open.
	0	Causes the READY line to change state; does not affect relays.
	ALL	Causes all the relays to open.
OPE?		Returns the number(s) of the currently open relay(s).
SCAN	**<num>** [,**<num>**...]	The order of the arguments (specifying the relay integers 1 through 10) sets up the scanning sequence.
	0	Does not change the relay scanning sequence.
SCAN?		Returns the current relay scanning sequence.
TREE	**CLOSE**	Causes the tree relay to close.
	OPEN	Causes the tree relay to open.
TREE?		Returns the current tree relay state.

50M41 Programming Commands (cont)

Header	Argument(s)	Description

50M41 Power-On Settings

DT	OFF
ARM	OFF
OPE	1,2,3,4,5,6,7,8,9,10
CLO	0
SCAN	0
TREE	OPEN
FILT	OFF (used with amplifier modules only)
OUTPUT	OFF (used with thermocouple amplifier modules only)

OPTIONAL SIGNAL CONDITIONING MODULE COMMANDS

Header	Argument(s)	Description
FILT	**ON**	Causes the 50M41 to insert a filter providing 60 dB of normal mode rejection at 60 Hz in the 50M41 output when using the optional signal conditioning modules.
	OFF	No filtering in the output.
FILT?		Returns the current FILTER command setting.
HWCOMP?		Returns current hardware temperature compensation setting.
OUTPUT	**TEMP**	Makes the iso-thermal block temperature available at the thermocouple amplifier module analog output.
	AMP	Makes the amplifier output available at the signal conditioning module analog output.
	OFF	Opens the output relay.
OUTPUT?		Returns the signal conditioning module's analog output setting.

50M50 Programming Commands

Header	Argument(s)	Description
ABORT		Stops the handshake and detaches all channels.
APPEND	<**name1**>, <**name2**>	Concatenates the buffer data identified by the argument <name2> to the end of buffer data identified by the argument <name1>.
ARM	**ON**	Generates a logical condition, detaches all channels, and asserts SRQ when the EOP line is asserted.
	COND	Generates a logical condition and detaches all channels when the EOP line is asserted.
	SRQ	Asserts SRQ and detaches all channels when the EOP line is asserted.
	OFF	No action results when EOP is asserted.
ARM?		Returns ARM status.
ATT	<**name**>, <**chan**>, <**type**>	Assigns name to buffer, channel number, and data type.
ATT?		Returns buffer name(s), channel number, and data type.
BACKUP	<**binary block**>	Outputs a 260 byte binary block: directory (256 bytes), system variables (4 bytes), and all buffer data.
BACKUP?		Returns binary block data.
CREATE	<**name**>, <**length**>	Assigns name to buffer and new buffer length in (bytes).
DEL	<**name**>	Deletes buffer name.

50M50 Programming Commands (cont)

Header	Argument(s)	Description
DIR?		Returns buffer names, length of buffer data, and buffer unused space (bytes).
EOP?		Returns 0 (EOP line not asserted) or 1 (EOP line is asserted).
FSET?		Returns current 50M50 settings:
MEM?		Returns the number of unused bytes in the buffer memory: MEM <num>.
PURGE		Clears all buffers in the memory card.
RAMERR?		Returns results of the self-test at power-on or after the RAMTEST command.
RAMTEST		Causes a complete RAM test (purges the memory).
REC	<**name**>, <**format**>, <**data**>	Names buffer receiving data, format of received data, and buffer data values.
REPEAT	**ON**	Enables REPEAT mode on Channel 1.
	OFF	Disables REPEAT mode.
REPEAT?		Returns repeat mode setting.
SEND	<**name**>, <**format**>	Interprets buffer data and outputs results over the GPIB.
START		Initiates data transfers between buffer memory and the front panel connector set up by the ATTACH command.
STAT?		Returns status of all channels.

50M50 Programming Commands (cont)

Header	Argument(s)	Description

50M50 Power-On Settings

ATT	NONE
REPEAT	OFF
ARM	OFF

50M70 Programming Commands

Header	Argument(s)	Description
ARM	**ON**	Causes handshake lines to generate both a logical condition and an SRQ when an ODR or IDV signal occurs on the selected channel (Channel 1 has no handshake lines).
	COND	Only a logical condition is generated for an ODR or IDV signal. The logical condition is defined as the satisfaction of the WAIT COND command.
	SRQ	Only an SRQ is generated for an ODR or IDV signal.
	OFF	No action is generated by the ODR or IDV signal.
ARM?		Arming status query.
CHA	**<num>**	Selects user defined channel. <num> = 1, 2, 3, or 4.
CHA?		Currently selected channel query.
DAT	**<num>**	Puts binary equivalent of a decimal number into the data output register of the currently selected channel.
	B<num>	Puts 8-bit binary number into the data output register of currently selected channel.
	H<num>	Puts the binary equivalent of a hexadecimal number into the data output register of the currently selected channel.
DAT?		Decimal data format query.
BDAT?		Binary data format query.
HDAT?		Hexadecimal data format query.

50M70 Programming Commands (cont)

Header	Argument(s)	Description
DIR	**<num>**	A decimal number is used to set up the data direction register of the currently selected channel.
	B<num>	An 8-bit binary number is used to set up the data direction register of the currently selected channel (0 = input port, 1 = output port). A port is a single data line (or bit).
	H<num>	A hexadecimal number is used to set up the data direction register of the currently selected channel.
	DIR?	Direction of decimal data query.
	BDIR?	Direction of binary data query.
	HDIR?	Direction of hexidecimal data query.
DT	**SET**	Causes 50M70 to wait for <GET> interface message or MI 5010 TRIG command before altering its settings.
	OFF	No action is taken on receipt of <GET> interface message or MI 5010 TRIG command.
FLAG?		ODR or IDV interrupt flag query.
FSET?		50M70 current settings query.
NAM?		Card name query.
SLO	**POS**	Causes 50M70 to respond to the positive edge of an ODR or IDV signal.
	NEG	Causes 50M70 to respond to the negative edge of an ODR or IDV signal.
SLO?		ODR or IDV signal slope setting query.

50M70 Programming Commands (cont)

Header	Argument(s)	Description
	50M70 Power-On Settings	
CHA		1
DT		OFF
CHA 1:		
DAT		255*
DIR		0
CHA 2:		
DAT		XXX*
DIR		0
ARM		OFF
SLO		NEG
CHA 3:		
DAT		255*
DIR		0
ARM		OFF
SLO		NEG
CHA 4:		
DAT		XXX*
DIR		0
ARM		OFF
SLO		NEG

***If data lines not connected.**

Section 5
Status Bytes and Error Codes

Programmable interrupts are provided in the MI 5010 Multifunction Interfacing System to inform the controller of asynchronous events, such as operation complete, command errors, and receipt of external triggers by the function cards. If the MI 5010 is set to respond to report such an event (by the RQS ON command), it asserts SRQ and sets its status byte and error code appropriately. The status byte returned in response to a serial poll and the error code returned in response to an error query (ERR?) are listed below.

Error Codes and Status Bytes

Description	ERR? Response	Serial Poll Response (STB)
No Errors or Events	**0**	**0**
Active, No Errors To Report	**0**	**128**
Command Errors		
Command header error	**101**	**97**
Header delimiter error	**102**	**97**
Command argument error	**103**	**97**
Argument delimiter error	**104**	**97**
Nonnumeric argument (numeric expected)	**105**	**97**
Missing argument	**106**	**97**
Invalid message unit delimiter	**107**	**97**
Execution Errors		
I/O buffers full, output dumped	**203**	**98**
Legal command, but settings conflict	**204**	**98**
Argument out of range	**205**	**98**
Group execute trigger ignored; busy processing last message	**206**	**98**
Select error. No card in that slot.	**220**	**98**
Internal Errors		
RAM error on card in slot x	**34x**	**99**
ROM error on card in slot x	**36x**	**99**

Error Codes and Status Bytes

Description	ERR? Response	Serial Poll Response (STB)
System Events		
Power on	**401**	**65**
Operation complete. Execution of buffered commands has been completed	**402**	**66**
User request (INST ID pressed)	**403**	**67**
Device Warnings		
Time-of-day clock not initialized and WAIT UNTIL command was to be executed.	**605**	**102**
Device Dependent (Card) Events		
Power on errors on card in slot x	**74x**	**225**
Hardware errors on card in slot x	**77x**	**226**
Armed condition warning on card in slot x	**79x**	**192+x**

Section 6
Sample Programs for the MI 5010 Multifunction Interfacing System

This section gives program listings for three different programs combining the operation of two or more function cards in the MI 5010 Multifunction Interfacing System. Two versions of each program are given, one using the Tektronix 4052A controller with the 4052R14 GPIB rompack and the other using the Tektronix 4041 controller.

The three programs are:

1. Sine, square, and triangle generator program, using the 50M50 Memory Card and the 50M20 Digital-to-Analog Converter Card.
2. Low-frequency digitizer program, using the 50M50 Memory Card and the 50M10 Analog-to-Digital Converter Card.
3. Data acquisition program, using the 50M50 Memory Card, the 50M10 Analog-to-Digital Converter Card, and the 50M41 Low-Level Scanner Card.

Other sample programs are found in the instruction manuals for each of the instruments. Still other programs are available from the Tektronix Instrumentation Software Library.

```
100   ! ************************************************************
110   ! ********* 50M50 MEMORY CARD / 50M20 DIGITAL TO ANALOG CARD ****
120   ! ************************************************************
130   !
140   ! May 25, 1984
150   !
160   ! Copyright (c) 1983 Tektronix, Inc.  All rights reserved.  This
170   ! software is provided on an "as is" basis without warranty of
180   ! any kind.  It is not supported.
190   !
200   ! This program may be reproduced without prior permission, in
210   ! whole or in part, by the original purchaser.  Copies must
220   ! include the above copyright and warranty notice.
230   !
240   ! PURPOSE:
250   ! Loads the 50M50 Memory Card with the byte pattern to produce a
260   ! sine wave, triangle wave and square wave based on given
270   ! parameters.
280   ! These parameters are amplitude, offset and symmetry of the
290   ! waveform.
300   ! The waveform is produced by the 50M20 Digital to Analog
310   ! Converter card which converts the binary representation of the
320   ! waveform to its analog equivalent.
330   ! The number of points of the waveform are 256.
340   ! The maximum frequency attainable with 256 points is 200 Hz
350   ! Higher frequencies are possible with fewer points.The frequency
360   ! of the output is controlled by applying a 1.1 microsecond wide
370   ! pulse to the PACE input of the 50M50 Memory Card (15A). The
380   ! frequency of the output is determined by the time between
390   ! pulses. The following equation is used to calculate the output
400   ! frequency:
410   !
420   ! Output Frequency=1/[2*(Time between pulses)*(Number of Points)]
430   !
440   ! The frequency applied to the pace input is limited to 102.4KHz
450   ! with a 256 point waveform. Each byte pattern is given a file
460   ! name in the 50M50 which is descriptive of its contents. The
470   ! file names are,SINE, SQUARE and TRIANG. Each file is selected
480   ! for output by attaching it to port 1 of the 50M50.
490   !
500   ! REQUIRED EQUIPMENT:
510   ! MI/MX 5010 Programmable Multifunction Interface
520   ! 50M50 Memory Card.
530   ! 50M20 Digital to Analog Converter Card.
540   ! 4052A Controller with 4052R14-1A GPIB Enhancement Rompack.
550   !
560   ! PROGRAM SEGMENT VARIABLES:
570   ! mi: MI 5010 primary address.
580   ! _points: Number of points making up the waveform.
590   ! wave: Array containing the calculated waveform.
600   ! vmax: Maximum peak voltage allowed by 50M20.
610   ! voltspp1: Peak to peak amplitude of sine wave.
620   ! voltspp2: Peak to peak amplitude of square wave.
630   ! voltspp3: Peak to peak amplitude of triangle wave.
640   ! _offset1: Offset of sine wave.
650   ! _offset2: Offset of square wave.
660   ! _offset3: Offset of triangle wave.
670   ! symmet2: Symmetry of square wave.
680   ! symmet3: Symmetry of triangle wave.
690   ! statbyte: Target variable for device identifier.
700   ! address: Address of instrument requesting service.
710   ! ecode: Error code returned by a Tektronix instrument in response
720   ! to an error query.
```

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Fig. 6-1. *Sine, square, and triangle wave generator (4052A).*

```
730   !
740   ! OPERATING INSTRUCTIONS:
750   ! 1) Connect MI 5010 and 4041 with GPIB cable.  Use port 0.
760   ! 2) Change instrument or program, if necessary, so primary
770   !    address in instrument and program agree--program expects 23.
780   ! 3) 50M20 must be installed in slot 1 and 50M50 in slot 2 of
790   !    MI 5010 or change program assignment of these cards.
800   ! 4) Connect:        50M20                    50M50
810   !                  16A (IDR)     to       17A (ODR)
820   !                  17A (IDV)     to       16A (ODV)
830   !                  19A (E06)     to       19A (I/06)
840   !                  20A (E05)     to       20A (I/05)
850   !                  21A (E04)     to       21A (I/04)
860   !                  22A (E03)     to       22A (I/03)
870   !                  23A (E02)     to       23A (I/02)
880   !                  24A (E01)     to       24A (I/01)
890   !                  25A (E00)     to       25A (I/00)
900   !
910   ! 5) Obtain output signal from: 50M20  Analog Out   Analog Return
920   !                                        7A            7B
930   !
940   ! 6) Connect PACE signal to 15A of 50M50.
950   ! 7) Set 50M50 to positive handshake.
960   !
970   ! ERRORS:
980   ! Instrument address must be set to 23 or the program assignment
990   ! changed.
1000   !
1010   ! INSTRUMENT CONTROL:
1020   ! Only polls instrument on address 23. Polling routine must be
1030   ! changed if other instruments are on the bus.
1040   !
1050   ! ***************************************************************
1060   ! Begin main program segment
1070 INIT
1080 Mi=23
1090 ON SRQ THEN 1990
1100 _points=256
1110 DIM Wave(_points)
1120 PRINT @Mi:"SEL 1;SOUR EXT"
1130 PRINT @Mi:"SEL 2;ABORT;PURGE;REPEAT ON;CREATE SINE,";2*_points
1140 PRINT @Mi:"CREATE SQUARE,";2*_points
1150 PRINT @Mi:"CREATE TRIANG,";2*_points
1160 Vmax=10.2
1170 PAGE
1180 PRINT "Enter Vpeak-peak and offset, Vpeak+offset must be <=10.2 V"
1190 PRINT "Peak to peak amplitude of sine wave:";
1200 INPUT Voltspp1
1210 PRINT "Offset of sine wave:";
1220 INPUT _offset1
1230 IF Voltspp1/2+ABS(_offset1)<=Vmax THEN 1260
1240 PRINT "Illegal combination of amplitude and offset, try again."
1250 GO TO 1190
1260 PRINT "Peak to peak amplitude of square wave:";
1270 INPUT Voltspp2
1280 PRINT "Offset of square wave:";
1290 INPUT _offset2
1300 IF Voltspp2/2+ABS(_offset2)<=Vmax THEN 1330
1310 PRINT "Illegal combination of amplitude and offset, try again."
1320 GO TO 1260
1330 PRINT "Peak to peak amplitude of triangle wave:";
1340 INPUT Voltspp3
1350 PRINT "Offset of triangle wave:";
```

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Fig. 6-1 (cont.). *Sine, square, and triangle wave generator (4052A).*

```
1360 INPUT _offset3
1370 IF Voltspp3/2+ABS(_offset3)<=Vmax THEN 1400
1380 PRINT "Illegal combination of amplitude and offset, try again."
1390 GO TO 1330
1400 PRINT "Enter symmetry desired (in percent) for square wave:";
1410 INPUT Symmet2
1420 PRINT "Enter symmetry desired (in percent) for triangle wave:";
1430 INPUT Symmet3
1440 SET DEGREES
1450 Index=0
1460   ! Generate sine wave array.
1470 FOR _degrees=0 TO 360-360/_points STEP 360/_points
1480    Index=Index+1
1490    Wave(Index)=(SIN(_degrees)*Voltspp1/2+_offset1)*200+2048
1500 NEXT _degrees
1510 CALL "LISTEN";Mi
1520 CALL "PRISTR","RECEIVE SINE,BINBLK,"
1530 CALL "BINOUT","PACK",Wave,E
1540 WBYTE @63,95:
1550   ! Generate square wave array.
1560 FOR Count=1 TO _points*Symmet2/100+1
1570    Wave(Count)=(Voltspp2/2+_offset2)*200+2048
1580 NEXT Count
1590 FOR Count=_points*Symmet2/100+1 TO _points
1600    Wave(Count)=(-Voltspp2/2+_offset2)*200+2048
1610 NEXT Count
1620 CALL "LISTEN";Mi
1630 CALL "PRISTR","RECEIVE SQUARE,BINBLK,"
1640 CALL "BINOUT","PACK",Wave,E
1650 WBYTE @63,95:
1660   ! Generate triangle wave array.
1670 FOR Count=1 TO Symmet3*_points/100
1680    Wave(Count)=Voltspp3*100/(Symmet3*_points)*Count
1690    Wave(Count)=(Wave(Count)-Voltspp3/2+_offset3)*200+2048
1700 NEXT Count
1710 FOR Count=Symmet3*_points/100 TO _points
1720    Wave(Count)=-Voltspp3*100/((100-Symmet3)*_points)*Count
1730    Wave(Count)=Wave(Count)+Voltspp3*100/(100-Symmet3)
1740    Wave(Count)=(Wave(Count)-Voltspp3/2+_offset3)*200+2048
1750 NEXT Count
1760 CALL "LISTEN";Mi
1770 CALL "PRISTR","RECEIVE TRIANG,BINBLK,"
1780 CALL "BINOUT","PACK",Wave,E
1790 WBYTE @63,95:
1800 PAGE
1810 PRINT USING "fa/fa":"Select function:","1. Sine wave";
1820 PRINT USING "fa/fa":"2. Square wave","3. Triangle wave";
1830 PRINT USING "fa":"4. Exit program"
1840 INPUT Wavform
1850 IF Wavform<1 OR Wavform>4 THEN
1860    GO TO 1800
1870 ELSE
1880    GOSUB Wavform OF 1910,1930,1950,1970
1890 END IF
1900 GO TO 1800
1910 PRINT @Mi:"SEL 2;ABORT;ATTACH SINE,1,DAC;START"
1920 RETURN
1930 PRINT @Mi:"SEL 2;ABORT;ATTACH SQUARE,1,DAC;START"
1940 RETURN
1950 PRINT @Mi:"SEL 2;ABORT;ATTACH TRIANG,1,DAC;START"
1960 RETURN
1970 END
1980   !SRQ handler
```

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Fig. 6-1 (cont.). *Sine, square, and triangle wave generator (4052A).*

```
1990 POLL Address,Statbyte;Mi
2000 PRINT @Mi:"ERR?"
2010 INPUT @Mi:Ecode
2020 PRINT " Status byte: ";Statbyte;" Error code: ";Ecode
2030 RETURN
2040 END
```

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Fig. 6-1 (cont.). *Sine, square, and triangle wave generator (4052A).*

```
100   ! ************************************************************************
110   ! ********* 50M50 MEMORY CARD / 50M20 DIGITAL TO ANALOG CARD **********
120   ! ************************************************************************
130   !
140   ! May 25, 1984
150   !
160   ! Copyright (c) 1983 Tektronix, Inc.  All rights reserved.  This
170   ! software is provided on an "as is" basis without warranty of
180   ! any kind.  It is not supported.
190   !
200   ! This program may be reproduced without prior permission, in whole
210   ! or in part, by the original purchaser.  Copies must include the
220   ! above copyright and warranty notice.
230   !
240   ! PURPOSE:
250   ! Loads the 50M50 Memory Card with the byte pattern to produce a
 **         sine wave,
260   ! triangle wave and square wave based on given parameters. These
 **         parameters
270   ! are amplitude, offset and symmetry of the waveform. The
 **         waveform is produced by the
280   ! 50M20 Digital to Analog Converter card which converts the
 **         binary representation
290   ! of the waveform to its analog equivalent. The number of points of the
300   ! waveform are 256. The maximum frequency attainable with 256 points is
310   ! 200 Hz. Higher frequencies are possible with fewer points. The
 **         frequency
320   ! of the output is controlled by applying a 1.1 microsecond wide pulse
330   ! to the PACE input of the 50M50 Memory Card (15A). The
 **         frequency of the
340   ! output is determined by the time between pulses. The following
 **         equation
350   ! is used to calculate the output frequency:
360   !
370   ! Output Frequency = 1/[2*(Time between pulses)*(Number of Points)]
380   !
390   ! The frequency applied to the pace input is limited to 102.4KHz
 **         with a 256
400   ! point waveform. Each byte pattern is given a file name in the 50M50
410   ! which is descriptive of its contents. The file names are SINE, SQUARE
420   ! and TRIANG. Each file is selected for output by attaching it
 **         to port 1
430   ! of the 50M50.
440   !
```

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Fig. 6-2. *Sine, square, and triangle wave generator (4041).*

```
450   ! REQUIRED EQUIPMENT:
460   ! MI/MX 5010 Programmable Multifunction Interface
470   ! 50M50 Memory Card.
480   ! 50M20 Digital to Analog Converter Card.
490   ! 4041 Controller (V2.0)
500   !
510   ! MAIN PROGRAM SEGMENT VARIABLES:
520   ! mi: MI 5010 logical unit number. Opened in line 1040.
530   ! points: Number of points making up the waveform.
540   ! wave: Array containing the calculated waveform.
550   ! vmax: Maximum peak voltage allowed by 50M20.
560   ! voltspp1: Peak to peak amplitude of sine wave.
570   ! voltspp2: Peak to peak amplitude of square wave.
580   ! voltspp3: Peak to peak amplitude of triangle wave.
590   ! offset1: Offset of sine wave.
600   ! offset2: Offset of square wave.
610   ! offset3: Offset of triangle wave.
620   ! symmet2: Symmetry of square wave.
630   ! symmet3: Symmetry of triangle wave.
640   ! statbyte: Status byte reported by instrument requesting service.
650   ! address: Address of instrument requesting service.
660   ! ecode: Error code returned by a Tektronix instrument in
 **         response to an error query.
670   !
680   ! OPERATING INSTRUCTIONS:
690   ! 1) Connect MI 5010 and 4041 with GPIB cable.  Use port 0.
700   ! 2) Change instrument or program, if necessary, so primary address in
710   !    instrument and program agree--program expects 23.
720   ! 3) 50M20 must be installed in slot 1 and 50M50 in slot 2 of MI
 **         5010 or
730   !    change program assignment of these cards.
740   ! 4) Connect:        50M20                    50M50
750   !                  16A (IDR)     to       17A (ODR)
760   !                  17A (IDV)     to       16A (ODV)
770   !                  19A (E06)     to       19A (I/06)
780   !                  20A (E05)     to       20A (I/05)
790   !                  21A (E04)     to       21A (I/04)
800   !                  22A (E03)     to       22A (I/03)
810   !                  23A (E02)     to       23A (I/02)
820   !                  24A (E01)     to       24A (I/01)
830   !                  25A (E00)     to       25A (I/00)
840   !
850   ! 5) Obtain output signal from: 50M20   Analog Out   Analog Return
860   !                                          7A            7B
870   !
880   ! 6) Connect PACE signal to 15A of 50M50.
890   ! 7) Set 50M50 to positive handshake.
900   !
910   ! ERRORS:
920   ! No GPIB or tape error handlers are linked so 4041 prints
 **         default system
930   ! error messages and stops if such errors occur (instrument
 **         power is off
940   ! or tape capacity exceeded, etc.).
950   !
960   ! INSTRUMENT CONTROL:
970   ! Polls all instruments on selected port.
980   !
990   ! ***************************************************************
```

4555-20

Fig. 6-2 (cont.). *Sine, square, and triangle wave generator (4041).*

```
1000   ! Begin main program segment
1010     Init
1020     On srq then call handler
1030     Mi=23
1040     Open #mi:"spib0(pri=23,eoa=(0)):"
1050     Enable srq
1060     Points=256
1070     Integer wave(points)
1080     Print #mi:"SEL 1;SOUR EXT"
1090     Print #mi:"SEL 2;ABORT;PURGE;REPEAT ON;CREATE SINE,";2*points,
  **         "CREATE SQUARE,";2*points,"CREATE TRIANG,";2*points
1100     Vmax=10.2
1110     Print "Enter peak to peak amplitude and offset, Vpeak + Offset
  **         no greater than 10.2 volts"
1120     Input prompt "Peak to peak amplitude of sine wave:":voltspp1
1130     Input prompt "Offset of sine wave:":offset1
1140     If voltspp1/2+abs(offset1)>vmax then print "Illegal
  **         combination of amplitude and offset, try again" else goto 1160
1150     Goto 1120
1160     Input prompt "Peak to peak amplitude of square wave:":voltspp2
1170     Input prompt "Offset of square wave:":offset2
1180     If voltspp2/2+abs(offset2)>vmax then print "Illegal
  **         combination of amplitude and offset, try again" else goto 1200
1190     Goto 1160
1200     Input prompt "Peak to peak amplitude of triangle wave:":voltspp3
1210     Input prompt "Offset of triangle wave:":offset3
1220     If voltspp3/2+abs(offset3)>vmax then print "Illegal
  **         combination of amplitude and offset, try again" else goto 1240
1230     Goto 1200
1240     Input prompt "Enter symmetry desired (in percent) for square
  **         wave:":symmet2
1250     Input prompt "Enter symmetry desired (in percent) for triangle
  **         wave:":symmet3
1260     Set angle 1
1270     Index=0
1280   ! GENERATE SINE WAVE ARRAY.
1290     For degrees=0 to 360-360/points step 360/points
1300       Index=index+1
1310       Wave(index)=(sin(degrees)*voltspp1/2+offset1)*200+2048
1320       Next degrees
1330     Print #mi:"RECEIVE SINE,BINBLK,"; !Instruct 50M50 to receive
  **         sine wave array.
1340     Print using "%" #mi:wave
1350   ! GENERATE SQUARE WAVE ARRAY.
1360     For count=1 to points*symmet2/100+1
1370       Wave(count)=(voltspp2/2+offset2)*200+2048
1380       Next count
1390     For count=points*symmet2/100+1 to points
1400       Wave(count)=(-voltspp2/2+offset2)*200+2048
1410       Next count
1420     Print #mi:"RECEIVE SQUARE,BINBLK,"; !Instruct 50M50 to receive
  **         square wave array.
1430     Print using "%" #mi:wave
1440   ! GENERATE TRIANGLE WAVE ARRAY.
1450     For count=1 to symmet3*points/100
1460       Wave(count)=(voltspp3*100/(symmet3*points)
  **         *count-voltspp3/2+offset3)*200+2048
1470       Next count
1480     For count=symmet3*points/100 to points
1490       Wave(count)=(-voltspp3*100/((100-symmet3)*points)
  **         *count+voltspp3*100/(100-symmet3)-voltspp3/2+offset3)*200+2048
1500       Next count
```

4555-21

Fig. 6-2 (cont.). *Sine, square, and triangle wave generator (4041).*

```
1510      Print #mi:"RECEIVE TRIANG,BINBLK,"; !Instruct 50M50 to receive
  **          triangle wave array.
1520      Print using "%" #mi:wave
1530      Print using "9(f8/)":"Select function:","1. Sine wave","2.
  **          Square wave","3. Triangle wave","4. Exit program"
1540      Input wavform
1550      If wavform<1 or wavform>4 then print "Undefined function, try
  **          again" else gosub wavform of sine,square,triangle,leave
1560      Goto 1530
1570 Sine:      print #mi:"SEL 2;ABORT;ATTACH SINE,1,DAC;START" ! Attach
  **          file SINE for output.
1580      Return
1590 Square:      print #mi:"SEL 2;ABORT;ATTACH SQUARE,1,DAC;START" !
  **          Attach file SQUARE for output.
1600      Return
1610 Triangle:      print #mi:"SEL 2;ABORT;ATTACH TRIANG,1,DAC;START" !
  **          Attach file TRIANG for output.
1620      Return
1630 Leave:      end

1700 Sub handler
1710      Poll statbyte,address
1720      Input prompt "ERR?" #address:ecode
1730      Print "Address: ";address;" Status byte: ";statbyte;" Error
  **          code: ";ecode
1740      Resume
1750      End
```

4555-22

Fig. 6-2 (cont.). *Sine, square, and triangle wave generator (4041).*

```
100   ! ********************************************************************
110   ! ******** 50M50 MEMORY CARD / 50M10 ANALOG TO DIGITAL CARD *****
120   ! ********************************************************************
130   !
140   ! May 25, 1984
150   !
160   ! Copyright (c) 1983 Tektronix, Inc.  All rights reserved.  This
170   ! software is provided on an "as is" basis without warranty of
180   ! any kind.  It is not supported.
190   !
200   ! This program may be reproduced without prior permission, in
210   ! whole or in part, by the original purchaser.  Copies must
220   ! include the above copyright and warranty notice.
230   !
240   ! PURPOSE:
250   ! Sets up the 50M50 to receive 512 samples from the 50M10 Analog
260   ! to Digital Converter Card. The sampling rate is controlled by
270   ! an External Start Conversion pulse 1.1 microseconds wide. The
280   ! sampling rate is determined by the time between pulses. The
290   ! time between pulses cannot be faster than 42 micro seconds. The
300   ! number of _points multiplied by the sampling rate equals the
310   ! time window.
320   !
330   ! Time Window=(Number of _points)*(Sampling Rate)
340   !
```

(4555-23) 5187-19

Fig. 6-3. *Low frequency digitizer (4052A).*

```
350   ! Once the data is received in the array WAVE it is scaled to the
360   ! proper voltage values in array WAVE1.
370   !
380   ! REQUIRED EQUIPMENT:
390   ! MI/MX 5010 Programmable Multifunction Interface
400   ! 50M50 Memory Card.
410   ! 50M10 Analog to Digital Converter Card.
420   ! 4052A Controller with 4052AR14-1A GPIB Enhancement Rompack.
430   !
440   ! MAIN PROGRAM SEGMENT VARIABLES:
450   ! mi: MI 5010 primary address.
460   ! _points: Number of samples.
470   ! wave: Array of samples.
480   ! wave1: Array of scaled samples.
490   ! flag: Flag to inform of data acquired (buffer full, error 200).
500   ! statbyte: Status byte reported by instrument requesting service.
510   ! address: Target variable for device identifier.
520   ! ecode: Error code returned by a Tektronix instrument in
530   ! response to an error query.
540   !
550   ! OPERATING INSTRUCTIONS:
560   ! 1) Connect MI 5010 and 4052A with GPIB cable.
570   ! 2) Change instrument or program, if necessary, so primary
580   !    address in instrument and program agree--program expects 23.
590   ! 3) 50M10 must be installed in slot 3 and 50M50 in slot 2 of
600   !    MI 5010 or change program assignment of these cards.
610   ! 4) Connect:        50M10                    50M50
620   !                  16A (ODR)     to       16A (IDR)
630   !                  17A (ODV)     to       17A (IDV)
640   !                  18A (D07)     to       18A (I/07)
650   !                  19A (D06)     to       19A (I/06)
660   !                  20A (D05)     to       20A (I/05)
670   !                  21A (D04)     to       21A (I/04)
680   !                  22A (D03)     to       22A (I/03)
690   !                  23A (D02)     to       23A (I/02)
700   !                  24A (D01)     to       24A (I/01)
710   !                  25A (D00)     to       25A (I/00)
720   !
730   ! 5) Apply input signal to: 50M10   Analog Input   Analog Ground
740   !                                       6A             6B
750   !
760   ! 6) Connect External Start Conversion (ESC) signal to 13A of
770   !    50M10.
780   ! 7) Set 50M50 to positive handshake.
790   ! 8) Set 50M10 to appropriate ESC polarity determined by
800   !    available external signal, 4 state handshake and conversion
810   !    to step mode.
820   !
830   ! ERRORS:
840   ! Instrument address must be set to 23 or the program assignment
850   ! changed.
860   !
870   ! INSTRUMENT CONTROL:
880   ! Only polls instrument on address 23. Polling routine must be
890   ! changed if other instruments are on the bus.
900   !
910   ! ************************************************************
```

4555-24

Fig. 6-3 (cont.). *Low frequency digitizer (4052A).*

```
920 INIT
930 Flag=0
940 Mi=23
950 ON SRQ THEN 1160
960  points=512
970 DIM Wave( points),Wave1( points)
980 PRINT @Mi:"SEL 3;EXT ON"
990 PRINT @Mi:"SEL 2;ABORT;PURGE;REPEAT OFF;ARM COND;OPC OFF"
1000 PRINT @Mi:"SEL 2;CREATE TEST,";2* points
1010 PRINT @Mi:"SEL 2;ATTACH TEST,1,ADC;START"
1020 WAIT
1030 IF Flag THEN 1050
1040 GO TO 1020
1050 Flag=0
1060 PRINT @Mi:"SEL 2;SEND TEST,BINBLK"
1070 CALL "BININ","PACK,UNSI",Wave,E;Mi
1080 PRINT @Mi:"SEL 3;EXT OFF;RANGE?"
1090 INPUT @Mi:Range
1100 Wave1=Wave-2048
1110 Wave1=Wave1*Range
1120 Wave1=Wave1/2000
1130 PRINT "Data Acquired and ScaledGG"
1140 END
1150   !SRQ handler
1160 POLL Address,Statbyte;Mi
1170 PRINT @Mi:"ERR?"
1180 INPUT @Mi:Ecode
1190 IF Ecode=200 THEN
1200    Flag=1
1210 ELSE
1220    Flag=0
1230 END IF
1240 IF Flag THEN 1260
1250 PRINT "Status byte: ";Statbyte;"Error code: ";Ecode
1260 RETURN
1270 END
```

4555-25

Fig. 6-3 (cont.). *Low frequency digitizer (4052A).*

```
100   ! ************************************************************************
110   ! ********** 50M50 MEMORY CARD / 50M10 ANALOG TO DIGITAL CARD ***********
120   ! ************************************************************************
130   !
140   ! May 25, 1984
150   !
160   ! Copyright (c) 1983 Tektronix, Inc.  All rights reserved.  This
170   ! software is provided on "as is" basis without warranty of
180   ! any kind.  It is not supported.
190   !
200   ! This program may be reproduced without prior permission, in whole
210   ! or in part, by the original purchaser.  Copies must include the
220   ! above copyright and warranty notice.
230   !
240   ! PURPOSE:
250   ! Sets up the 50M50 to receive 512 samples from the 50M10 Analog to
260   ! Digital Converter Card. The sampling rate is controlled by an
 **         External
270   ! Start Conversion pulse 1.1 micro seconds wide. The sampling rate is
280   ! determined by the time between pulses. The time between pulses
290   ! cannot be faster than 42 microseconds. The number of points
 **         multiplied
300   ! by the sampling rate equals the sampled time window.
310   !
320   ! Time Window=(Number of points)*(Sampling Rate)
330   !
340   ! Once the data is received in the array WAVE it is scaled to
 **         the proper
350   ! voltage values in array WAVE1.
360   !
370   ! REQUIRED EQUIPMENT:
380   ! MI/MX 5010 Programmable Multifunction Interface
390   ! 50M50 Memory Card.
400   ! 50M10 Analog to Digital Converter Card.
410   ! 4041 Controller (V2.0)
420   !
430   ! MAIN PROGRAM SEGMENT VARIABLES:
440   ! mi: MI 5010 logical unit number. Openened in line 930.
450   ! points: Number of samples.
460   ! preamb$: String to acquire data preamble (SEND ).
470   ! wave: Array of samples.
480   ! wave1: Array of scaled samples.
490   ! flag: Flag to inform of data acquired (buffer full, error 200).
500   ! statbyte: Status byte reported by instrument requesting service.
510   ! address: Address of instrument requesting service.
520   ! ecode: Error code returned by a Tektronix instrument in
 **         response to an error query.
530   !
540   ! OPERATING INSTRUCTIONS:
550   ! 1) Connect MI 5010 and 4041 with GPIB cable.  Use port 0.
560   ! 2) Change instrument or program, if necessary, so primary address in
570   !    instrument and program agree--program expects 23.
580   ! 3) 50M10 must be installed in slot 3 and 50M50 in slot 2 of MI
 **         5010 or
590   !    change program assignment of these cards.
```

(4555-26) 5187-20

Fig. 6-4. *Low frequency digitizer (4041).*

```
600    ! 4) Connect:          50M10                    50M50
610    !                    16A (ODR)     to       16A (IDR)
620    !                    17A (ODV)     to       17A (IDV)
630    !                    18A (D07)     to       18A (I/07)
640    !                    19A (D06)     to       19A (I/06)
650    !                    20A (D05)     to       20A (I/05)
660    !                    21A (D04)     to       21A (I/04)
670    !                    22A (D03)     to       22A (I/03)
680    !                    23A (D02)     to       23A (I/02)
690    !                    24A (D01)     to       24A (I/01)
700    !                    25A (D00)     to       25A (I/00)
710    !
720    ! 5) Apply input signal to: 50M10      Analog Input      Analog Ground
730    !                                          6A                6B
740    !
750    ! 6) Connect External Start Conversion (ESC) signal to 13A of 50M10.
760    ! 7) Set 50M50 to positive handshake.
770    ! 8) Set 50M10 to appropriate ESC polarity determined by available
780    !    external signal, handshake to 4 state and conversion to step mode.
790    !
800    ! ERRORS:
810    ! No GPIB or tape error handlers are linked so 4041 prints
 **          default system
820    ! error messages and stops if such errors occur (instrument
 **          power is off
830    ! or tape capacity exceeded, etc.).
840    !
850    ! INSTRUMENT CONTROL:
860    ! Polls all instruments on selected port.
870    !
880    ! ************************************************************************
890      Init
900      On srq then call handler
910      Flag=0
920      Mi=23
930      Open #mi:"spib0(pri=23,eoa=(0)):"
940      Enable srq
950      Points=512
960      Dim preamb$ to 5
970      Integer wave(points)
980      Long wave1(points)
990      Print #mi:"SEL 3;EXT ON"
1000     Print #mi:"SEL 2;ABORT;PURGE;REPEAT OFF;ARM COND;OPC OFF;
 **          CREATE TEST,";2*points
1010     Print #mi:"SEL 2;ATTACH TEST,1,ADC;START"
1020     Wait
1030     If flag then goto 1040 else goto 1020
1040     Flag=0
1045     Print #mi:"SEL 2;SEND TEST,BINBLK"
1050     Input #mi using "5a%":preamb$,wave
1060     Input prompt "SEL 3;EXT OFF;RANGE?" #mi:range
1070     Wave1=(wave-2048)/2*range/1000
1080     Print "Data Acquired and Scaled^G^G"
1090     End

1200 Sub handler
1210     Poll statbyte,address
1220     Input prompt "ERR?" #address:ecode
1230     If address=mi and ecode=200 then flag=1 else flag=0
1240     If flag then goto 1260
1250     Print "Address: ";address;" Status byte: ";statbyte;" Error
 **          code: ";ecode
1260     Resume
1270     End
```

(4555-27) 5187-21

Fig. 6-4 (cont.). *Low frequency digitizer (4041).*

```
100   ! ************************************************************
110   ! * 50M50 MEMORY CARD/50M10 ANALOG TO DIGITAL CARD/50M41 SCANNER*
120   ! ************************************************************
130   !
140   ! May 25, 1984
150   !
160   ! Copyrisht (c) 1983 Tektronix, Inc.  All rights reserved.  This
170   ! software is provided on an "as is" basis without warranty of
180   ! any kind.  It is not supported.
190   !
200   ! This program may be reproduced without prior permission, in
210   ! whole or in part, by the orisinal purchaser.  Copies must
220   ! include the above copyrisht and warranty notice.
230   !
240   ! PURPOSE:
250   ! Scans ten different voltage points ten times for a total of 100
260   ! readings. The readings are then scaled to the proper voltage
270   ! levels accordins to the 50M10 input ranse. Once the readinss
280   ! are scaled the ten readings from each point are averased and
290   ! printed out on the 4050A screen.
300   !
310   ! REQUIRED EQUIPMENT:
320   ! MI/MX 5010 Prosrammable Multifunction Interface
330   ! 50M50 Memory Card.
340   ! 50M10 Analos to Digital Converter Card.
350   ! 50M41 Low Level Scanner Card.
360   ! 4052A Controller with 4052R14-1A GPIB Enhancement Rompack.
370   !
380   ! PROGRAM SEGMENT VARIABLES:
390   ! mi: MI 5010 primary address.
400   ! test: Array used to input the 100 readings from the 50M50.
410   ! testvolt: Array containins the scaled voltage levels.
420   ! avesvolt: Array containing the averased readings.
430   ! flas: flas to inform of data acquired (buffer full, error 200).
440   ! statbyte: Status byte reported by instrument requesting service.
450   ! address: Tarset variable for device identifier.
460   ! ecode: Error code returned by a Tektronix instrument in response
470   ! to an error query.
480   !
490   ! OPERATING INSTRUCTIONS:
500   ! 1) Connect MI 5010 and 4050A with GPIB cable.
510   ! 2) Chanse instrument or program, if necessary, so primary addres
520   !    instrument and program asree--program expects 23.
530   ! 3) 50M41 must be installed in slot 1 and 50M10 in slot 2
540   !    and 50M50 in slot 3 or chanse prosram assisnment of
550   !    these cards.
560   ! 4) Connect:        50M10                  50M50
570   !                  16A (ODR)    to       16A (IDR)
580   !                  17A (ODV)    to       17A (IDV)
590   !                  18A (D07)    to       18A (I/07)
600   !                  19A (D06)    to       19A (I/06)
610   !                  20A (D05)    to       20A (I/05)
620   !                  21A (D04)    to       21A (I/04)
630   !                  22A (D03)    to       22A (I/03)
640   !                  23A (D02)    to       23A (I/02)
650   !                  24A (D01)    to       24A (I/01)
660   !                  25A (D00)    to       25A (I/00)
670   !
680   ! 4) Connect:        50M10                  50M41
690   !                  13A (ESC)    to        1B (READY)
700   !                  14A (READY)  to        2B (EXT TRIG)
710   !                   6A (INPUT)  to       13B (Hi)
720   !                   6B (COM)    to       14B (Lo)
730   !                   5A (GUARD)  to       15B (GUARD)
740   !
```

(4555-28) 5187-22

Fig. 6-5. *Data acquisition program (4052A).*

```
750    ! 5) Connect input signals to:50M41      Hi      Lo      Guard
760    !              Chan  1                    4B      5B       6B
770    !                    2                    4A      5A       6A
780    !                    3                    7B      8B       9B
790    !                    4                    7A      8A       9A
800    !                    6                   13A     14A      15A
810    !                    7                   16B     17B      18B
820    !                    8                   16A     17A      18A
830    !                    9                   19B     20B      21B
840    !                   10                   19A     20A      21A
850    !
860    ! 6) Set 50M41 jumpers for 1-of-10 and trisser slope to positive.
870    ! 7) Set 50M50 to positive handshake.
880    ! 8) Set 50M10 input ranse jumpers to accomdate input signal.
890    ! 9) Set 50M10 ESC polarity jumper to positive.
900    !
910    ! ERRORS:
920    ! Instrument address must be set to 23 or the program assignment
930    ! chansed.
940    !
950    ! INSTRUMENT CONTROL:
960    ! Only polls instrument on address 23. Polling routine must be
970    ! chansed if other instruments are on the bus besides the MI 5010
980    !
990    ! ************************************************************
1000    ! Besin main program sesment
1010 INIT
1020 Flas=0
1030 Mi=23
1040 ON SRQ THEN 1360
1050 DIM Test(100),Testvolt(10,10),Avesvolt(10)
1060 PRINT @Mi:"INIT;SEL 1;SCAN 1,2,3,4,5,6,7,8,9,10;TREE OPEN"
1070 PRINT @Mi:"SEL 2;CONVERT;EXT ON"  ! Set up 50M10
1080 PRINT @Mi:"SEL 1;ARM COND"  ! Set 50M41 to respond to EXT TRIG.
1090 PRINT @Mi:"SEL 3;ABORT;PURGE;REPEAT OFF;CREATE TEST,200"
1100 PRINT @Mi:"ATTACH TEST,1,ADC;START"
1110 PRINT @Mi:"BUFFER ON;SEL 1;NEXT;WAIT COND;BUFFER OFF"
1120 PRINT @Mi:"EXEC 100"  ! Execute the buffer 100 times.
1130 WAIT   ! Wait for service request interrupt.
1140 IF Flas THEN 1160
1150 GO TO 1130
1160 Flas=0
1170 PRINT @Mi:"SEL 3;SEND TEST,BINBLK"
1180 CALL "BININ","PACK,UNSI",Test,E;Mi
1190 PRINT @Mi:"SEL 2;EXT OFF;RANGE?"
1200 INPUT @Mi:Ranse
1210   ! Scale and averase data.
1220 PAGE
1230 FOR Column=1 TO 10
1240    Tempsum=0
1250    FOR Row=1 TO 10
1260       Testvolt(Row,Column)=(Test((Row-1)*10+Column)-2048)/0.2*Ranse
1270       Testvolt(Row,Column)=Testvolt(Row,Column)/10000
1280       Tempsum=Tempsum+Testvolt(Row,Column)
1290    NEXT Row
1300    Avesvolt(Column)=Tempsum/10
1310    PRINT USING "6A2D2X8D.5D":"POINT ",Column,Avesvolt(Column)
1320 NEXT Column
1330 PRINT "Data Acquired and ScaledG"
1340 END
1350   !SRQ handler
```

4555-29

Fig. 6-5 (cont.) *Data acquisition program (4052A).*

```
1360 POLL Address,Statbyte;Mi
1370 PRINT @Mi:"ERR?"
1380 INPUT @Mi:Ecode
1390 IF Ecode=200 THEN
1400    Flag=1
1410 ELSE
1420    Flag=0
1430 END IF
1440 IF Flag THEN 1460
1450 PRINT "Status byte: ";Statbyte;"Error code: ";Ecode
1460 RETURN
1470 END
```

4555-40

Fig. 6-5 (cont.) *Data acquisition program (4052A).*

```
100   ! ************************************************************************
110   ! * 50M50 MEMORY CARD / 50M10 ANALOG TO DIGITAL CARD / 50M41 SCANNER  *
120   ! ************************************************************************
130   !
140   ! May 25, 1984
150   !
160   ! Copyright (c) 1983 Tektronix, Inc.  All rights reserved.  This
170   ! software is provided on an "as is" basis without warranty of
180   ! any kind.  It is not supported.
190   !
200   ! This program may be reproduced without prior permission, in whole
210   ! or in part, by the original purchaser.  Copies must include the
220   ! above copyright and warranty notice.
230   !
240   ! PURPOSE:
250   ! Scans ten different voltage points ten times for a total of 100
260   ! readings. The readings are then scaled to the proper voltage levels
270   ! according to the 50M10 input range. Once the readings are scaled the
280   ! ten readings from each point are averaged and printed out on the
290   ! 4041 printer.
300   !
310   ! REQUIRED EQUIPMENT:
320   ! MI/MX 5010 Programmable Multifunction Interface
330   ! 50M50 Memory Card.
340   ! 50M10 Analog to Digital Converter Card.
350   ! 50M41 Low Level Scanner Card.
360   ! 4041 Controller (V2.0)
370   !
380   ! PROGRAM SEGMENT VARIABLES:
390   ! mi: MI 5010 logical unit number. Opened in line 1030.
400   ! test: Array used to input the 100 readings from the 50M50.
410   ! testvolt: Array containing the scaled voltage levels.
420   ! avesvolt: Array containing the averaged readings.
430   ! flag: flag to inform of data acquired (buffer full, error 200).
440   ! statbyte: Status byte reported by instrument requesting service.
450   ! address: Address of instrument requesting service.
460   ! ecode: Error code returned by a Tektronix instrument in
 **         response to an error query.
470   !
```

(4555-41) 5187-23

Fig. 6-6. *Data acquisition program (4041).*

```
480   ! OPERATING INSTRUCTIONS:
490   ! 1) Connect MI 5010 and 4041 with GPIB cable.  Use port 0.
500   ! 2) Change instrument or program, if necessary, so primary address in
510   !    instrument and program agree--program expects 23.
520   ! 3) 50M41 must be installed in slot 1 and 50M10 in slot 2 of MI
 **          5010 and
530   !    and 50M50 in slot 3 or change program assignment of these cards.
540   ! 4) Connect:        50M10                    50M50
550   !                  16A (ODR)     to       16A (IDR)
560   !                  17A (ODV)     to       17A (IDV)
570   !                  18A (D07)     to       18A (I/07)
580   !                  19A (D06)     to       19A (I/06)
590   !                  20A (D05)     to       20A (I/05)
600   !                  21A (D04)     to       21A (I/04)
610   !                  22A (D03)     to       22A (I/03)
620   !                  23A (D02)     to       23A (I/02)
630   !                  24A (D01)     to       24A (I/01)
640   !                  25A (D00)     to       25A (I/00)
650   !
660   ! 4) Connect:        50M10                    50M41
670   !                  13A (ESC)     to        1B (READY)
680   !                  14A (READY)   to        2B (EXT TRIG)
690   !                   6A (INPUT)   to       13B (Hi)
700   !                   6B (COM)     to       14B (Lo)
710   !                   5A (GUARD)   to       15B (GUARD)
720   !
730   ! 5) Connect input signals to:50M41      Hi      Lo      Guard
740   !              Chan  1                    4B      5B       6B
750   !                    2                    4A      5A       6A
760   !                    3                    7B      8B       9B
770   !                    4                    7A      8A       9A
780   !                    5                   10B     11B      12B
790   !                    6                   13A     14A      15A
800   !                    7                   16B     17B      18B
810   !                    8                   16A     17A      18A
820   !                    9                   19B     20B      21B
830   !                   10                   19A     20A      21A
840   !
850   ! 6) Set 50M41 jumpers for 1-of-10 and trisser slope to positive.
860   ! 7) Set 50M50 to positive handshake.
870   ! 8) Set 50M10 input range jumpers to accomdate input signal.
880   ! 9) Set 50M10 ESC polarity jumper to positive.
890   !
900   ! ERRORS:
910   ! No GPIB or tape error handlers are linked so 4041 prints
 **          default system
920   ! error messages and stops if such errors occur (instrument
 **          power is off
930   ! or tape capacity exceeded, etc.).
940   !
950   ! INSTRUMENT CONTROL:
960   ! Polls all instruments on selected port.
970   !
980   ! ************************************************************************
990   ! Begin main program segment
1000    Init
1010    On srq then call handler
1020    Mi=23
1030    Open #mi:"gpib0(pri=23,eos=(0)):"
1040    Enable srq
1050    Integer test(10,10)
1060    Long testvolt(10,10),avesvolt(10)
1070    Print #mi:"INIT;SEL 1;SCAN 1,2,3,4,5,6,7,8,9,10;TREE OPEN" !
 **          Set up 50M41.
```

4555-42

Fig. 6-6 (cont.). *Data acquisition program (4041).*

```
1080      Print #mi:"SEL 2;CONVERT;EXT ON" ! Set up 50M10
1090      Print #mi:"SEL 1;ARM COND" ! Set 50M41 to respond to EXT TRIG.
1100      Print #mi:"SEL 3;ABORT;PURGE;REPEAT OFF;CREATE TEST,200;ATTACH
  **          TEST,1,ADC;START" ! Set up 50M50
1110      Print #mi:"BUFFER ON;SEL 1;NEXT;WAIT COND;BUFFER OFF" ! Load
  **          MI 5010 buffer with scan and wait for EXT TRIG signal.
1120      Print #mi:"EXEC 100" ! Execute the buffer 100 times.
1130      Wait ! Wait for service request interrupt.
1140      If flag then goto 1150 else goto 1130 ! If SRQ is caused by
  **          50M50 buffer full error, then continue.
1150      Flag=0
1160      Input prompt "SEL 3;SEND TEST,BINBLK" using "5a%" #mi:preamb$,
  **          test ! Input data from 50M50.
1170      Input prompt "SEL 2;EXT OFF;RANGE?" #mi:range ! Obtain range
  **          information from 50M10.
1180    ! Scale and average data.
1190      For column=1 to 10
1200        Tempsum=0
1210        For row=1 to 10
1220          Testvolt(row,column)=(round((test(row,column)-2048)/0.2*range))
1230          Testvolt(row,column)=testvolt(row,column)/10000
1240          Tempsum=tempsum+testvolt(row,column)
1250          Next row
1260        Avesvolt(column)=tempsum/10
1270        Print using "6A2D2X8.5G" #"PRIN:":"POINT ",column,avesvolt(column)
1280        Next column
1290      Print #"PRTP:":"Data Acquired and Scaled^G"
1300      End

1400 Sub handler
1410      Poll statbyte,address
1420      Input prompt "ERR?" #address:ecode
1430      If address=mi and ecode=200 then flag=1 else flag=0
1440      If flag then goto 1460
1450      Print "Address: ";address;" Status byte: ";statbyte;" Error
  **          code: ";ecode
1460      Resume
1470      End
```

4555-43

Fig. 6-6 (cont.). *Data acquisition program (4041).*

Section 7
Instrumentation Software Library

ASCII & GPIB CODE CHART

B7 B6 B5 BITS / B4 B3 B2 B1	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 NUL 0 0	20 DLE 10 16	40 SP 20 32	0 60 0 30 48	100 @ 40 64	0 120 P 50 80	140 ` 60 96	0 160 p 70 112
0 0 0 1	1 GTL SOH 1 1	21 LLO DC1 11 17	41 ! 21 33	1 61 1 31 49	101 A 41 65	1 121 Q 51 81	141 a 61 97	1 161 q 71 113
0 0 1 0	2 STX 2 2	22 DC2 12 18	42 " 22 34	2 62 2 32 50	102 B 42 66	2 122 R 52 82	142 b 62 98	2 162 r 72 114
0 0 1 1	3 ETX 3 3	23 DC3 13 19	43 # 23 35	3 63 3 33 51	103 C 43 67	3 123 S 53 83	143 c 63 99	3 163 s 73 115
0 1 0 0	4 SDC EOT 4 4	24 DCL DC4 14 20	44 $ 24 36	4 64 4 34 52	104 D 44 68	4 124 T 54 84	144 d 64 100	4 164 t 74 116
0 1 0 1	5 PPC ENQ 5 5	25 PPU NAK 15 21	45 % 25 37	5 65 5 35 53	105 E 45 69	5 125 U 55 85	145 e 65 101	5 165 u 75 117
0 1 1 0	6 ACK 6 6	26 SYN 16 22	46 & 26 38	6 66 6 36 54	106 F 46 70	6 126 V 56 86	146 f 66 102	6 166 v 76 118
0 1 1 1	7 BEL 7 7	27 ETB 17 23	47 ' 27 39	7 67 7 37 55	107 G 47 71	7 127 W 57 87	147 g 67 103	7 167 w 77 119
1 0 0 0	10 GET BS 8 8	30 SPE CAN 18 24	50 (28 40	8 70 8 38 56	110 H 48 72	8 130 X 58 88	150 h 68 104	8 170 x 78 120
1 0 0 1	11 TCT HT 9 9	31 SPD EM 19 25	51) 29 41	9 71 9 39 57	111 I 49 73	9 131 Y 59 89	151 i 69 105	9 171 y 79 121
1 0 1 0	12 LF A 10	32 SUB 1A 26	52 * 2A 42	10 72 : 3A 58	112 J 4A 74	10 132 Z 5A 90	152 j 6A 106	10 172 z 7A 122
1 0 1 1	13 VT B 11	33 ESC 1B 27	53 + 2B 43	11 73 ; 3B 59	113 K 4B 75	11 133 [5B 91	153 k 6B 107	11 173 { 7B 123
1 1 0 0	14 FF C 12	34 FS 1C 28	54 , 2C 44	12 74 < 3C 60	114 L 4C 76	12 134 \ 5C 92	154 l 6C 108	12 174 |* 7C 124
1 1 0 1	15 CR D 13	35 GS 1D 29	55 - 2D 45	13 75 = 3D 61	115 M 4D 77	13 135] 5D 93	155 m 6D 109	13 175 } 7D 125
1 1 1 0	16 SO E 14	36 RS 1E 30	56 . 2E 46	14 76 > 3E 62	116 N 4E 78	14 136 ^ 5E 94	156 n 6E 110	14 176 ~ 7E 126
1 1 1 1	17 SI F 15	37 US 1F 31	57 / 2F 47	15 77 ? UNL 3F 63	117 O 4F 79	15 137 UNT _ 5F 95	157 o 6F 111	15 177 DEL (RUBOUT) 7F 127
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS (PPE) (PPD)	

KEY

octal 25 PPU / NAK / hex 15 21

GPIB code
ASCII character
decimal

*| on some keyboards or systems

Tektronix
COMMITTED TO EXCELLENCE

REF: ANSI STD X3. 4-1977
IEEE STD 488-1978
ISO STD 646-1973

TEKTRONIX INSTRUMENTATION SOFTWARE LIBRARY

Utility Software for TM 5000 Instruments

Utility Software is available from Tektronix, Inc. for TM 5000 Instruments. This software consists of a set of subroutines and subprograms that perform common instrument functions over the GPIB such as data acquisition, front-panel set-up, etc. These routines are designed to be easily integrated into your application programs. And since they are small and well documented, the routines are easy to modify to suit your particular applications. Refer to the current Tektronix Instrumentation Software Library Catalog for instrument options, ROM packs, and other required equipment.

The following Utility Software was available when this Instrument Interfacing Guide was printed. Other software may be available; contact your local Tektronix Field Office for further information.

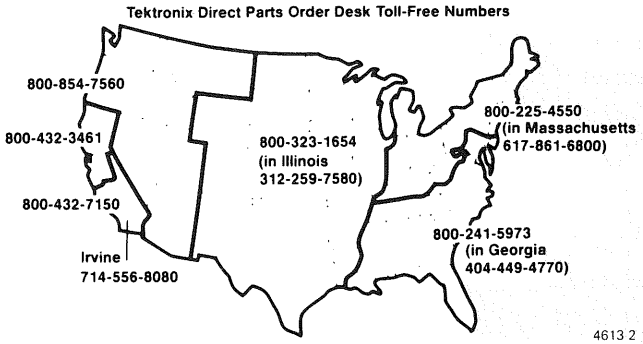
Description	Tektronix Part No.
TM 5000/4041 Utility Software (DC-100 tape)	062-6958-01
TM 5000/4052A Utility Software (DC-300 tape)	062-6957-01

Ordering Utility Software (U.S. Only)

Your local Tektronix Field Office has the current prices for software available from the Tektronix Instrumentation Software Library.

Order Tektronix Instrumentation Software Library programs from Tektronix Central Parts Ordering by using the toll-free number serving your area. The following map identifies the geographical regions in the U.S. and the toll-free number serving each region.

Call the toll-free number serving your area and give the Customer Service Representative the Tektronix nine-digit part number and name of the software package you want to order. If you have any questions about the software, call your local Tektronix Field Office.



Ordering Utility Software (Outside the U.S.)

Outside of the U.S., order Tektronix Instrumentation Software Library programs through your local Tektronix sales office or from the Tektronix Instrumentation Software Library order point serving your area. Refer to the following list for the applicable library order point.

Africa, Europe, Middle East

Contact local Tektronix sales office.

Australia

Tektronix Instrumentation Software Library
Tektronix Australia Pty. Limited
Sydney
80 Waterloo Road
North Ryde, N.S.W. 2113

Canada

Tektronix Instrumentation Software Library
Tektronix Canada Ltd.
P.O. Box 6500
Barrie, Ontario
Canada L4M 4V3

Caribbean, Latin America, and Far East (except Japan)

Tektronix Instrumentation Software Library
Export Marketing
Tektronix, Inc.
P.O. Box 500
Beaverton, OR 97077
U.S.A.

Japan

Tektronix Instrumentation Software Library
Sony/Tektronix Corporation
9-31 Kitashinagawa-5
Tokyo 141 Japan

Program Library

The Tektronix Instrumentation Software Library includes over 200 software programs for a variety of Tektronix programmable instruments and controllers. The Library Catalog provides abstracts of the available software. Programs are available as ready-to-load media or as listings (see Catalog). For a copy of the latest catalog, contact your local Tektronix Field Office or representative and ask for Tektronix Instrumentation Software Library Catalog #99W-5570.

Program Contributions

If you have a program which you would like to submit to the Tektronix Instrumentation Software Library, we will send you, in exchange, one software package of your choice from the Customer/User Software portion of the Program Library (see current library catalog). Submitted programs must use Tektronix programmable instruments and must meet certain coding and documentation standards.

To contribute a program, submit a copy of the program on media along with a listing and a Tektronix Instrument Software Library release form (see current library catalog). If the program was created as part of your employment, the release must be signed by an authorized representative of your employer. Acceptance of the program is subject to review of the Tektronix Instrumentation Software Library staff.

For further information on submitting a program or for information about coding and documentation standards, contact:

Tektronix Instrumentation Software Library
Tektronix, Inc.
Group 157, 54-016
P.O. Box 500
Beaverton, OR 97077

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