TEK OPERATOR'S MANUAL

Part No. 070-3918-00
Product Group 14

4041
SYSTEM CONTROLLER

Please Check for CHANGE INFORMATION at the Rear of this Manual

First Printing OCT 1981
Revised JUL 1982

Tektronix®
COMMITTED TO EXCELLENCE

WARNING

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the users at their own expense will be required to take whatever measures may be required to correct the interference.

MANUAL REVISION STATUS

PRODUCT: 4041 System Controller

This manual supports the following versions of this product: Serial Numbers B010100 and up.

REV DATE	DESCRIPTION
OCT 1981	Original Issue
JUL 1982	Revised: pages iv, vi, vii, 1-1 through 1-3, 1-7, 3-1, 4-4, 4-13, 4-15, and I-1.

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ILLUSTRATIONS

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PREFACE

This manual, the 4041 System Controller Operator's Manual, contains all the instructions, procedures, and data required to operate the 4041. It includes system specifications, installation and setup procedures, detailed functional descriptions of all controls, keys, and indicators (including the Option 31 keyboard), operator check procedures, and maintenance procedures.

Three other manuals for the 4041 System Controller are available:

- *The 4041 BASIC Programmer's Reference Manual* contains all of the information required to program the 4041 when Option 30, Program Development, is installed. This manual details the accepted syntax of the enhanced BASIC language used in the 4041, complete with examples and explanations of proper programming techniques. This manual is supplied as a standard accessory to the 4041 Option 30, Program Development.
- *The 4041 BASIC Programmer's Reference Guide* is a condensed pocket-size version of the 4041 BASIC Programmer's Reference Manual. It is also included as a standard accessory to the 4041 with Option 30, the Program Development option.
- *The 4041 System Controller Service Manual* contains all the information required for servicing the 4041. This manual is available as an optional accessory to the 4041. It contains all schematics, block diagrams, parts lists, along with detailed service procedures. The service manual must be used only by qualified service technicians.

OPERATOR'S SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

Terms in This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditons or practices that could result in personal injury or loss of life.

Terms as Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property, including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols in This Manual


This symbol indicates where applicable cautionary or other information is to be found.

Symbols as Marked on Equipment


DANGER — High voltage.


Protective ground (earth) terminal.


ATTENTION — refer to manual.

Power Source

This product is intended to operate from a power source that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Figure 2-2.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating as specified in the parts list for your product.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

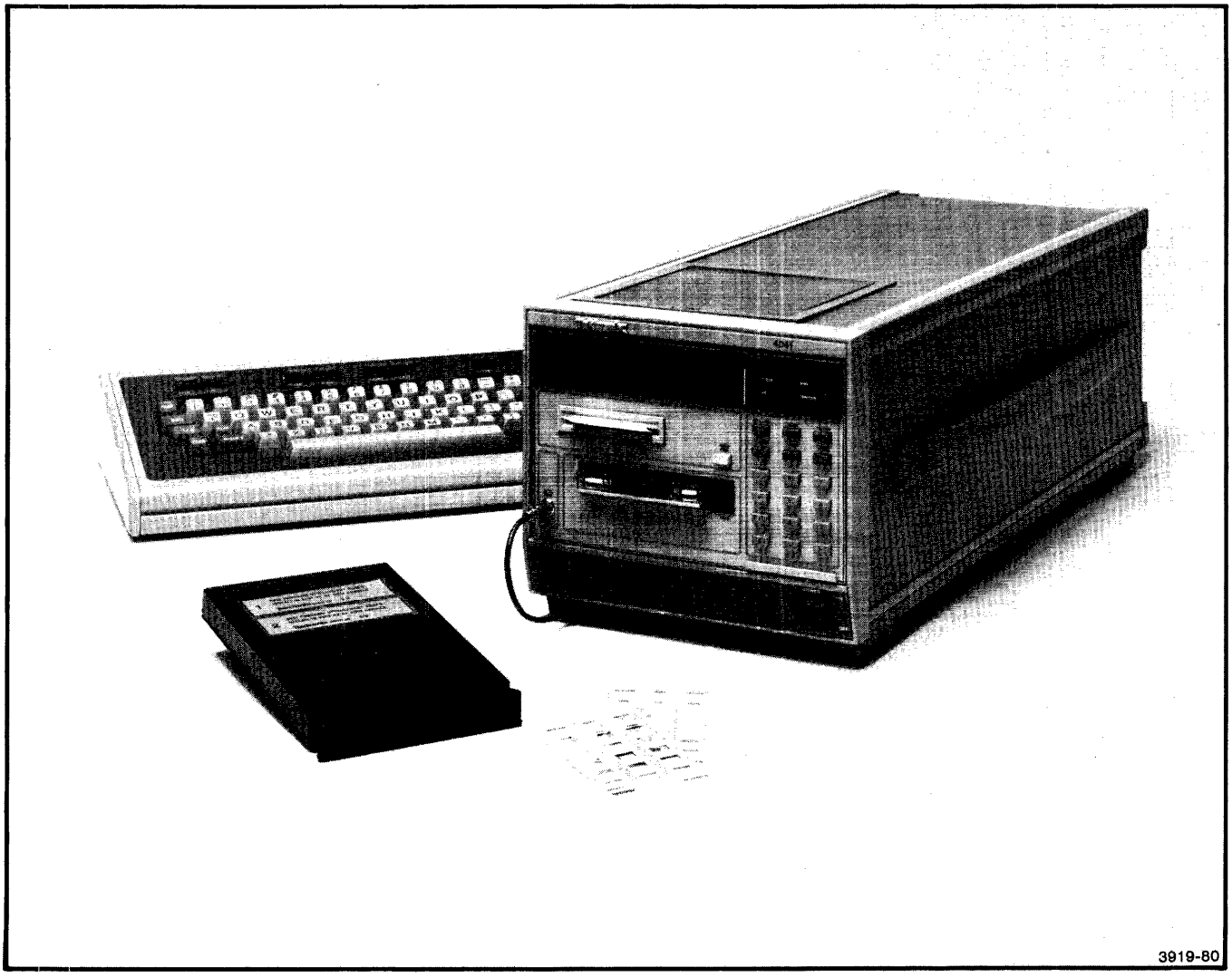


Figure 1-1. The 4041 System Controller With the Program Development Keyboard (Option 31) and Standard Accessories.

Section 5

MAINTENANCE

This section lists recommended routine maintenance procedures. These procedures are necessary to keep the 4041 performing optimally. Routine maintenance should be done at frequent intervals, as recommended below.

This section also describes special maintenance procedures. These procedures may be required on occasion and may be done by the operator. Special maintenance procedures are only done when necessary. This section includes instructions for changing the power fuse and for respooling the DC-100 Tape Cartridge.

ROUTINE MAINTENANCE

EXTERNAL CLEANING

CAUTION

Do not use chemical cleaning agents that may damage the paint, plastics, or metal in this instrument. Avoid using chemicals that contain benzene, toluene, xylene, acetone, or similar solvents. Avoid using abrasive cleansers that might scratch or mar the paint or plastics.

CAUTION

The power on the 4041 should be turned off before doing any external cleaning. Moisture seeping into the instrument could damage sensitive internal components and cause shock hazzard. Unplug the 4041 before cleaning.

The exterior surfaces and keypad of the 4041 should be cleaned with a mild detergent and water. Dampen a soft cloth with the detergent solution and wring it out thoroughly before wiping the surface.

Touch-up paint for extensive scratches and finish damage may be ordered through a Tektronix representative.

SYSTEM VERIFICATION

The System Verification Tape, discussed in Section 4, checks the performance of the system components. This tape should be run:

- monthly,
- after an extended period of disuse,
- after cleaning the magnetic tape head, or
- any time the system performance is in doubt.

CLEANING THE DC-100 TAPE HEAD

The surface of the internal magnetic tape unit read/write head (Figure 5-1) must be kept clean to preserve the life of the tape head and to prevent data errors. Oxide deposits, dust, and other foreign deposits may be left on the tape head during tape operation. These deposits act as abrasives, causing excessive wear on both the tape head and the magnetic tape itself. The lifetime of magnetic tape cartridges is directly related to the condition of the tape head.

The recommended frequency of cleaning depends on the amount of tape use and on the cleanliness of the area where the 4041 is used. Under ordinary conditions, the tape head should be cleaned once a week. With heavy use or in a dusty environment, the cleaning interval should be much more frequent — even daily.

The following steps describe how to inspect and clean the tape head.

CAUTION

Do not use magnetic devices near the tape head. Do not touch the tape head with metal or other hard objects. Doing so may damage the head, which in turn could damage tape cartridges and cause loss of data.

1. Turn off the 4041 power switch. Unplug the power cord.
2. Hold the tape door open and inspect the tape head by shining a light at an angle across the surface of the head. Figure 5-1 shows the placement of the tape head within the tape compartment.

   Check for accumulations of foreign material or signs of damage to the tape head. If the head is dirty, follow Steps 3 through 6. If the tape head is visibly scratched, scored, or excessively worn, it may require replacement. Contact the nearest Tektronix field office for service.

CAUTION

The tape read/write head should be cleaned with reagent grade 91% isopropyl alcohol. Other solvents can damage the plastic of the tape head and chassis.

3. Rub off accumulated deposits with a cotton swab moistened with isopropyl alcohol. Special cleaning pads are available through Tektronix representatives.

   Light accumulations of oxide are usually easily removed. Heavier deposits may require additional cleaning with several clean swabs. Use extreme care when wiping the head to avoid scratching or damaging the tape head surface.
4. After cleaning, use a clean dry cotton swab to remove any alcohol residue. Reinspect the head surface for signs of wear, such as scratches or flat spots.
5. Plug in the power cord and turn the 4041 on.
6. Run the System Verification Tape to check magnetic tape unit operation. Refer to Section 4.

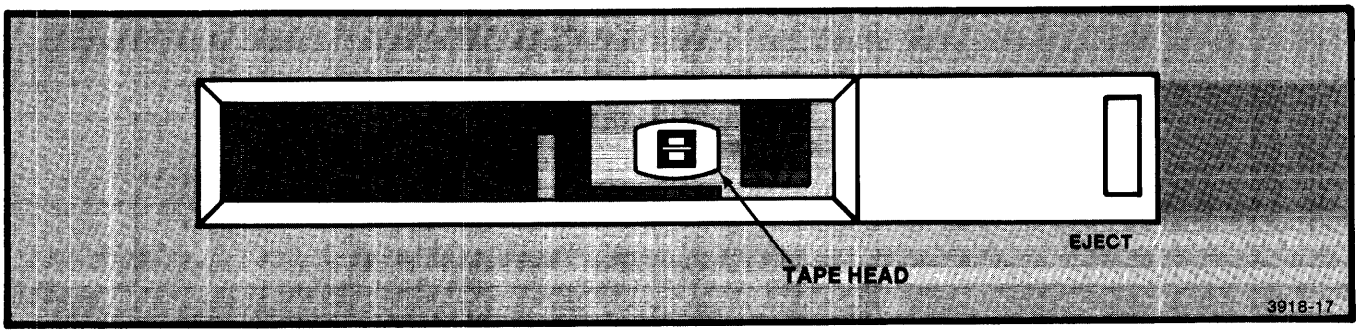


Figure 5-1. The DC-100 Tape Read/Write Head.

TAPE CARTRIDGE CARE

Magnetic tape cartridges have proven to be an inexpensive and reliable way to store data and program instructions. They should be treated with care; no storage medium will survive much abuse. Follow these guidelines to get the highest accuracy and longest life from magnetic tape cartridges.

1. NEVER expose the cartridge to a magnetic field unless the tape is intentionally being bulk-erased. Magnetic fields can erase data from magnetic tape cartridges. Remember that magnetic fields frequently exist around electronic equipment. Airport scanners can also damage the information on magnetic tape.
2. ALWAYS keep the tape cartridges in their protective plastic cases when they are not in use. Dust and dirt can damage both the tape and the tape drive head.
3. NEVER touch the tape itself. Fingerprints leave an oily residue on the tape. Hard objects can scratch the sensitive surface of the tape.
4. Store tape cartridges in a cool, dry place. Magnetic tape is sensitive to heat and excessive humidity.
5. Regularly clean and inspect the tape head, as described previously in this section. The condition of the tape read/write head directly affects tape lifespan.
6. ALWAYS back-up (make duplicate copies of) important programs and data. Under ideal, controlled laboratory conditions, the DC-100 tape should be good for 5,000 cycles. Under normal circumstances, tape may not last this long before giving read/write errors.

THERMAL PRINTER PAPER CARE

The paper used in the 4041 thermal printer is extremely sensitive to temperature. Store this paper in a cool place.

Thermal printer paper may darken at room temperature over a long period of time. Therefore, it is not suitable for permanent data storage. Make copies of paper tape printouts for storage or later reference.

SPECIAL MAINTENANCE

FUSE REPLACEMENT

When the 4041 power cord is plugged in and the power switch is turned on, the POWER system function light on the front panel should light and the fan on the rear panel should run. If both fail to operate, the power fuse may be at fault.

The fuse is located on the rear panel, as shown in Figure 5-2.

The fuse selection depends on the voltage specified for the particular instrument. Use the fuse specified on the rear panel of the instrument. This fuse will probably be one of the following:

Input Voltage	Fuse Specification
115 Volts	2.5 amp fast blow
230 Volts	1.6 amp slow blow

If the fuse blows repeatedly, do not continue to operate the 4041; call the nearest Tektronix field office.

Use the following procedure to replace the 4041 rear panel fuse. These steps apply to the standard 4041, Option 01, and Option 02 rear panels.

1. Turn the power switch off. Unplug the power cord.
2. Use a screwdriver to turn the fuse holder 1/8 turn counterclockwise. Slight inward pressure is necessary to release the fuse holder from the locked position.
3. Pull the fuse holder straight out.
4. Remove the old fuse. Place a good fuse in the fuse holder. Either end may be inserted.
5. Replace the fuse holder into its socket, gently rotating the holder until it slips into a groove.
6. Push the fuse holder straight in against the spring, using the screwdriver.
7. Turn the fuse holder 1/8 turn clockwise until it locks into place.

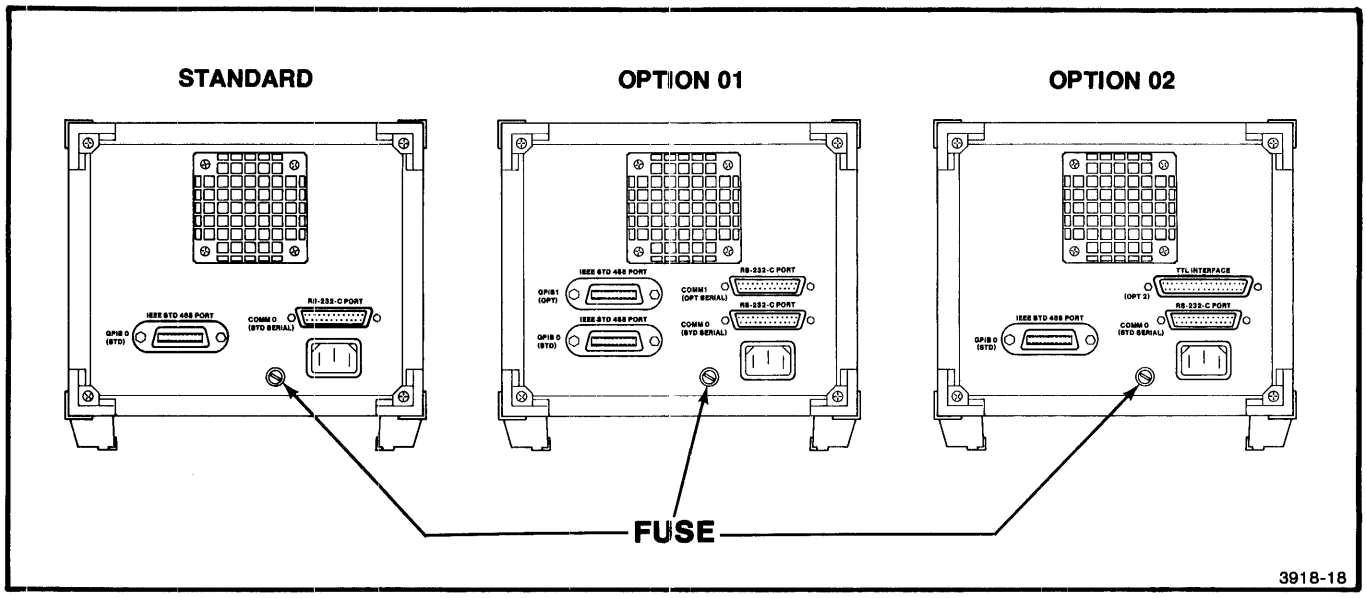


Figure 5-2. Power Fuse Location.

DC-100 TAPE CARTRIDGE RESPOOLING

The tape in the DC-100 Magnetic Tape Cartridge is open-ended; neither end of the tape is secured to the spools. The tape unit relies on a light-sensing mechanism to stop the tape winding at either end of the tape. Small holes in the tape indicate the end of the tape.

If the light path is obstructed, either by dust in the light path or by a soiled or blocked tape cartridge, the tape fails to stop winding in time. If this happens, the tape will unwind off one of the tape spools. (Note that a tape-like band holds the proper tension on the tape spools. Do not mistake that band for the magnetic tape.)

Figure 5-3A shows the light path through the DC-100 tape cartridge. If the tape unwinds from a spool, check that the light path is not obstructed through the tape cartridge. Check also for dust or dirt inside the tape compartment.

The tape cartridge can be respooled by following these steps:

CAUTION

Do not use a magnetic screwdriver when working on or around a magnetic tape cartridge. A magnetic screwdriver may erase data from the tape.

1. Position the tape cartridge with the metal side up and remove the four screws that attach the metal base to the plastic cover (Figure 5-3B).
2. Turn the cartridge over and carefully lift the plastic cover from the metal base (Figure 5-3C).
3. Pull the loose end of the tape across the front of the cartridge, threading it in front of the two guideposts (Figure 5-3D).
4. Keep loose tension on the tape and tuck the end of the tape around the outside of the take-up spool and under the black tension band (Figure 5-3E).
5. Rotate the drive roller (Figure 5-3F) so that the tape winds onto the empty roller. If the tape is loose, tighten the tape by moving the two rollers in opposite directions.
6. Continue winding the tape by rotating the drive roller until three sets of double holes have passed both guideposts. Make certain that the tape is being wound evenly and that it is centered on the spool.
7. Lower the plastic cover straight onto the cartridge base. Be very careful not to catch or wrinkle the tape with the cover.
8. Turn the cartridge over and replace the four screws. Tighten the screws evenly.

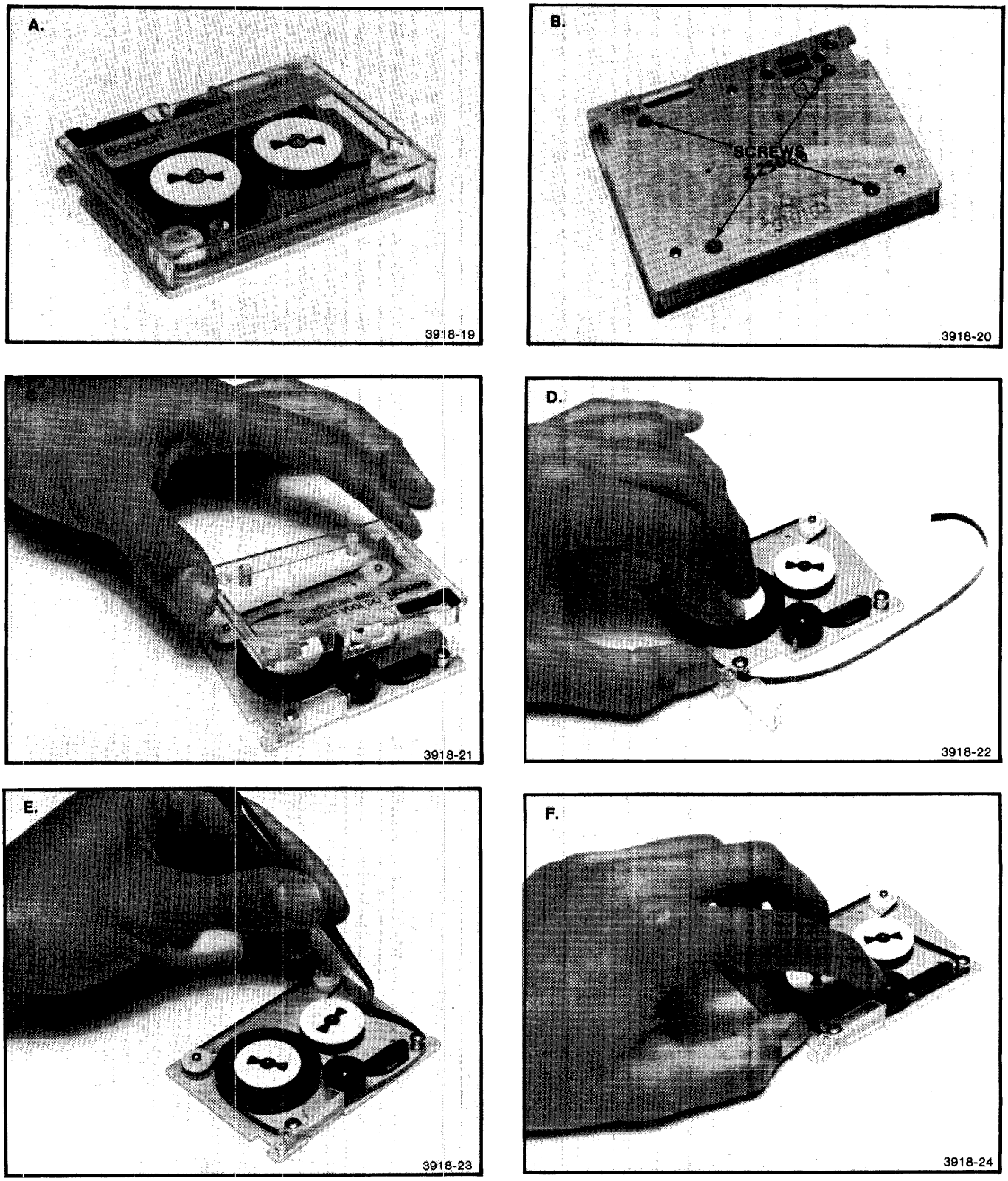


Figure 5-3. Tape Cartridge Respooling Procedure.

Section 1

INTRODUCTION

The TEKTRONIX 4041 System Controller (Figure 1-1) is a GPIB (general purpose interface bus) controller with the processing capabilities of a small minicomputer. The 4041 may be used with any other GPIB (ANSI/IEEE 488) compatible instruments. It is designed particularly for test and measurement applications. The 4041 is flexible enough to use in applications ranging from unattended manufacturing tests to highly complex interactive research analysis.

Standard features of the 4041 System Controller include:

- GPIB (ANSI/IEEE 488) interface port for programmed communications with as many as fourteen other GPIB devices.
- RS-232-C interface port for data communications with a terminal, printer, other computer, or other RS-232-compatible device.
- Internal 20-character-wide alphanumeric thermal printer for reporting data and program results.
- Magnetic tape drive for program and data storage.
- 32K bytes of random access memory (RAM).
- 20-character alphanumeric light-emitting diode (LED) display for program prompts and reporting.
- Front panel keypad for data entry and program control.
- Four system status indicator lights.
- Interchangeable carrying handle.
- Power-up self-test.
- System verification programs.

Instrument options, described later in this section, provide additional interfacing, additional memory, programming capability, and a full ASCII keyboard. Figure 1-2 shows the 4041 front panel features.

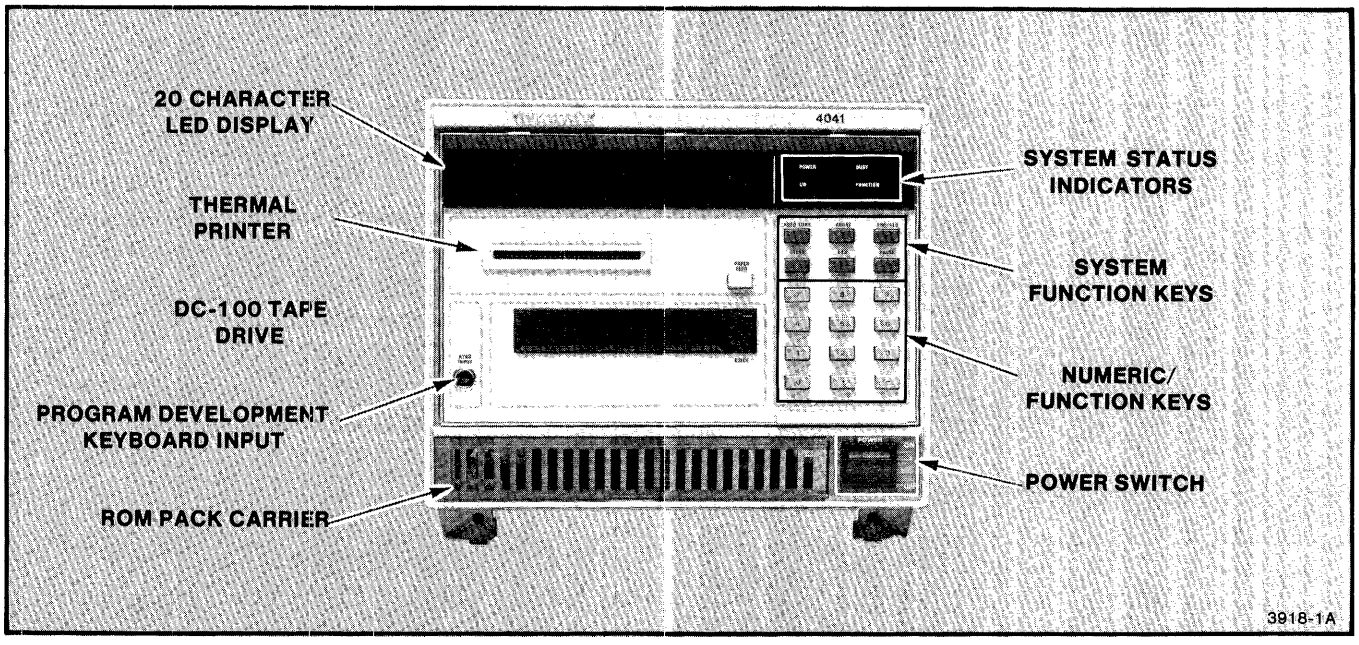


Figure 1-2. The 4041 Front Panel.

DESCRIPTION

CAUTION

This section describes the parts of the 4041 System Controller. Before turning on or using the 4041, read Section 2. Section 2 describes how to set up the 4041. Turning the 4041 power on without following certain setup procedures could damage sensitive components in the instrument.

THERMAL PRINTER

The 4041 includes an alphanumeric printer with fixed print heads. Characters are printed in a 5 x 7 dot matrix, with 20 characters per line and six lines per inch. The thermal printer prints all 128 ASCII characters. The print speed is approximately 1.8 lines per second.

The printer may be used to display program or computational results, to record incoming data, or to print program listings or system information. The printer uses a temperature-sensitive, 60 mm-wide roll of paper. Instructions for loading the printer paper are given in Section 2.

DC-100 TAPE DRIVE

The 4041 contains an internal magnetic tape drive. The magnetic tape stores controller programs and system information and logs data for fast and easy retrieval. The tape drive uses DC-100 magnetic tape cartridges.

Forty-eight named files (maximum) may be stored on a single tape. The tape stores 256 eight-bit bytes per physical record. Typically, 650 physical records may be stored on a tape; a tape will hold at least 600 records. Using this format and record size, the data cartridge capacity is approximately 160K bytes.

The effective data transfer rate for the tape drive, assuming no stopping at gaps, is about 1280 bytes per second.

KEYBOARD INPUT

The KYBD INPUT jack is used to attach the Program Development Keyboard (Option 31) to the 4041. Refer to Section 6 for Option 31 installation.

ALPHANUMERIC DISPLAY

The red plastic strip across the front of the 4041 covers a 20-character 16-segment alphanumeric display. This display may be used to give operator prompts, program results, or system status reports. See Section 3 for a description of the displayable character set.

SYSTEM STATUS LIGHTS

Four LEDs (light-emitting diodes), called status lights, indicate the state of the system. They are located on the right side of the red display strip. These lights are discussed further in Section 3, Controls, Indicators, and Operations.

SYSTEM CONTROL KEYS

Six system control keys are located below the status lights on the front panel. These brown keys give the operator direct control of the 4041 system. See the explanation in Section 3.

FUNCTION/NUMERIC KEYS

The twelve beige keys below the system control keys are called function/numeric keys. They are used either to input numeric values (like a normal keypad) or to select from multiple program options or routines.

SPECIFICATIONS

Tables 1-1 through 1-4 list specifications for the 4041 System Controller. Within these specifications, the following terms apply:

- **Performance Requirement:** A statement that defines a characteristic in quantitative terms of performance. Verification procedures are described in the 4041 System Controller Service Manual.
- **Supplemental Information:** Statements that amplify or supplement performance requirements or that provide performance information.

The 4041 specifications in Tables 1-1 and 1-2 are valid within the environmental conditions specified in Table 1-4.

Table 1-1

FUNCTIONAL SPECIFICATIONS

Characteristic	Performance Requirement	Supplemental Information
Printer		
Head Resistance	80 ohms, minimum 200 ohms, end-of-life	
Head Peak Power	2.0 Watts	Per element
Thermal Pulse On-time	2.5 ±0.1 ms	Measured at FPC U361-13.
Character Quality	The printed figure 8 does not appear bent in center.	Dots line up to within better than ¼ dot interval.
Motor Drive Voltage	Adjust for 1.8 lines per second but not to exceed 18 volts	Measured at tab of printer interface board U151. Initial setup voltage. Print speed will increase with wear in.
Line Spacing	6 ± ½ lines per inch	
Print Speed	2 ± 0.24 lines per second	
GPIB		
Interface Function Subsets	SH1, AH1, T6, TE0, L4, LE0, SR1, RL0, PP1, DC1, DT0, C1, C2, C3, C4, and C5.	ANSI/IEEE 488-1978.

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
GPIB (cont)		
Input Transfer Rates (kbytes per second)		Burst rates to/from a string with fast handshake peripheral.
Std. Normal	5 minimum	
Std. Fast	16.5 minimum	
Opt. 1 Normal	3 minimum	
Opt. 1 Fast	12.5 minimum	
Opt. 1 DMA	600 minimum	
Output Transfer Rates (kbytes per second)		Burst rates to/from a string with fast handshake peripheral.
Std. Normal	5 minimum	
Std. Fast	19.5 minimum	
Opt. 1 Normal	3 minimum	
Opt. 1 Fast	18.5 minimum	
Opt. 1 DMA	240 minimum	
Option 1 Clock	20 ± 0.01 MHz	
System Clock	16 ± 0.0016 MHz	
Timer (6840 PTM)	±10 seconds per 24 hour period	Interrupt generated every 10 milliseconds to update firmware maintained time of day. Derived from system clock.
RS-232		
Full Duplex	Fully supported	
Half Duplex	—	Not supported
Parity	Odd, even, high, low, none	
External Clock	—	Not supported
Transmit/receive rates	Matched only	
Baud Rate	Selectable, any integer between 2 and 9600	
Number of data bits	5, 6, 7, or 8	
Number of stop bits	1 or 2	

Table 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
DC-100		
Soft error rate	Less than 1 recoverable error in 10E6 bits	
Hard error rate		Less than 1 non-recoverable error in 10E8 bits
Read Amplitude gain	2 ± 0.2 V p-p	

Table 1-2

ELECTRICAL SPECIFICATIONS

Characteristic	Performance Requirement	Supplemental Information
Input Power		120 Watts maximum 410 BTU/hour
Line Voltage		
Low range High range	90-132 V ac 180-250 V ac	Test at selected voltage range
Line Frequency	48-66 Hertz	
Line Disturbances		
Oscillatory Transients	Up to 2.5 kV at 1.5 MHz	No effect on operation
Ride through without primary power	Greater than 16.6 milliseconds	
High-Pot Test	No breakdown and less than 30 mA leakage current	Line and neutral shorted; power switch on; 1.5 kV RMS 60 Hz appled between line/neutral and chassis ground for 1 minute
Restart Pulse	TD= 100 milliseconds, minimum	
Wrong Voltage Selected	No damage	Will only blow fuse

Table 1-2 (cont)

Characteristic	Performance Requirement	Supplemental Information
+5 V Supply		
Minimum Voltage	5.047 V dc	Measured on MI/PS board, 25° C, low line, 10 Amp load, 60 Hz
Maximum Voltage	5.253 V dc	Measured on MI/PS board, 25° C, high line, 3 Amp load, 60 Hz
Capacity	10 Amps Maximum	
Current Limit Typical Minimum Maximum	 15 Amps 11 Amps 19 Amps	With ± 12 and + 24 supplies delivering rated maximum capacity current
Ripple	50 mV maximum	P-P with 1 MHz bandwidth, typical load
Voltage range in assembled instrument	5.05 ± 0.15 V dc	Measured on PD keyboard jack, 25° C, 115 V 60 Hz input
Overvoltage Shutdown	< 6 V dc	
+12 V Supply		
Nominal Voltage	12.0 ± 0.48 V dc	Range in assembled instrument at 25° C
Minimum Voltage	11.520 V dc	Measured on MI/PS board, 25° C, low line, 0.8 Amp load, 60 Hz
Maximum Voltage	12.480 V dc	Measured on MI/PS board, 25° C, high line, 50 mA load, 60 Hz
Maximum Continuous Current	0.8 Amp.	No configuration shall draw a nominal sustained current greater than this value.
Capacity	0.8 Amps maximum	
Current Limit	1.5 Amp minimum	Via 3-pin regulator
Ripple	50 mV maximum	P-P with 1 MHz bandwidth, typical load
Overvoltage Shutdown	< 14 V dc	

Table 1-2 (cont)

Characteristic	Performance Requirement	Supplemental Information
−12 V Supply		
Nominal Voltage	−12.0 ± 0.48 V dc	Range is assembled instrument at 25° C
Minimum Voltage	−11.520 V dc	Measured on MI/PS board, 25° C, low line, −0.5 Amp load, 60 Hz
Maximum Voltage	−12.480 V dc	Measured on MI/PS board, 25° C, high line, −50 mA load, 60 Hz
Maximum Continuous Current	−0.5 Amp.	No configuration shall draw a nominal sustained current greater than this value.
Capacity	1.5 Amps Maximum	
Current Limit	−1.5 Amp minimum	Via 3-pin regulator
Ripple	50 mV maximum	P-P with 1 MHz bandwidth, typical load
Overvoltage Shutdown	< −14 V dc	
+24 V Supply		
Nominal Voltage	24.0 ± 3.0 V dc	Range is assembled instrument at 25° C
Minimum Voltage	21.000 V dc	Measured on MI/PS board, 25° C, low line, 0.6 Amp load, 60 Hz
Maximum Voltage	27.000 V dc	Measured on MI/PS board, 25° C, high line, 50 mA load, 60 Hz

Table 1-2 (cont)

Characteristic	Performance Requirement	Supplemental Information
+24V Supply (cont)		
Maximum Continuous Current	0.6 Amp.	No configuration shall draw a nominal sustained current greater than this value.
Current Limit		This supply is unregulated. For all other supplies at nominal load, total power from this supply is limited to 38 Watts by power limit. The actual limit is approximately 12 volts where current is approximately 2 Amps.
Ripple	50 mV maximum	P-P AC with 1 MHz bandwidth, typical load
−5 V Supply to RAM memory on Std I/O and Option 20	−5.00 ± 0.5 V dc	Controlled by a 5% Zener
Option 2 Voltage outputs		Measured at rear panel
+ 5.00 V dc	5.00 ± 0.25 V dc	
+ 12.00 V dc	12.00 ± 0.6 V dc	
−12.00 V dc	−12.00 ± 0.6 V dc	
+ 24 V dc	24.00 ± 3 V dc	
Option 2 Current outputs		
5 V dc		2 Amps maximum
+ 12 V dc		200 mA maximum
−12 V dc		100 mA maximum
24 V dc		100 mA maximum

Table 1-3

MECHANICAL SPECIFICATIONS

Characteristic	Performance Requirement
Dimensions	
Length	20.75 in (527.1 mm)
Width	8.50 in (215.9 mm)
Height	7.20 in (183 mm)
Weight	
Standard instrument	17 lb 5 oz (7.72 kg)
plus options	19 lb 5 oz (8.62 kg)

Table 1-4

ENVIRONMENTAL SPECIFICATIONS

Characteristic	Performance Requirement	Supplemental Information
Temperature		
Operating without tape cassette or printer paper	32° to 130°F (0° to 55°C)	
Operating with tape cassette and printer paper	32° to 112°F (0° to 45°C)	
Non-operating	−40° to 165°F (−40° to 75°C)	
Altitude		
Operating	15,000 ft (4.5 km)	
Non-operating	50,000 ft (15 km)	
Humidity (relative)		
Operating without tape cassette or printer paper	95%	
Operating with tape cassette and printer paper	85%	
Non-operating (storage)	95% max at 150°F (65°C)	
Static Immunity		
Operating	15 kV	Tested in typical system configuration
Non-operating	20 kV	
No effect on operation (Option 02 only)	2 kV	
EMI	Meets FCC Part 15, Subpart J, Class A requirements, and VDE 0871, Class B requirements	
Packaged Transportation	Meets NSTA requirements for packaged shock and vibration	
Vibration	Less than 0.025 inches (0.64 mm) p-p amplitude	
Shock	50Gs	

ACCESSORIES

STANDARD

Table 1-5 lists the standard accessories and part numbers for the 4041. The table also lists the standard accessories supplied with Instrument Options. Any of these parts may be ordered individually from the nearest Tektronix field office or service facility.

Table 1-5

STANDARD ACCESSORIES

Item	Quantity	Description	Part No.
4041	1	System verification tape	062-5828-00
	1	Operator's manual	070-3918-00
	2	Blank keypad overlays	334-4074-00
	1	Roll printer paper	006-3557-00
	1	Power cord	161-0066-00
	1	Blank DC-100 tape cartridge	119-1350-00
	1	RS-232 Self-test adaptor	013-0198-00
Option 02	1	Electrical connector	131-0422-00
	2	Connector covers	200-1709-00
	4	Hex nuts	210-0406-00
	4	Machine screws	211-0102-00
	2	Thumb screws	213-0340-00
Option 30	1	4041 BASIC Programmer's Reference Manual	070-3917-00
	1	4041 BASIC Programmer's Reference Guide	070-3916-00
Option 31	2	Blank keyboard overlays	334-2630-03

OPTIONAL

Table 1-6 lists commonly requested accessories for the 4041. Contact the nearest Tektronix field office or service facility for details and ordering information.

Table 1-6

OPTIONAL ACCESSORIES

Quantity	Description	Part No.
1	4041 Computer/Controller Service Manual	061-2513-00
5	Blank DC-100 data cartridges (1 box)	119-1350-01
4	Printer paper rolls (1 carton)	006-3557-01
10	Blank keypad overlays (1 box)	334-4074-01
10	PD keyboard overlays (1 box)	334-2630-04
1	RS-232 Interconnect cable 16 foot (data terminal adapter cable)	012-0689-01
1	RS-232 Extension cable 12 foot	012-0911-00
1	1-meter GPIB cable, single shield	012-0630-05
1	2-meter GPIB cable, single shield	012-0630-01
1	4-meter GPIB cable, single shield	012-0630-02
1	2-meter GPIB cable, double shield	012-0630-03
1	4-meter GPIB cable, double shield	012-0630-04
1	1-meter GPIB cable, double shield	012-0630-07
1	Interconnect cable (used with Option 02)	012-0432-02
1	Cable, Interface (Option 02 to personality module)	012-0432-02
1	Extender board	670-7054-00
1	Cable 16" long, 10 cond. (two required; used to place standard I/O on above extender)	175-3388-00
1	4041 Test Fixture Support kit	067-1070-00
1	68000 personality module	067-1047-00
1	ROM Pack Extender Board	670-7730-00

INSTRUMENT OPTIONS

Table 1-7 lists the available instrument options to the standard 4041. Unless noted, these options are factory installed. Contact your nearest Tektronix field office or service facility for details on field-installed options.

The 4041 can be equipped with multiple options. Option 01 and Option 02 are mutually exclusive.

Table 1-7

INSTRUMENT OPTIONS

Option	Description
Option 01	One additional GPIB port with direct memory access (DMA), and one additional RS-232 port
Option 02	8-bit parallel TTL Interface
Option 20	64K bytes total memory
Option 21	96K bytes total memory
Option 22	128K bytes total memory
Option 23	160K bytes total memory
Option 30	Program Development ROMs and carrier
Option 31	Program Development Keyboard
Option A1	Universal European 220V/16A power cord
Option A2	United Kingdom 240V/13A power cord
Option A3	Australian 240V/10A power cord
Option A4	North American 240V/15A power cord
Option A5	Swiss 250V/15A power cord
4041F01	Field-installable Option 01
4041F02	Field-installable Option 02
4041F30	Field-installable Option 30
4041F31	Field-installable Option 31
040-1021-00	Field-installable initial memory expansion; expands memory from 32K bytes to 64K bytes
040-1022-00	Additional 32K bytes field-installable memory for memory expansion above 64K bytes and up to 160K bytes

UNPACKING AND REPACKAGING

Save the box and packaging material. If the 4041 must be shipped or packed for moving, the original packaging will adequately protect it. Figure 1-3 shows how the 4041 is originally packed for shipment.

If you ever need to return the 4041 to a Tektronix service center for service or repair, attach a tag to the instrument identifying the owner, address, and the name of the individual to be contacted. The tag should also list the complete instrument serial number and a description of the trouble or service required.

If the original packaging is unfit for use or not available, repackage the instrument as follows:

1. Obtain a corrugated cardboard carton with inside dimensions no less than six inches more than the instrument dimensions; this will allow for cushioning. The recommended shipping carton test strength is 200 pounds.
2. Surround the 4041 with polyethylene sheeting to protect the finish.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the 4041, allowing three inches of padding on all sides.
4. Seal the carton with shipping tape or industrial staples.
5. Mark the shipping carton "FRAGILE — DELICATE INSTRUMENT."

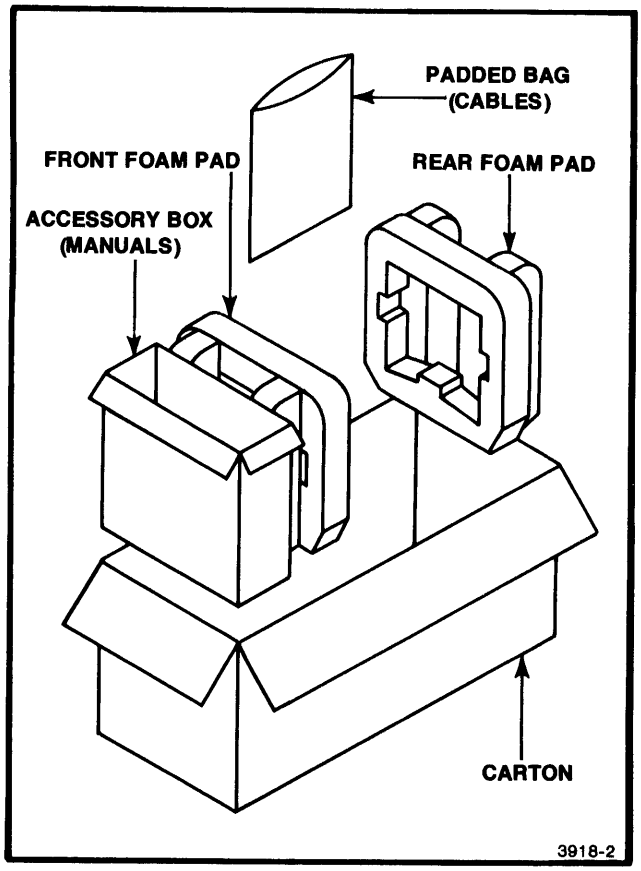


Figure 1-3. Packaging the 4041 for Shipment.

Section 2

SYSTEM SETUP

INTRODUCTION

This section describes the system setup procedures: connecting the power cord, loading printer paper, and loading ROM packs (if required). This section also discusses setting up instruments systems using the GPIB, RS-232, and TTL interfaces.

CAUTION

Before attempting to use the 4041, follow the entire prescribed setup procedure. The 4041 automatically starts self-test operations when it is turned on. Operating the printer without paper may damage the printer and, without paper, the output messages are lost. ROM packs, if used, must be loaded before the power is turned on. Loading them with the power on can damage the ROMs or the 4041.

CONNECTING THE POWER CORD

Figure 2-1 shows the location of the power socket on the back of the 4041. The female plug of the power cord must be plugged into this socket.

Check that the rated power requirements shown on the rear panel of the 4041 (Figure 2-1) correspond to the power that you are using.

Check also that the power cord's male connector fits the socket used in your facility. Refer to Figure 2-2 for a summary of different power plug options.

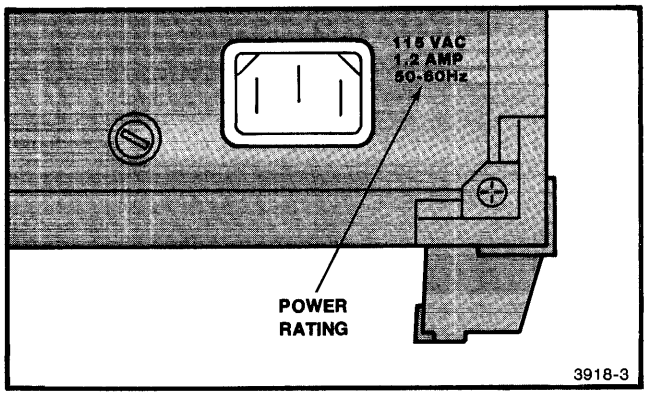
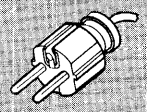
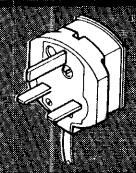
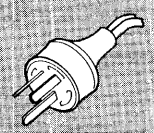


Figure 2-1. The Power Socket on the 4041 Rear Panel.

Plug Configuration	Usage	Nominal Line Voltage (AC)	Reference Standards	Option Number
	North American	120V, 60Hz	ANSI C73.11[1] NEMA 5-15-P[2] IEC 83[3]	STANDARD
	Universal European	220V, 50Hz	CEE (7), II, IV, VII[4] IEC 83[3]	A1
	United Kingdom	240V, 50Hz	BS 1363[5] IEC 83[3]	A2
	Australian	240V, 50Hz	AS C112[6]	A3
	North American	240V, 60Hz	ANSI C73.20[1] NEMA 6-15-P[2] IEC 83	A4

[1] ANSI—American National Standards Institute
[2] NEMA—National Electrical Manufacturer's Association
[3] IEC—International Electrotechnical Commission
[4] CEE—National Commission on Rules for the Approval of Electrical Equipment
[5] BS—British Standards Institution
[6] AS—Standards Association of Australia

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Figure 2-2. Power Plug Options.

LOADING THERMAL PRINTER PAPER

CAUTION

Operating the 4041 printer without paper loaded may damage the printer mechanism. Do not turn the 4041 on until paper is loaded in the printer. Turning on the 4041 power automatically starts self-test operations that may attempt to use the printer.

The thermal printer paper roll is loaded through the door on top of the 4041 (Figure 2-3).

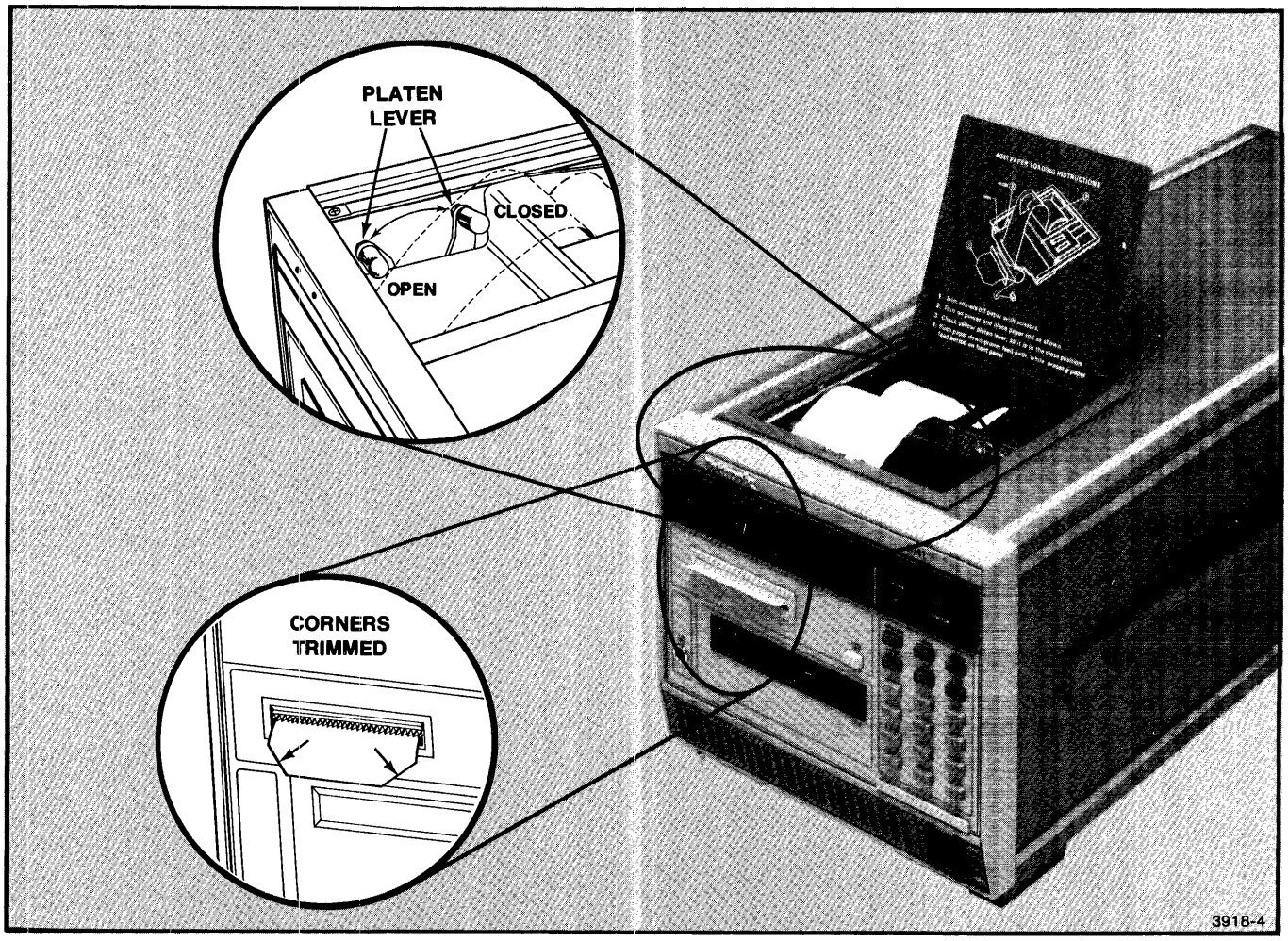


Figure 2-3. Thermal Printer Paper Compartment.

NOTE

Directions for loading the thermal printer paper are printed on the paper door. The procedure shown in this section is different from the procedure given on the 4041 paper door. Both sets of procedures work; the following procedure is recommended for initial setup. The procedure on the top door of the 4041 gives paper replacement instructions that require that the power be on. See the preceding caution.

1. Open the paper tray door on top of the 4041 by sliding the latch to the right and lifting the door.
2. Unwrap a fresh roll of thermal printer paper. Trim the end corners as shown in the inset in Figure 2-3.

NOTE

If the paper is loaded with the wrong side up, the printer will not print. Only one side of the paper is thermal sensitive.

3. Place the roll in the paper tray (Figure 2-3) with the leading end going under the roll toward the front of the 4041.
4. Open the platen lever (Figure 2-3 inset). The platen lever is open when it is pulled toward the front panel and closed when it is pushed back.
5. Insert the end of the paper downward into the slot at the front of the paper tray. Slowly feed paper into this slot until the paper emerges from the paper feed slot on the front panel.
6. Close the platen lever (push it back). Wind any loose paper back onto the roll, and pull any loose paper out of the paper feed slot. Tear off the end of the paper at the paper feed slot. Close and latch the paper tray door.

LOADING DC-100 MAGNETIC TAPE CARTRIDGES

The 4041 uses DC-100 magnetic tape cartridges for program and data storage. These small tape cartridges are loaded in the slot on the front panel.

The tape cartridges may be write-protected. When the tape is write-protected, it may be read, but not written to. This protects against accidentally writing over, and thus losing, important tape files. Files or data cannot be added, changed, or deleted.

The write-protection is controlled by a black sliding tab at the leading edge of the cartridge. This plastic tab is labeled RECORD. When the tab is slid to the left, in the direction of the arrow, the cartridge can be written to. When it is slid to the right, the cartridge is write-protected. Refer to Figure 2-4.

Load the tape cartridge with the metal side down, putting the side with the opening in first. This is the side that the RECORD tab borders, and the side with the flip door. (This door exposes the tape to the read/write tape head. It protects the tape when the cartridge is removed.) Push the cartridge through the tape drive door until it is flush with the front panel.

When the tape cartridge is fully and correctly inserted, the EJECT button pops out.

CAUTION

Never remove a tape cartridge while a tape read or write operation is in progress, or while the tape is winding or rewinding. Files and directories may be left open and may be lost or damaged.

To remove a tape cartridge, press the EJECT button on the right side of the tape slot. The tape will pop loose and can be pulled from the slot.

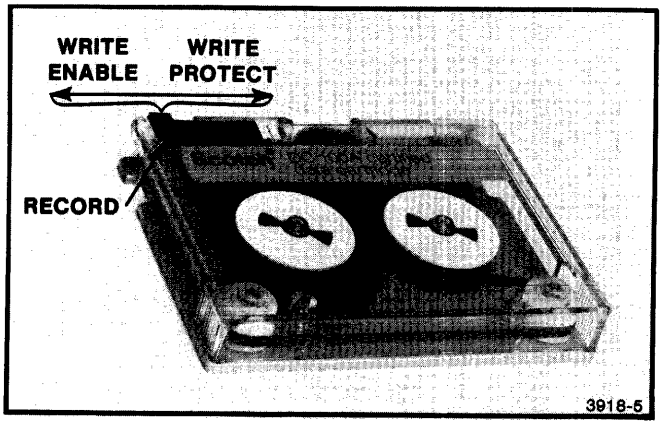


Figure 2-4. DC-100 Magnetic Tape Cartridge Write-Protection.

All tapes must be properly formatted before they may be used in the 4041. Formatting destroys all old information and creates the proper labels and directory space on the tape. Formatting can be done with a special utility program. This utility program is located on the System Verification Tape, and is described in Section 4. Tapes may also be formatted using the FORMAT command provided with Option 30, Program Development. Refer to the 4041 BASIC Programmer's Reference Manual.

Tape care and usage recommendations are given in Section 5, Maintenance.

LOADING ROM PACKS AND THE ROM CARRIER

This section applies to the use of additional ROM packs, such as the 4041 Option 30. ROM (read-only memory) packs are optional; they supply additional instructions and features to the 4041.

NOTE

When the 4041 is turned on, it automatically starts a series of self-tests. (These tests are described in Section 6.) Part of this self-testing determines whether any ROM packs are installed and checks that they are functioning correctly. Therefore, ROM packs must be installed before turning on the 4041. The system does not recognize any ROM packs unless they are correctly installed before the 4041 is turned on.

REMOVING THE ROM PACK CARRIER

CAUTION

Turn the 4041 power off before removing the ROM carrier. Never remove the ROM carrier while the power is on. Removal can cause power fluctuations which damage the ROM chips.

The ROM pack carrier is a tray located behind the grill on the front of the 4041 (Figure 2-5).

To remove the carrier (if it is already installed), first remove the grill. The grill has a horizontal coin slot at its top; pry out the grill using a coin in the cutout. Pull the carrier out of its compartment using the carrier's plastic strap.

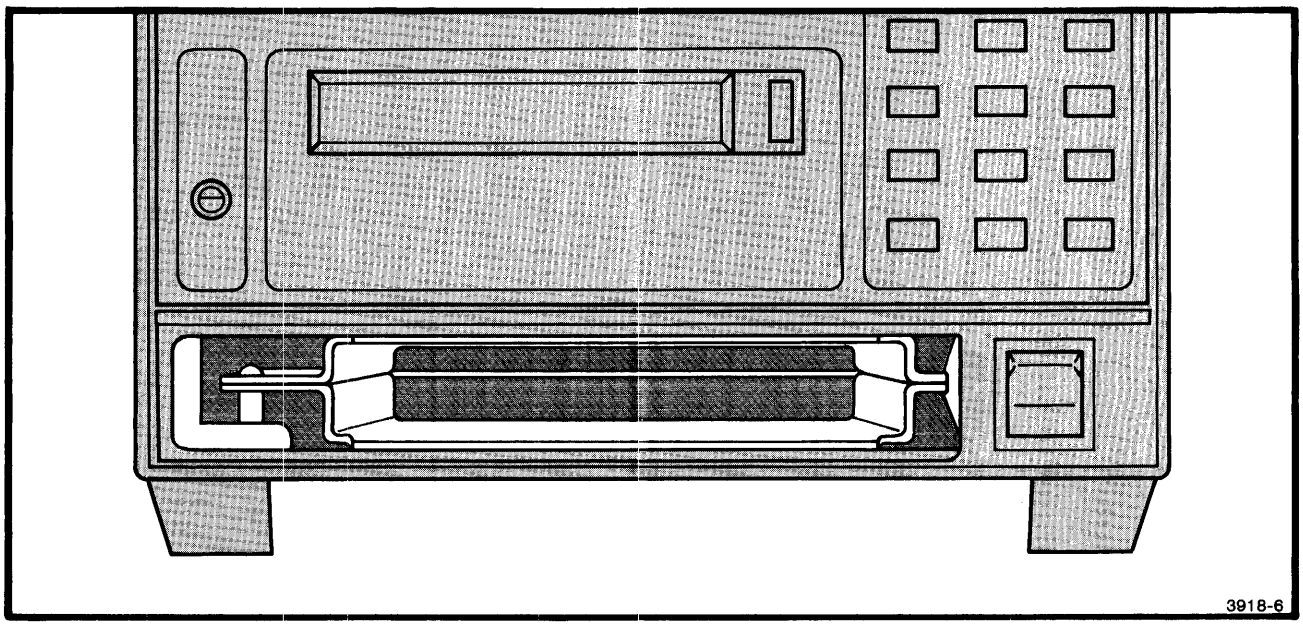


Figure 2-5. The ROM Pack Carrier Location.

PUTTING THE ROM PACKS INTO THE CARRIER

CAUTION

Do not touch the metal leads on the underside of the ROM packs. The ROM packs are static-sensitive and could be damaged by static charges from fingers or tools. Hold the ROM packs by the plastic holders.

Figure 2-6 shows a ROM pack and the ROM carrier. The individual ROM packs are placed into the carrier, and the carrier is slid into the compartment on the 4041 (Figure 2-5).

The ROM pack carrier holds up to six ROM packs. The individual ROM packs specify a particular slot in the carrier where they must be placed. Match the numbers on the ROM packs with the numbers on the carrier.

To insert ROM packs into the ROM carrier, place the ROM pack right side up (Figure 2-6) over the desired slot and gently press the pack into position. The ROM packs are keyed and will only go in one way. When properly inserted, the top of the ROM pack should be flush with the top of the ROM carrier. Be gentle.

Figure 2-6 also shows the underside of the ROM carrier. To remove ROM packs from the carrier, turn the carrier over. Gently press the two indentations over the ROM pack that must be removed; the ROM pack pops out of the carrier.

PUTTING THE ROM CARRIER INTO THE 4041

The ROM carrier is placed in the compartment covered by the grill on the front panel of the 4041 (Figure 2-5).

CAUTION

The 4041 power must be turned off before the ROM carrier is installed. If the power is left on, power surges could develop that could damage the sensitive ROM packs.

If the 4041's power is on, turn it off. Snap out the grill by prying at the coin slot at the top of the grill.

Slide the ROM carrier into position in its compartment with the ROM pack side up and the carrier handle last. Press the carrier firmly into place to securely seat the ROM connectors. Make certain that the carrier is seated all the way in the compartment and is securely held in place.

Replace the front panel grill. The grill should easily snap back into place; if it does not, check that the ROM carrier is inserted all the way. The grill's coin slot should be at the top.

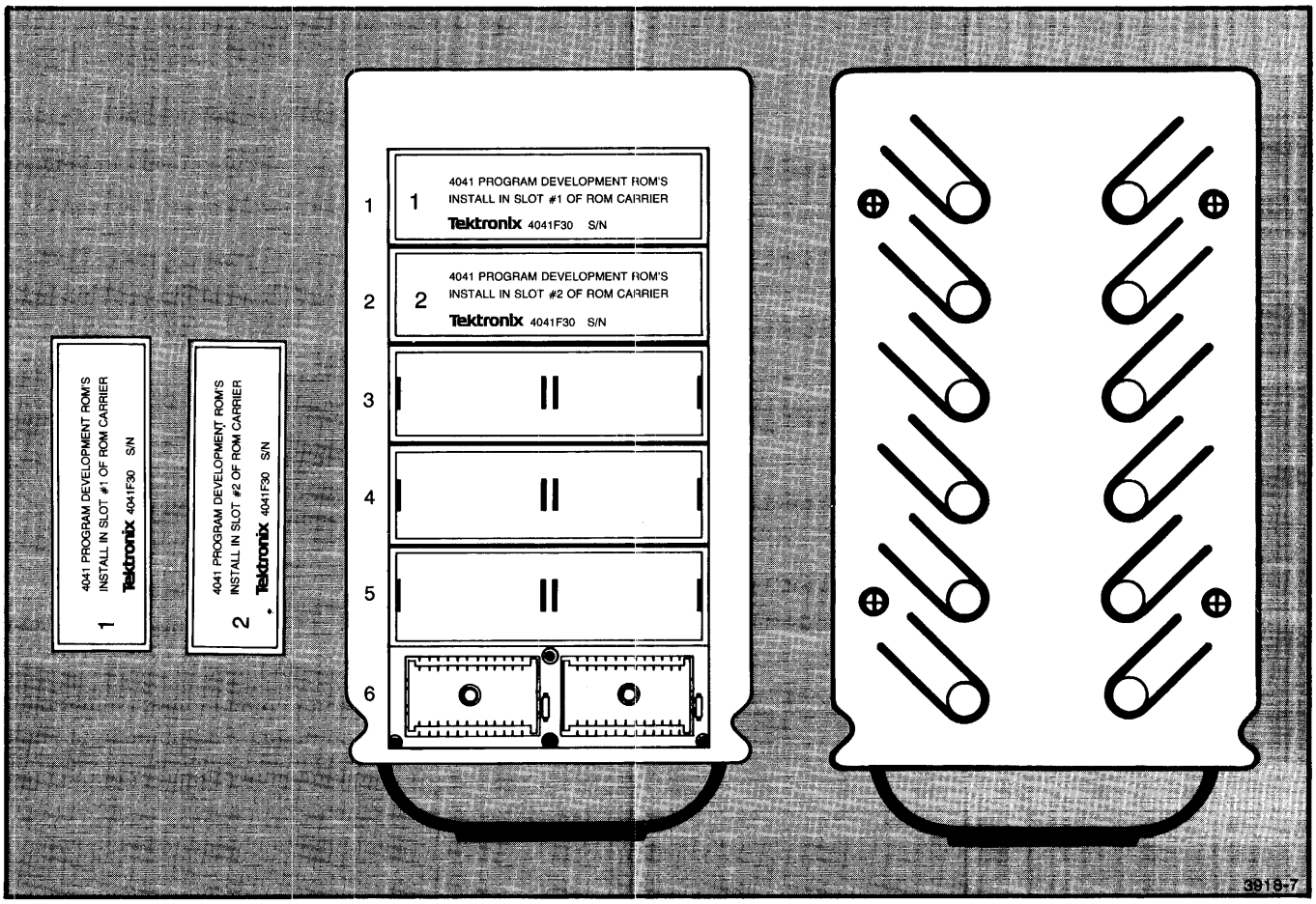


Figure 2-6. ROM Packs and the ROM Pack Carrier.

INTERFACE SETUP

The 4041 is supplied with one of three possible rear panels, as shown in Figure 2-7.

The standard 4041 rear panel (Figure 2-7A) includes one GPIB (IEEE 488) interface port and one RS-232-C data communications interface port.

The 4041 with Option 01 has two GPIB interface ports and two RS-232-C data communications interface ports (Figure 2-7B).

The 4041 with Option 02 includes a TTL interface port and the standard one GPIB port and one RS-232-C port (Figure 2-7C).

INTERFACE CONCEPTS

An interface is the connection or common boundary between two devices or instruments. The 4041, being a controller device, is specifically designed to work with other devices and instruments. The interfaces are a critical part of the 4041.

As shown above, the 4041 may include three different types of interfaces. It may include multiple ports (two of the same type of interface). All these interfaces have the same purpose, to transfer binary data from one device to another. Each differs in the manner in which they pass the data.

- GPIB is a commonly used interface, designed primarily for digital test and measurement devices and instrumentation. It is specifed by the ANSI/IEEE Standard 488-1978. It is a high-speed interface for short-distance data transfer. A number of devices (up to 14 plus the 4041) may be connected to the same interface.
- RS-232-C is an interface standard adopted by the Electronic Industries Association. It is commonly used as an interface between computers and terminals, printers, or other computers. Data transfer is generally slower than transfer over the GPIB interface, but data may be transferred over much longer distances.
- The TTL interface is a custom interface, used for specialized applications. Characteristics depend largely on how the interface is used within specific systems.

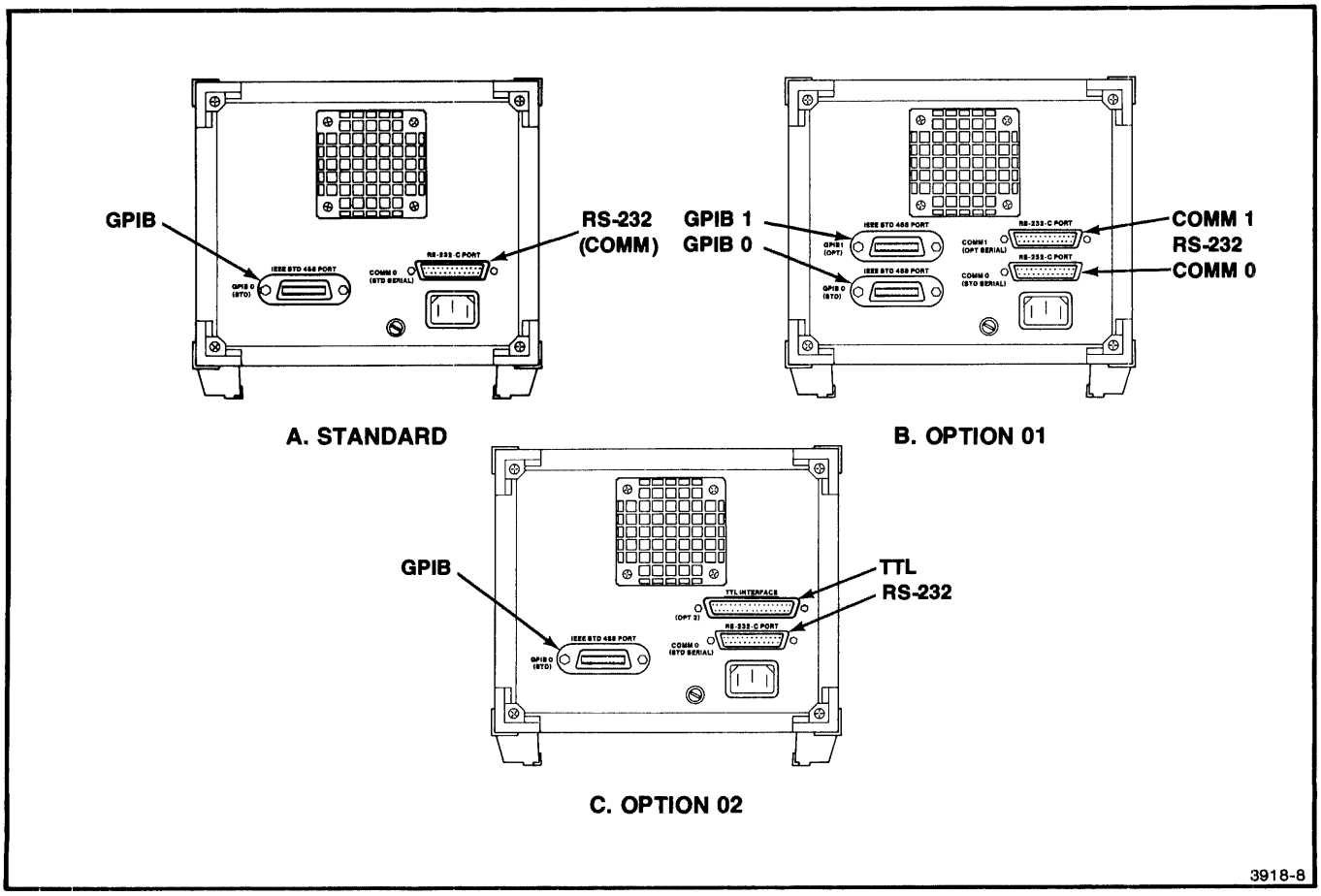


Figure 2-7. Interface Connectors on the 4041 Rear Panel.

THE GPIB INTERFACE

The General Purpose Interface Bus (GPIB) is a digital interface. It establishes a protocol by which instruments may communicate with other devices in a system. Each component in this system must conform to IEEE Standard 488-1978, which describes a byte-serial, bit-parallel interface for programmable measuring apparatus and peripheral devices.

Table 2-1 describes the exact subsets of the IEEE Standard 488-1978 that are implemented in the 4041.

THE CONNECTOR

IEEE Standard 488-1978 specifies a standard connector/cable system for instruments. Standardizing the connectors and cables ensures that standard-conforming instruments are pin-compatible when linked.

CAUTION

Certain instruments that functionally implement the GPIB conform to IEC Standard 625-1. IEC 625-1 uses a different connector than the IEEE 488. The IEC 625-1 connector is the same connector used for EIA RS-232. If an instrument with an IEC 625-1 connector is connected to the 4041 RS-232 port, the 4041 and the instrument may be damaged. The IEC 625-1 connector must be rewired into an IEEE 488 connector.

The GPIB connector (Figure 2-8) has 24 pins, with 16 pins assigned to specific signals and eight pins assigned to shields and grounds.

Eight of the 16 signal lines make up the data bus, used to carry the data to be transferred on the GPIB; five lines make up the management bus, used to control the data transfers; and three lines make up the transfer or "handshake" bus, used to synchronize data transfers between instruments.

Table 2-1

GPIB—ANSI/IEEE 488-1978 INTERFACE FUNCTION SUBSET

Function	Subset	Capability
Source Handshake	SH1	Complete
Acceptor Handshake	AH1	Complete
Basic Talker	T6	Basic talker, serial poll, unaddress if my listen address is received
Basic Listener	L4	Basic listener, unaddress if my talk address is received
Service Request	SR1	Complete
Parallel Poll	PP1	Remote configuration
Device Clear	DC1	Complete
Device Trigger	DT0	No Capability
Remote/Local	RL0	No Capability
Controller	C1	System controller
Controller	C2	Send IFC and take charge
Controller	C3	Send REN
Controller	C4	Respond to SRQ
Controller	C5	Send IF messages, receive control, pass control, pass control to self, parallel poll, take control synchronously

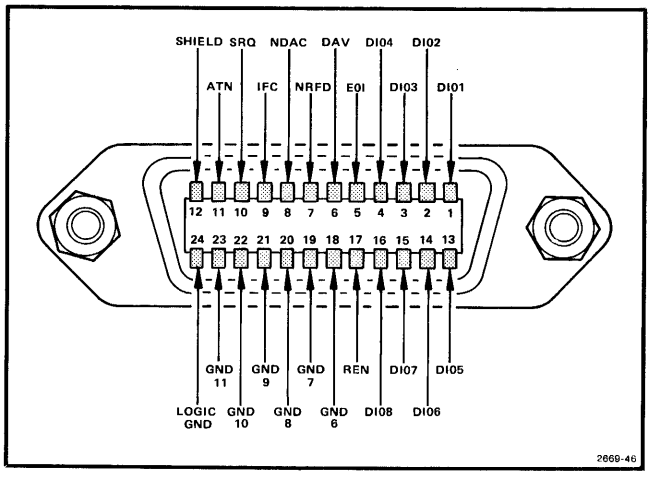


Figure 2-8. GPIB Connector Pin Arrangement and Nomenclature.

CONFIGURATIONS

Figure 2-9 shows possible configurations of instruments connected through the GPIB interface. Only four instruments are shown, but a single GPIB can support a maximum of 15 instruments connected directly to the bus (14 plus the 4041).

Instruments may be connected in a "linear" configuration: one instrument connects to the controller, another instrument connects to the first, another instrument connects to the second, and so forth. Instruments may also be connected in a "star" configuration: each instrument on the bus connects directly to the controller. They may also be connected in any combination of the two configuration types, subject to the restrictions described under Limits and Restrictions below.

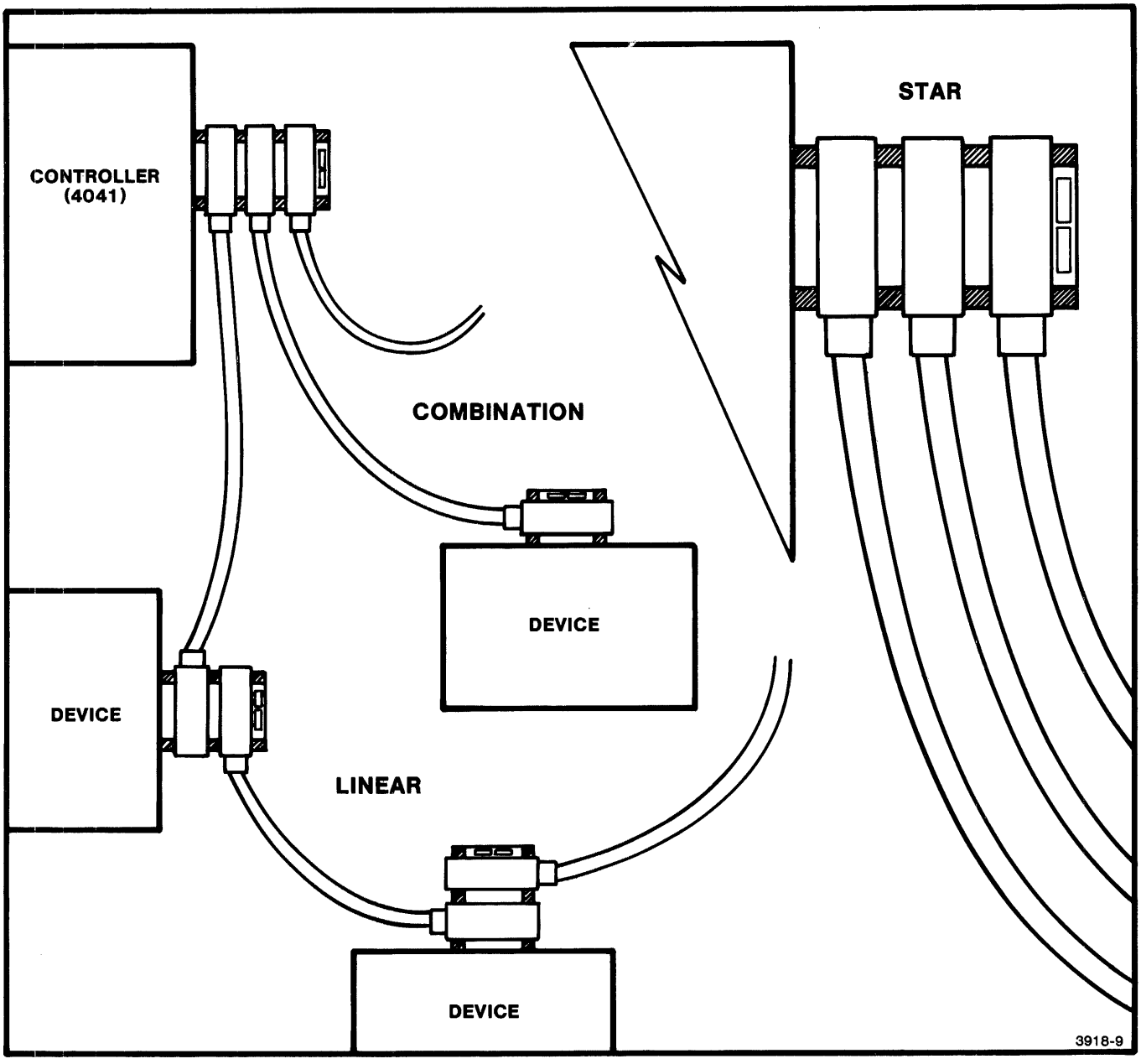


Figure 2-9. "Linear" and "Star" Configurations.

LIMITS AND RESTRICTIONS

Several rules must be followed in connecting a GPIB setup to preserve the proper electrical charactistics on the bus. First, the total cable length of all cables on a single bus must not exceed 20 meters. Second, the average cable length between devices on a single bus must not be more than two meters. (Average cable length is the sum length of all cables divided by the number of devices.)

Although instruments are usually spaced no more than two meters apart, they can be separated further if devices are lumped at some point on the bus. In other words, several devices could be attached to the bus using one-meter long cables. This would allow another device to be attached at a further distance and still not violate the two-meter average length restriction.

NOTE

At least two-thirds of the devices connected to the interface must be turned on for the GPIB to function. For further details, consult IEEE Standard 488-1978, Section 6.2.4, "Devices Powered Off and On."

SETTING DEVICE ADDRESSES

Every instrument connected to the bus must have a unique primary address or a unique primary and secondary address combination. On most devices, the primary address can be set by the user through a system of binary switches located at the rear of the device.

Some devices, however, have their primary addresses preset by the manufacturer. The primary addresses of many devices in this group can be changed by qualified service personnel. If in doubt, check the user's manual for each device.

The binary switch system at the rear of most instruments looks similar to the one shown in Figure 2-10.

Each switch in the system represents a binary digit, with value equal to 1 if the switch is in the "on" position, or 0 if it is in the "off" position. Reading from right to left, the place value of each succeeding switch increases by a factor of two; thus, the rightmost switch has a place value of 1, the second switch from the right has a place value of 2, the third has a place value of 4, and so on.

To determine the value of the address represented by a given switch setting, simply add up the place values of all the switches in the "on" position. In the example shown, switches with place values of 16, 2, and 1 are in the "on" position. Since 16+ 2+ 1= 19, an instrument on the GPIB with switches set in these positions would have a primary address of 19.

Certain devices also require secondary addresses. Different manufacturers use GPIB secondary addressing for different purposes. Some devices have user-definable secondary addresses, which function and are set like primary addresses. Refer to the operating instructions for the specific devices for additional information.

No two instruments on the GPIB can have the same primary-secondary address. Primary addresses can range from 0 to 30. Secondary addresses can range from 0 to 31.

The 4041 has a default primary address of 30, though a program may assign a different address.

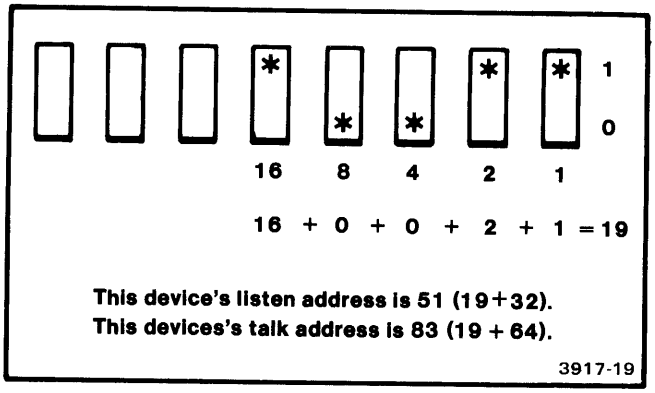


Figure 2-10. Typical Binary Switch System.

RS-232-C INTERFACE

CAUTION

Certain instruments that functionally implement the GPIB conform to IEC Standard 625-1. The connector specified by IEC 625-1 is the same connector as is used by RS-232. If an IEC 625-1 instrument is connected to the 4041 RS-232 port, the ports can short out and both the 4041 and the other instrument may be damaged.

RS-232-C is a recommended standard adopted by the Electronic Industries Association (EIA) to describe a commonly used interface for serial data transmission. This interface is used for data communications and is frequently referred to as the COMM interface.

Basically, the EIA Standard RS-232-C (the international equivalent is CCITT V.24) ensures three things:

1. That voltage and signal levels will be compatible for all devices using this interface.
2. That the interface connectors may be plugged together (mated) with identical pin wiring and corresponding pin connections for all devices using this interface.
3. That certain control information supplied by one device must be understood by the other device when this interface is used.

All devices with RS-232-C interfaces have compatible pins and wiring. This does not ensure that all devices with RS-232-C interfaces work together. The actual functioning and use of the interface depends on the way the manufacturer of the device has implemented the interface.

RS-232-C specifies a 25-pin connector, as shown in Figure 2-11. Figure 2-11 shows all possible lines specified by the RS-232 standard. In practice, no system needs to use all twenty-five lines. Devices working together on the interface do not both have to use all lines. They do have to agree on which lines are being used.

Devices with RS-232-C interfaces must be configured to work together. Configuring the interface involves making devices compatible at three different levels.

First, the physical connector hardware and lines of the interface must be compatible. This aspect is discussed by the RS-232-C standard, but the standard allows for variation. Each device must use or recognize the same signals and lines.

Second, the physical format of the information sent through the interface must be compatible to both devices. The hardware must be able to handle the data received across the interface. This refers to the timing of signals being sent over the interface, control signals sent or expected, and the format of the data transfer.

Third, the information transferred must be understandable or logically compatible to both devices. Both devices must be speaking the same language and must interpret control messages in a compatible manner.

The following paragraphs describe the actual connector and the pins used by the 4041 (the physical configuration). The subsection on Configuring the Interface, found later in this section, describes the functions affecting physical format and logical compatibility of the data transfer.

The following material is for reference only. For more information about RS-232-C interfacing, consult the EIA RS-232-C standard itself, or contact Tektronix Customer Service.

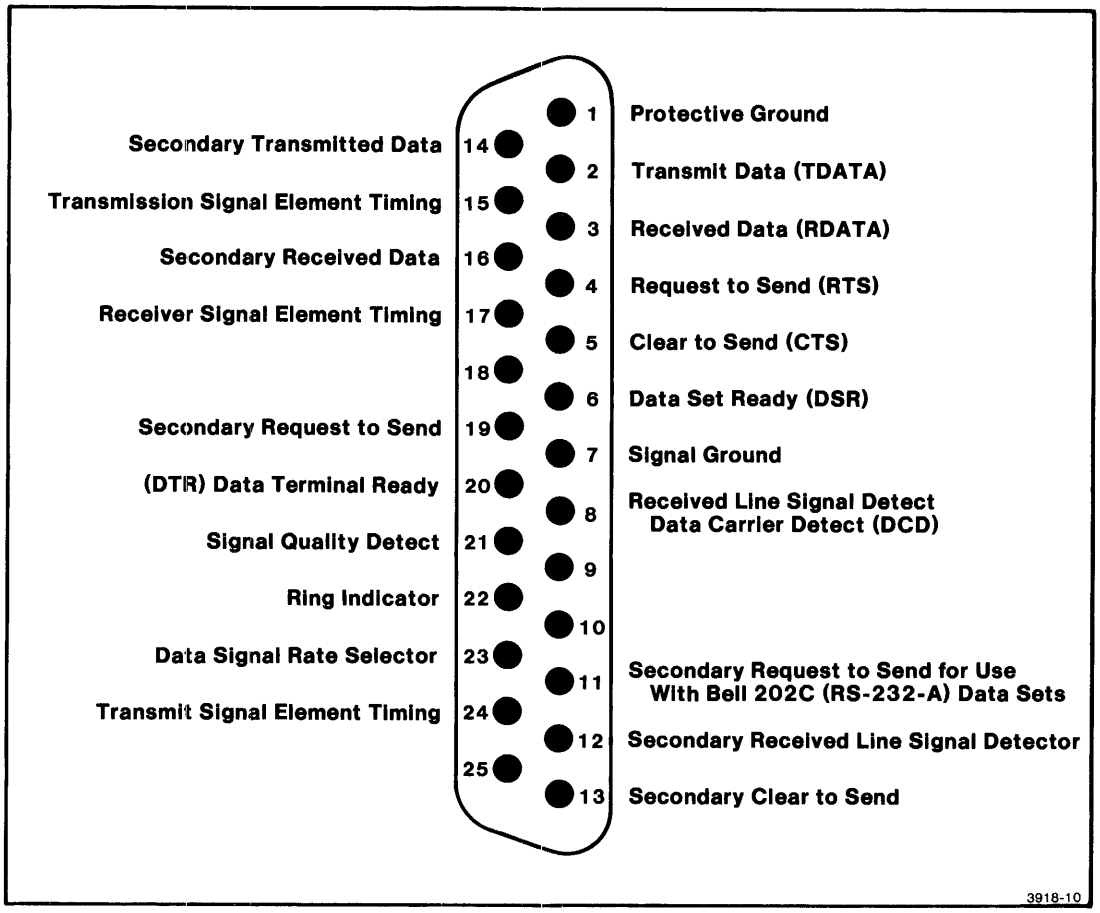


Figure 2-11. RS-232-C Pin Arrangement and Nomenclature (DTE, or Male, Connector).

CONNECTING THE INTERFACE

NOTE

RS-232-C is the most recent version of the standard. It was preceded by RS-232-A and RS-232-B. The 4041 is compatible with RS-232-A and RS-232-B, as well as RS-232-C.

RS-232 specifies a 25-pin connector. The manner in which an RS-232 device uses signal lines is indicated by whether the device has a male connector or a female connector. A computer, terminal, or printer is referred to in the standard as a DTE (Data Terminal Equipment) device and has a male connector. A modem is referred to as a DCE (Data Communication Equipment) device and has a female connector. (The standard was established to specify equipment used for data communications over long distances. Modems are devices which convert the digital signals of computers to audible tones for data transmission over phone lines. The modems are intermediate devices in the communications link. RS-232 protocol (wiring) is still applicable to and commonly used in systems that do not use modems.)

The RS-232 interface on the rear panel of the 4041 has a female connector. The 4041 computer is thus wired as a DCE device. The 4041 is not a modem, but has a DCE connector so that a terminal or printer can be directly connected without any intermediate devices or cables. Figure 2-12 illustrates possible setups using the RS-232 interface.

Most RS-232 compatible terminals and printers are DTE devices and have male RS-232 connectors. These devices can be connected directly to the 4041 with an extender cable, which is usually permanently attached to the DTE device. The Data Communications Extension Cable (see Optional Accessory List, Table 1-6)) has a male end and a female end, and can be used to extend the distance of the interface.

To attach the 4041 to another DCE device, such as another 4041 or a modem, an adapter cable must be used. The Data Terminal Adapter Cable (see Optional Accessory List, Table 1-6) has a male connector on both ends (DTE on both ends). This cable switches the signal lines to give the 4041 a male connector. With the male connector, the 4041 indirectly becomes a DTE device (Figure 2-12).

The distinction between DCE and DTE is important to an understanding of RS-232 because it determines which device controls which lines. Table 2-2 lists the signal lines used by the 4041 and their functions. In this table, and in the RS-232 standard, signals are named from the DTE device's point of view. For example, if the Data Terminal Adapter Cable is not used and the 4041 is a DCE device, Pin 2 (Transmitted Data) is used for data being received by the 4041, while Pin 3 (Received Data) is used for outgoing or transmitted data from the 4041.

Table 2-2

RS-232-C SIGNALS USED BY THE 4041

Signal Name	MNEMONIC	Pin	Use
Protective Ground		1	Connection to the device's metal chasis.
Transmitted Data	TDATA	2	Outgoing data path from the DTE to the DCE.
Received Data	RDATA	3	Incoming data path to the DTE from the DCE.
Request to Send	RTS	4	Activated by the DTE to tell the DCE to prepare to receive data from the DTE.
Clear to Send	CTS	5	Activated by the DCE to tell the DTE that the DCE is ready to receive data from the DTE.
Data Set Ready	DSR	6	Activated by the DCE to tell the DTE that the DCE is operational.
Signal Ground		7	Return path for all other signals on the interface.
Data Carrier Detect	DCD	8	Activated by the DCE to tell the DTE that a valid data path has been established.
Data Terminal Ready	DTR	20	Activated by the DTE to tell the DCE that the DTE is operational.

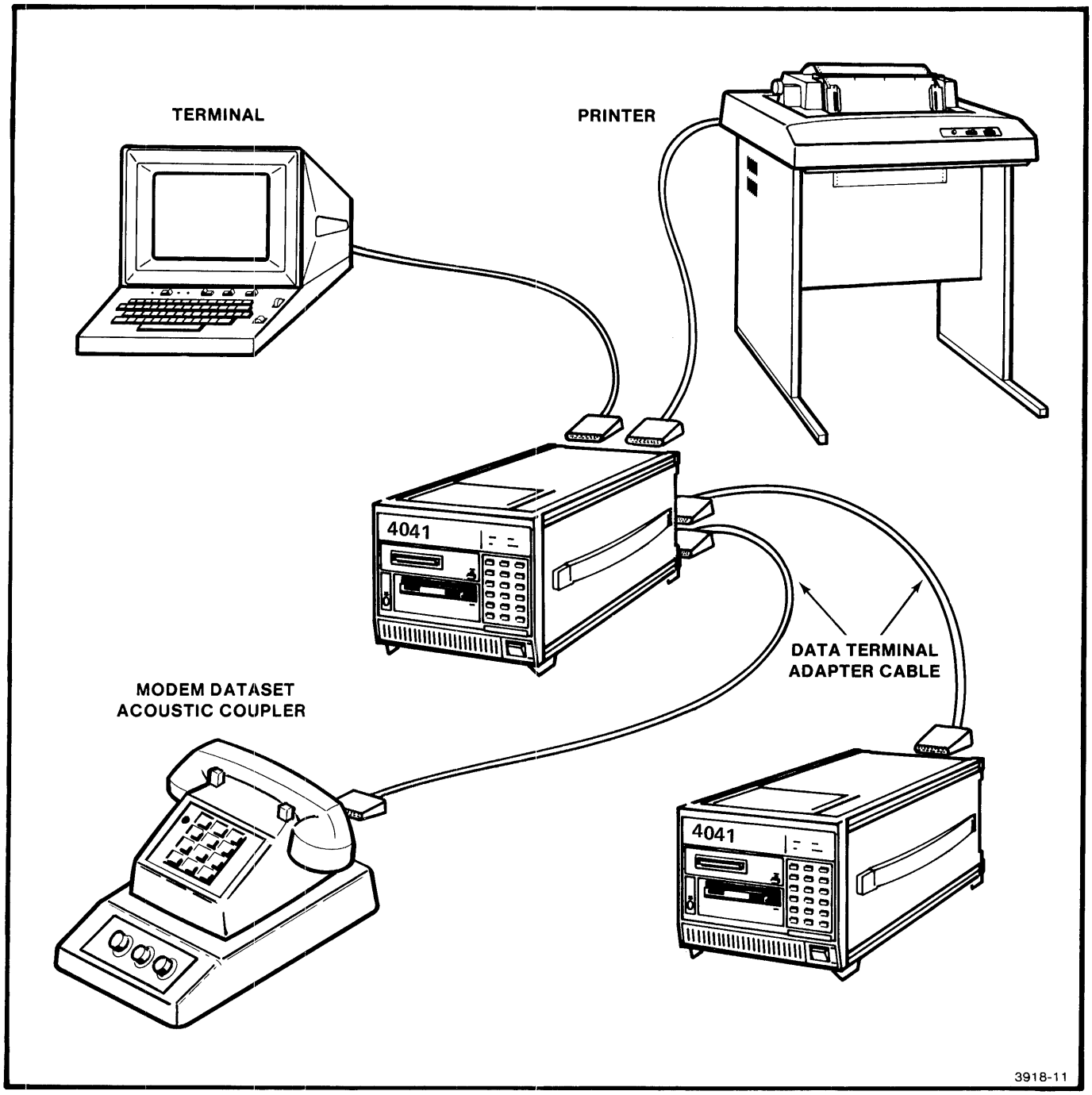


Figure 2-12. DCE and DTE Devices and Connectors.

Figure 2-13 shows the lines that are transferred by the Data Terminal Adapter Cable. Numbers on this figure correspond to the pin numbers in Table 2-2.

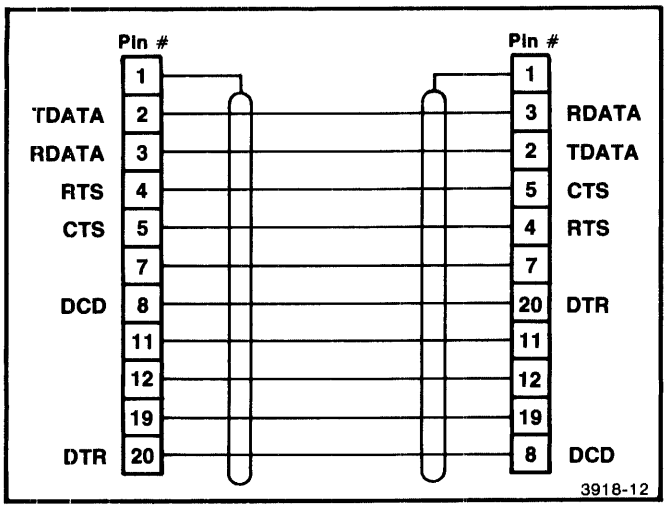


Figure 2-13. Data Terminal Adapter Cable Pin Switching.

The pins listed in Table 2-2 are the only pins and lines that the 4041 supports. If a device requires signal lines not listed in this Table, the connector may need to be rewired.

CONFIGURING THE INTERFACE

For the 4041 and the device at the other end of the interface to understand each other, they must each transfer the same type and format of data. Configuring the interface means setting up both devices to assure data from each is correctly recognized by the other. Configure the interface by setting switches on the 4041 and on the other device.

Configure the 4041 by setting *soft switches*, or parameters within the software. RS-232 parameters can be set as follows:

- Preprogrammed instructions on a program tape can set the RS-232 configuration.
- The System Verification tape can set an RS-232 configuration. The utility on the System Verification tape (see Section 4) allows the System Verification tests to be displayed on an RS-232 terminal. After the System Verification tests are completed, the RS-232 port is still set up as the system console (refer also to Section 3).
- If the 4041 is equipped with both Option 30, Program Development, and Option 31, the Program Development Keyboard, the RS-232 configuration can be directly entered. (Refer to the 4041 BASIC Programmer's Manual.)

Regardless of how the 4041 configuration is established, it must be compatible with the configuration of the device that the 4041 is connected to. The following discussion describes the parameters and concepts that must be agreed upon for the COMM interface to work correctly.

BITS — How many bits are in a character? What binary coding schemes are the devices using? For example, ASCII (American Standard Code for Information Interchange) requires seven bits per character and may use eight. EBCDIC (Expanded Binary Coded Decimal Interchange Code) requires eight bits per character. Other code systems may use only five or six bits per character. Both devices on the interface must know how many bits to read as a character; whether five, six, seven, eight, or nine. The number of bits specified should also include the parity bit if used.

PARITY — Are parity bits used? A parity bit is often used as a check for data transfer errors. A parity bit is an additional bit added to each character transmitted, according to how parity is specified. The receiving device removes this bit and checks that it is the correct value according to these same specifications. Parity may be set high or low, or odd or even, or none.

If parity is set high, for example, the sending device adds a high (1) bit to each character sent. If the receiver finds a low (0) parity bit on any character, it signals that a parity error has occurred. The bit received did not have the expected value and a transmission error probably occurred.

If parity is set even, the sender adds up all the "1"s in the character and attaches a "1" or "0" so that the number of "1"s is an even number. The receiver does the same check, and if the sum is odd, it issues a parity error. If any single bit in the character is not transmitted correctly, even or odd parity bits will not be correct.

When parity is set to none, no parity bit is appended, and any extra received bit is ignored.

STOP — How many stop bits are used? Most RS-232 devices use either one or two bits after each character to synchronize the data being transferred. These bits indicate that a single character transmission is complete.

BAUD — How fast are the bits in each character being sent and received? The baud rate (signals per second) tells the sender how fast to send the bits in each character. The receiver reads the transmission at that same rate. Mismatched baud rates cause missed or duplicated bits and garbled characters.

It may be necessary to convert between bits per second and characters per second. Using eight-bit characters, for example, with two stop bits, means characters per second may be transmitted at one eleventh of the baud rate (an automatic "start" bit is always appended.)

FORMAT — Does the device use eight-bit ASCII characters? ASCII requires seven bits to distinguish characters. Some devices use eight-bit ASCII characters. The extra bit may need to be stripped.

TYPEAHEAD BUFFER — How large a buffer should be maintained? Many devices have input and output buffers to temporarily store input or output data until it can be properly distributed. The amount of buffer space needed depends on the transmission speed (or baud rate) and frequency of transmission. The buffer takes a specified amount of space (in bytes) from available memory.

FLAGGING — How should devices communicate their buffer status? When a device's input buffer is almost full, that device may be able to flag this status by sending a signal to the other device. The other device should recognize this signal and halt transmission. Devices may also be able to flag requests for data when buffers are empty. Of course, both devices must agree on what signals they are using. The 4041 can use ASCII characters DC1 and DC3 or it can use RS-232 lines CTS and DTR to indicate its own buffer status and to recognize the other device's buffer status.

Specifically, the 4041 can be set to send DC1 and DC3 to indicate buffer status to the other device (INPUT), or to recognize DC1 and DC3 as buffer status indicators when the other device sends them (OUTPUT), or both to send and to recognize (BIDIRECTIONAL). (The capitalized terms INPUT, OUTPUT, and BIDIRECTIONAL are the actual terms used in setting the flagging parameter.)

RS-232 lines can also be used to indicate buffer status. When MODEM flagging is set, the 4041 sets CTS (Clear To Send) OFF to indicate that the 4041 input buffer is almost full. CTS is turned ON again when the buffer is emptied. The 4041 recognizes DTR set LOW (with MODEM flagging) as a request from the other device to stop sending the data transmission. DTR HIGH is seen as a request to resume data transmission.

ECHO — Does the other device expect the 4041 to echo characters back to it? Terminals will sometimes use echoing to double-check character transmission. Many terminals may be set for Remote or Local echoing. When terminal echo is set to remote, characters entered at the terminal are transmitted to the computer but not directly displayed on the terminal screen. The computer must be set to echo (return) terminal transmission back to the terminal, where the characters are displayed. If an error in data transmission occurs, the wrong character is displayed. If the computer did not echo characters, terminal entries would not be displayed at the terminal.

When the terminal is set to Local echo, characters appear directly on the terminal display, and the computer should not echo characters back to the terminal. If it did, characters would appear twice on the display.

CONTROL — Should ASCII control characters be sent as control characters over the interface, or should they be sent as "∧character?" (Certain control characters like ∧M or CR are always executed. Other control characters have special meaning when used for input from a terminal over the COMM port. Refer to Section 3 for a list of these characters.)

EDIT — Can the terminal erase characters? The ASCII RUBOUT character can be sent as a backspace-erase sequence for raster-scan terminals, or a \ character sequence. The former, raster, is more common while the latter, storage, is sometimes preferable with storage or printing terminals where backspacing is undesirable.

With the \ character sequence, when the first rubout is entered, it is recorded as a slash, followed by the last character. Subsequent rubout entries repeat prior characters. When a character other than rubout is entered, a closing slash is displayed, followed by the newly entered character.

CR — What character sequence should be sent at the end of a line? Different devices give different responses to carriage return characters. These may be the ASCII CR character, or a CR-LF sequence, or an LF-CR sequence.

LF — How does the other device treat line feeds? Different devices give different responses to line feed characters. These may be the the ASCII LF character, or a CR-LF sequence, or an LF-CR sequence.

END-OF-MESSAGE — What ASCII character signifies the end of an input message? The normal end-of-message character is CR, carriage return. The end-of-message character can be changed, though. For example, the escape (ESC) character could be set as the message terminator.

End-Of-Argument, End-Of-Header, and End-Of-Unit characters may also be specified. These characters allow a programmer to format special print output strings. These characters are explained in the 4041 BASIC Programmer's Reference Manual.

TIMEOUT — How long should the RS-232 line remain idle before an error message is sent? The 4041 can be set to give an error message if it does not receive input within a certain period of time (TIM). The 4041 can also be set to give an error message if output is not completed within a specified time (TMS).

ERROR — If transmission errors (parity, framing, or overrun errors) are detected, how should they be reported? The 4041 can either log the errors and not interrupt execution, or it can report them immediately, stop execution, and await a response.

Signal Lines are also controlled by software commands. Lines CTS, DCD, and DSR can be turned ON and OFF by software controls.

Table 2-3 lists the RS-232 configuration parameters which may be set on the 4041.

Table 2-3

RS-232 CONFIGURATION PARAMETERS DEFAULT SETTINGS

Description	Parameter	Possible Settings	Default
Signal lines	CTS	OFF,ON	ON
	DCD	OFF,ON	ON
	DSR	OFF,ON	ON
Baud rate	BAU	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600	2400
	IBA	integers, 2-9600	—
Bits	BIT	5, 6, 7, 8, 9	8
Parity	PAR	NO, ODD, EVEN, HIGH, LOW	NO
Stop bits	STO	1, 2	2
Format	FOR	ASCII, ITEM	ASCII
Typeahead buffer	TYP	integers>=100	100
Flagging	FLA	NO, INPUT, OUTPUT, BIDIRECTIONAL, MODEM	OUTPUT

Description	Parameters	Possible Settings	Default
Echo	ECH	YES, NO	YES
Control chars	CON	YES, NO	YES
Edit type	EDI	RASTER, STORAGE	RASTER
Carriage return	CR	CR, CRLF, LFCR	CRLF
Line feeds	LF	LF, CRLF, LFCR	LF
End-of-message	EOM	ASCII<1—127>	<13>
Timeout	TIM	seconds	2.14748E+7
	TMS	seconds	2.14748E+7
Error reporting	ERR	LOG, REPORT	LOG
End-of-argument	EOA	ASCII<0—255>	<0>
End-of-header	EOH	ASCII<0—255>	<0>
End-of-unit	EOU	ASCII<0—255>	<9>

TTL INTERFACE (OPTION 02)

The TTL (transistor-transistor logic) interface is a custom bit-parallel interface supplied as Option 02. The interface has 37 signal lines. Eight lines are data lines, seven are address lines, four are control lines, nine are power lines, and nine are grounds. Figure 2-14 shows the interface connector and Table 2-4 lists pin assignments.

The TTL interface is located on the rear panel (Figure 2-7C). Optional extension cables and additional connectors are available for this connector. Refer to the Optional Accessories list in Section 1.

Figure 2-15 is a sample circuit diagram for a driver to the TTL interface. Part A is a suggested circuit for address signals PA-0 through PA-6 and control lines INIT, RSTB, and WSTB. Part B is a suggested circuit for the data lines.

Figure 2-16 gives timing information for TTL interface signals (in nanoseconds).

From the programmer's standpoint, the interface is treated like a ROM pack. Data is read from or written to the interface by RCALL statements. Refer to the 4041 BASIC Programmer's Reference Manual.

Table 2-4

TTL INTERFACE PIN ASSIGNMENTS

Pin #	Mnemonic	Function
1	PD0-0	Data bit 1
2	PD1-0	Data bit 2
3	PD2-0	Data bit 3
4	PD3-0	Data bit 4
5	PD4-0	Data bit 5
6	PD5-0	Data bit 6
7	PD6-0	Data bit 7
8	PD7-0	Data bit 8
9	PA0-0	Address bit 1
10	PA1-0	Address bit 2
11	PA2-0	Address bit 3
12	PA3-0	Address bit 4
13	PA4-0	Address bit 5
14	INIT-0	Initialization
15	PA5-0	Address bit 6
16	RSTB-0	Read status bit
17	+5	Voltage
18	GND	Ground
19	+24	Voltage
20	PA6-0	Address bit 7
21	+24	Voltage
22	−12	Voltage
23	+12	Voltage
24	+12	Voltage
25	WSTB-0	Write status bit
26	+5	Voltage
27	+5	Voltage
28	−12	Voltage
29	IRQ	Interrupt Request
30	GND	Ground
31	GND	Ground
32	GND	Ground
33	GND	Ground
34	GND	Ground
35	GND	Ground
36	SHIELD (CHASSIS)	
37	SHIELD (CHASSIS)	

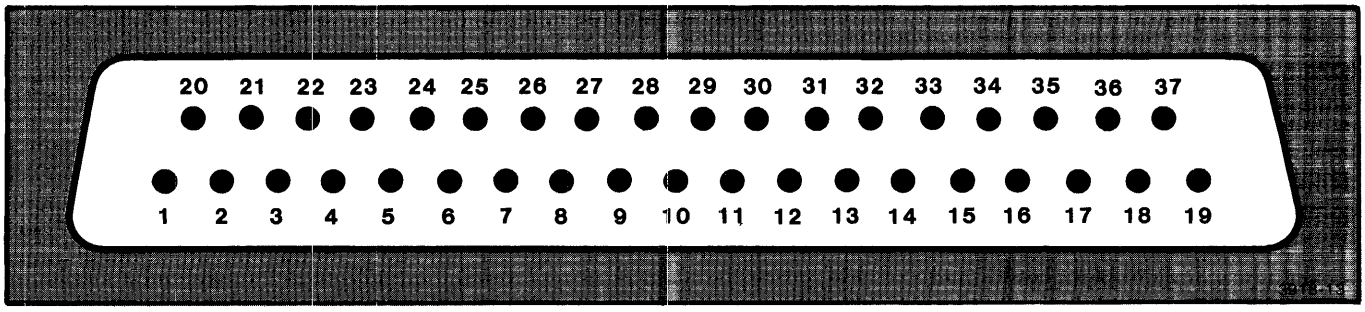


Figure 2-14. TTL Interface (Option 02) Connector (Female Connector).

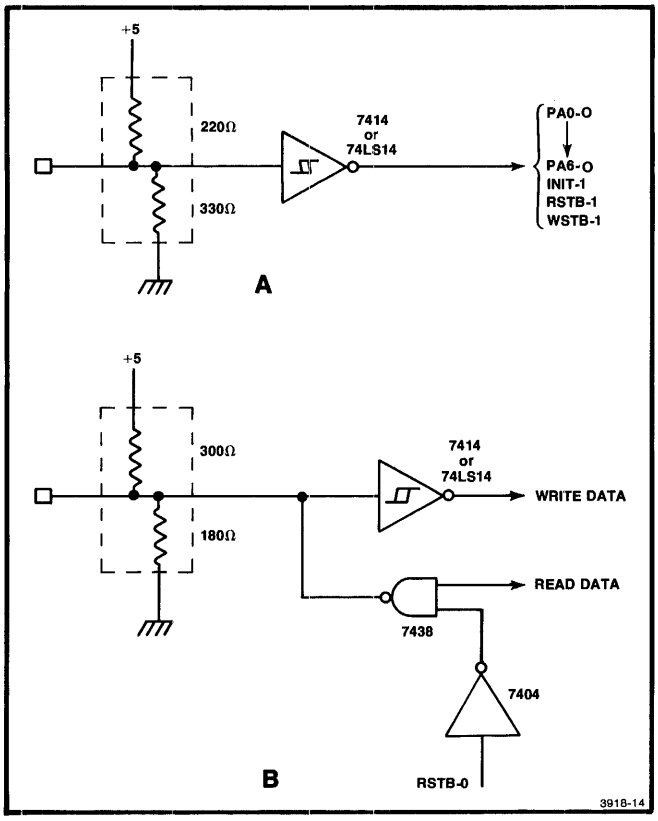


Figure 2-15. Sample TTL Interface Drivers.

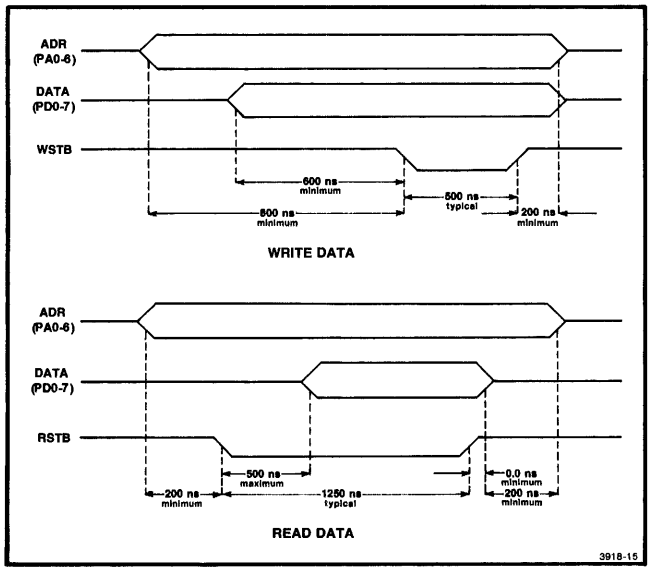


Figure 2-16. TTL Interface Signal Timing.

Section 3

CONTROLS, INDICATORS, AND OPERATIONS

After the 4041 is turned on and the self-test is completed, the 4041 is in Ready mode. If Option 30, Program Development, is installed, then the 4041 will accept a number of commands, as documented in the 4041 BASIC Programmer's Reference Manual. Otherwise, the 4041 waits for instructions from a program tape.

Before examining how to load programs, though, this section gives an overview of the controls and indicators available.

FRONT PANEL CONTROLS AND INDICATORS

Figure 3-1 shows the controls and indicators on the 4041 front panel.

SYSTEM STATUS LIGHTS

Four LED's (light emitting diodes) indicate the operating status of the 4041. These indicator lights are located at the upper right of the front panel, next to the display.

- POWER indicates that the 4041 is turned on.
- BUSY indicates that a program is running. A blinking BUSY light indicates that the system is PAUSEd. Refer to the paragraph describing the PAUSE System Function Key below.
- I/O indicates an I/O operation is being performed.
- FUNCTION indicates that the user-definable function/numeric keys are interpreted as function keys, and not as numeric input keys. The difference is explained in the discussion of the user-definable function/numeric keys later in this section.

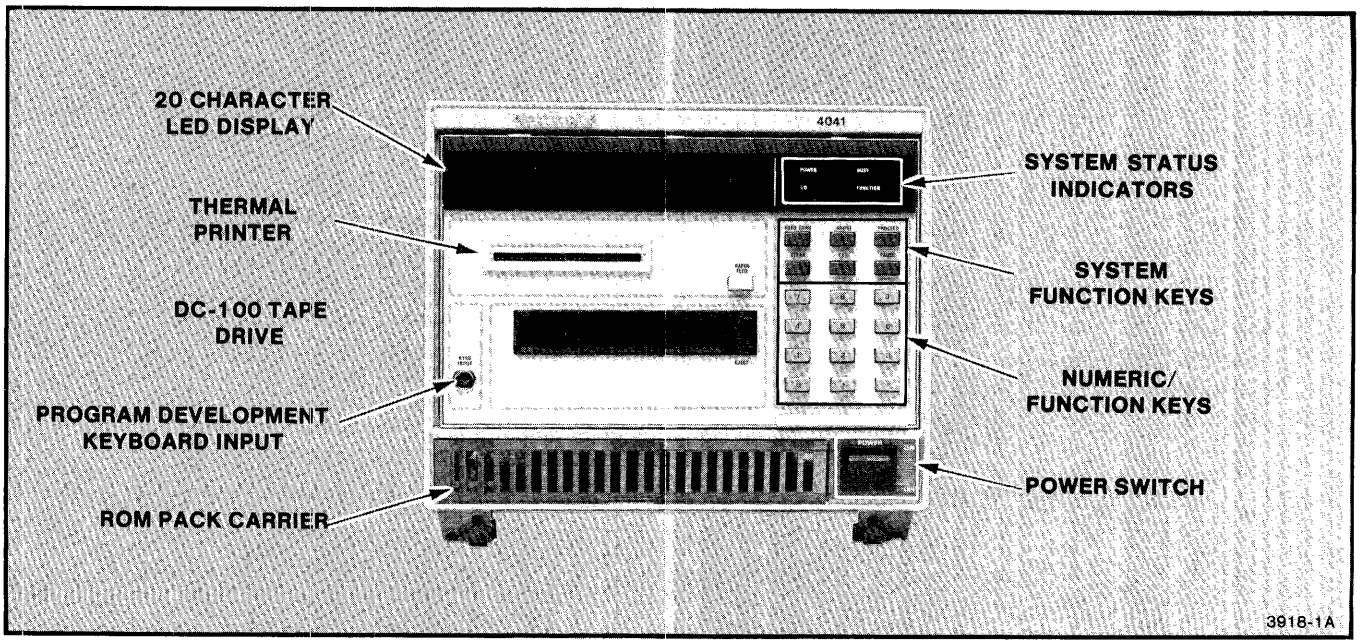


Figure 3-1. The 4041 Front Panel.

ALPHANUMERIC DISPLAY

The front panel alphanumeric display shows program and system prompts and operator input. The displayable character set consists of all numerals, uppercase letters, and ASCII symbols. Lowercase letters are displayed as uppercase. ASCII control characters are displayed as ∧ character-equivalent.

SYSTEM FUNCTION KEYS

Six system function keys are located below the function lights on the front panel. These dark brown keys are labeled <AUTO LOAD>, <ABORT>, <PROCEED>, <CLEAR>, <EEX>, and <PAUSE>.

NOTE

The front panel system function keys are enclosed in angle brackets when referred to in text. This distinguishes the keys from the operations that they initiate.

The AUTO LOAD Key

Pressing the <AUTO LOAD> key loads and runs a file named AUTOLD from the current DC-100 tape. The AUTOLD file is a supervisory program that controls subsequent operation.

The ABORT Key

Pressing the ABORT key cancels execution of a running program. Control transfers to a program-defined ABORT handler, if one is in effect.

The PROCEED Key

Pressing the <PROCEED> key: (a) starts execution beginning with the first line of the program if the system is not PAUSEd or STOPped, or (b) continues program execution following a PAUSE or STOP, or (c) continues program or statement execution following an input operation from the front panel or Program Development Keyboard.

The CLEAR Key

Pressing the <CLEAR> key clears operator input from the alphanumeric display while input is allowed. It has no effect on data already stored in the 4041's memory.

The EEX Key

Pressing the <EEX> key during an input operation indicates that the numbers that follow are part of the exponent of a number written in scientific notation. For example, to input the number 1000 using the numeric keypad, the user can press <1>, <0>, <0>, <0>, <PROCEED>, or <1>, <EEX>, <3>, <PROCEED>. This second sequence tells the 4041 that the input number is "one-times-ten-to-the-third," displayed as 1E3, and equivalent to 1000.

NOTE

The <EEX> key enters an "E" on the display. The 4041 interprets one "E" as an exponentiation symbol when a numeric value is input. A numeric value can only contain one "E," and additional "E"s are interpreted as garbage. The 4041 ignores a second "E" and any characters that follow it.

The PAUSE Key

Pressing the <PAUSE> key stops program execution without cancelling it. Execution can be resumed from the point at which the program was PAUSEd by pressing the <PROCEED> key. The BUSY status light blinks after <PAUSE> is pressed, indicating that the program may be continued.

USER-DEFINABLE FUNCTION/NUMERIC KEYPAD

The twelve keys on the user-definable function/numeric keypad are located below the six system function keys. These light beige keys are labeled 0 through 9, " . " and " - ".

User-definable functions are options which may be designed into a program. The program may, for example, specify that pressing one of the function keys executes one program option, while pressing another key triggers execution of a different program option.

When the FUNCTION system status light is lit, pressing keys 0 through 9 selects user-definable functions. If the program allows selection of user-definable functions when this key is pressed, the function executes. If not, the function entry is saved until selection is allowed.

NOTE

If the program does not execute the function or clear the storage, the 4041 saves the function entry. Pressing a second key rings the error buzzer, and the 4041 ignores the second entry. The ABORT key will clear the storage, but will also end the program.

When the FUNCTION light is off, these keys are used for numeric input to the 4041. The decimal and minus sign may be used to specify decimals or negative numbers, and the <EEX> key may be used for scientific notation.

NOTE

The decimal and minus sign, like the <EEX> key, are interpreted as ASCII input and are not dependant on the FUNCTION light. These characters are stored in an ASCII buffer, and may pop up unexpectedly if the program requests ASCII input.

OTHER CONTROLS

Paper Feed

The PAPER FEED button advances the 4041 printer paper. After the printer has printed something, the PAPER FEED button advances the paper so that the last line printed is visible. Each time the button is pressed the paper will advance one line further.

CAUTION

A tape cartridge should not be removed while the tape is being written to, read from, or being rewound, or while a file on the tape is being used. Removing the tape at the wrong time (while it is being written to) could damage the information on the tape. As a general rule, never remove a tape while a program is executing, unless specifically instructed otherwise.

Eject

The EJECT button removes tapes from the tape drive unit. This button pops out when a tape is properly inserted, and is flush with the front panel when the tape drive is empty.

OPERATING THE 4041

LOADING PROGRAMS

NOTE

Option 30, Program Development, includes a number of commands to handle files. Refer to the 4041 BASIC Programmer's Reference Manual for more information if this option is installed.

Programs for the 4041 are stored on DC-100 magnetic tape cartridges. Programs may also be stored on other storage media, such as disk drives attached through the GPIB, but the control program that allows access to other devices must still be kept on a DC-100 tape cartridge.

Section 2 describes the procedure for inserting tape cartridges. Once the proper tape cartridge is installed, the tape's programs can be loaded in two different ways.

- After the self-test is completed when the 4041 power is turned on, the 4041 checks whether there is a tape mounted in the tape drive. If there is, the 4041 automatically loads the AUTOLD program.
- The AUTO LOAD key on the front panel loads the AUTOLD program from the tape in the DC-100 tape drive.

AUTO LOADing, whether commanded automatically or by the AUTO LOAD key, is the only way to load a program when the 4041 is not equipped with Option 30. The AUTO LOAD operation looks for a tape file named "AUTOLD." This file is a supervisory program which may in turn load other tape files.

From this point on, the way the 4041 operates depends on the specific program loaded. The program may request numeric input from the front panel. It may require alphanumeric input from a terminal or Program Development keyboard. It may require choice of program functions through the user-definable function keys.

SYSTEM CONSOLE

The system console encompasses both the display where system prompts are shown and the keyboard where system commands are entered.

When the 4041 is turned on, it recognizes the front panel keyboard and display as the system console. Prompts indicating the self-test and ready status are shown on the front panel display. System control keys on the front panel, such as the AUTO LOAD key, function as described earlier in this section. (The Program Development Keyboard, Option 31, is an extension of the front panel. When the front panel is assigned as the system console, input is accepted from the front panel keys or from the Program Development Keyboard.)

The system console role can be reassigned. A terminal connected through the RS-232 port can be assigned as system console. System prompts and system commands go through the terminal, rather than through the front panel.

Displays, prompts, instructions, or data may be sent to any device, regardless of which device is the system console. Conversely, input may be received from any device, regardless of the system console assignment. The system console is the default device for all input and output. It is the device that maintains direct control over the system.

If Option 30, Program Development, is installed, the SET CONSOLE command reassigns the system console. The system console on a standard 4041 can be reassigned if this command is on a program tape which is AUTO LOADed.

Terminal as System Console

When a terminal is assigned as system console, certain front panel functions are disabled and no longer work.

- AUTO LOAD is disabled; pressing this key has no effect.
- ABORT is not affected; still halts program execution.
- PROCEED is disabled; only used to terminate input when front panel input is specifically requested.
- CLEAR is disabled; only clears the front panel display while front panel input is specifically requested.
- EEX is disabled; only enters an E (scientific notation) when front panel input is specifically requested.
- PAUSE is not affected; still stops program execution and blinks the BUSY system status light.
- Function/numeric keys are disabled; only used for numeric input when front panel input is specifically requested.

The system status lights on the front panel are not affected by changing system console assignments.

The system console terminal is used for alphanumeric input. The terminal also takes on all of the system control abilities of the front panel system console. Because most terminals do not have the same special function keys, special functions are assigned to control characters. Table 3-1 lists special control characters and their functions when a terminal is assigned system console status.

Figure 3-2 summarizes the information in Table 3-1.

Table 3-1

RS-232 TERMINAL SPECIAL CONTROL KEY FUNCTIONS

Control Character	Function
Control-A	Autonumber (Option 30)
Control-B or BREAK	BREAK or PAUSE
Control-C	ABORT
Control-D followed by 1—9, 0	Functions 11—20
Control-E, Rubout, or BS	Delete < or RUBOUT
Control-F followed by 1—9, 0	Functions 1—10
Control-N	Recall Next Program Line (Option 30)
Control-P	Recall Previous Program Line (Option 30)
Control-Q	Continue 4041 Output (cancels Control-S)
Control-R	Recall Program Line (Option 30)
Control-S	Stop 4041 Output (Control-Q resumes)
Control-T	Step (Option 30)
Control-U	Erase Current Input or CLEAR
Control-V	Auto Load
Control-X	Delete Program Line (Option 30)
ESCAPE	Suppress immediate execution of the subsequent control character.

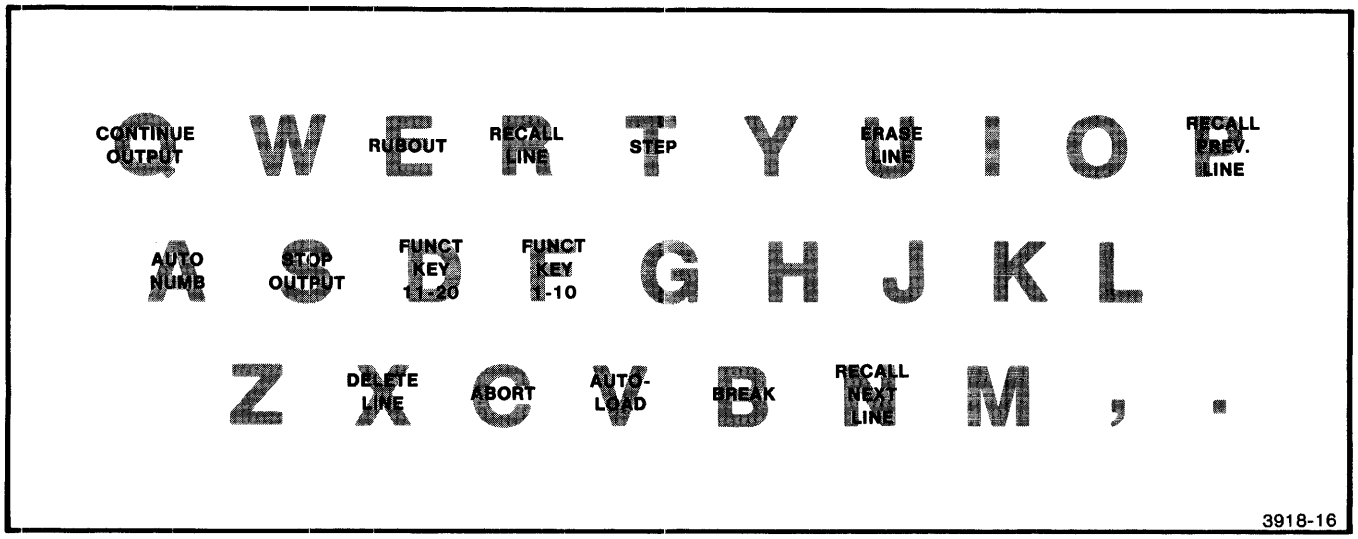


Figure 3-2. Special Terminal Control Characters.

Section 4

OPERATOR CHECK PROCEDURES

Check procedures verify that all major sections of the instrument function correctly. The check procedures consist of a series of tests. These tests may indicate that adjustment or repair is necessary. More detailed checks of internal and external instrument characteristics are provided in the Service Manual.

The operator may check system performance through two different sets of tests. The first set of tests, referred to as the self-test, is automatically run every time the 4041 is turned on. The other series of tests is on the System Verification Tape. These tests should be run whenever there is any question about the 4041's performance.

SELF-TEST (SYSTEM DIAGNOSTICS)

The self-test is run each time power is applied to the instrument or when commanded to run by a program or the system verification tape. Self-test verifies, in a broad manner, the ability of the 4041 to operate and communicate. Operational checks are performed by the processor and verify its ability to execute instructions. Communication tests are performed between the processor and the front panel and between the processor and both types of memory (RAM/ROM). There are four classes of tests performed by the power-up self-test:

- ROM (read-only memory, the memory which contains all the firmware or system operating instructions) tests consist of ROM checksumming.
- Front panel communications tests check the ability of the main CPU (central processing unit) to communicate with the front panel control board. The front panel also conducts a processor test and ROM checksum on itself.
- RAM (random access memory, the memory available for user programs, data, and processing) tests verify the size of memory present and check the ability to read and write to the RAM.
- I/O device tests verify the operation of the GPIB, RS-232C, timer operation, and tape drive communications. GPIB testing checks the ability of the GPIB adapter to function as a talker, listener, or controller. RS-232 testing consists of enabling the internal self-test loopback circuit, transmitting data, and verifying that the same data looped back as input. Tape drive testing ensures the ability of the main CPU to handshake with the tape drive board.

The following sequence of events should occur during the self-test.

1. The display is blank, and the POWER, BUSY, I/O, and FUNCTION lights are lit. The I/O light and the FUNCTION light go off. The POWER and BUSY status lights remain lit throughout the self-test.
2. SELF TEST appears on the 4041 display.
3. The display goes blank, and then the firmware version in use is displayed as VER. n.n (where n.n is the version number).
4. The firmware version is followed by the size of functional RAM (random access memory). The display shows VER. n.n MEM= , and when the RAM is tested the display reads VER. n.n MEM= xxx.
5. The display is cleared and READY displays. An asterisk and cursor appear in the display. The 4041 is ready for action.

If any of the self-tests fail, a message is displayed and printed. Table 4-1 lists these messages.

Table 4-1

SELF-TEST FAILURE MESSAGES

Message	Explanation
FAILED: TIMER	Timer failure is a "hard" failure. The 4041 will not be able to run.
FAILED: STD. RS232	The standard RS-232 channel is unusable but the 4041 will try to operate without it.
FAILED: GPIB	The standard GPIB port is unusable but the 4041 will try to operate without it.
FAILED: TAPE	The DC-100 tape drive is unusable but the 4041 will try to operate without it.
FAILED: MEMORY	Less than 32K bytes of RAM were found. The 4041 will not run.
HARD FAILURE	Either a timer failure or memory failure occured. The 4041 will not run.
FAILED ROMS: name	ROM (read-only memory) failed. The 4041 will not be able to execute if the XO or IO ROMs fail. If other ROMs fail, the 4041 will operate but cannot execute any tasks from the failed ROM.
FAILED:OPT 1 GPIB	GPIB Port 1 failed. The 4041 will try to operate without it.
FAILED:OPT 1 RS232	The COMM1 port failed. The 4041 will try to operate without it.

If the 4041 self-test does not successfully proceed to completion, either displaying READY or HARD FAILURE, the self-test has obviously failed. Repeat the self-test (turn the power off and back on). Note at which point the test stopped, and whether it stopped at the same point each time. This information will help the Tektronix service technician analyze the cause of failure.

Unless there is a HARD FAILURE (either failed memory or failed timer) the 4041 will operate. It may not be able to execute correctly or perform neccessary tasks if the "nonessential" hardware fails.

NOTE

If there is a ROM failure and the failed ROMs are ROM packs loaded in the ROM carrier, check that the ROM packs and ROM carrier are loaded correctly. Refer to Section 2 of this manual. Reload the ROM packs and the ROM carrier and repeat the self-test.

SYSTEM VERIFICATION TAPE

The system verification tape is a DC-100 tape cartridge supplied as a standard accessory. It contains tests to conveniently verify the operation of parts of the 4041 and its interfaces not tested by the self-test.

The tests on the system verification tape are divided into four groups. These tests are summarized in Table 4-2.

Table 4-2

SYSTEM VERIFICATION TAPE TESTS

Test	Description
0	SYSVER EXIT
Group 1 Primary I/O tests	
1	Display and bell test
2	Keypad test
3	Printer test
4	Tape test
Group 2 Secondary Tests	
10	Repeat Group 1 I/O tests
11	RS-232 loopback test
12	RS-232 Option 01 loopback test
13	Timer test
14	Program Development Keyboard (Option 31) test
15	GPIB test
16	GPIB Option 01 test
17	GPIB standard-to-Option 01 test
18	GPIB communication test
19	Repeat power-up self-test
20	<Pause> test
Group 3 Calibration Aids	
31	Tape calibration
32	Printer calibration
Group 4 Utilities	
41	Tape cartridge format
42	Rotating test pattern
43	Option Utility
44	Option 2 Utility
99	Help

Group 1 tests are run automatically every time the system verification tape is run. These tests check the operation of the primary I/O devices of the 4041. If the display, keypad, printer, or tape are not functioning correctly, none of the other tests can be valid. Note that while the self-test checks the internal communications between the processors controlling these devices, it does not check the operation of the individual devices. The system verification tape does.

Group 2 tests check the external operation of other 4041 devices and functions. For example, the self-test only tests the internal circuitry of the GPIB or RS-232. The system verification tape Group 2 tests check the external interfaces.

Group 3 tests are used for field calibration of the 4041 tape and printer.

Group 4 tests are utilities that exercise peripherals. One utility formats DC-100 tape cartridges. The test pattern utility sends a test string to further test interfaces and devices. The option utility reports what ROM is present and what the RAM size is. The Option 2 utility verifies internal communication between the processor and the Option 2 circuit board.

In addition to the four groups of test, test number 0 exits SYSVER (placing the system in monitor mode) and test number 99 prints a help file. The help file gives instructions on how to answer program prompts and a list of tests available on the SYSVER Tape.

RUNNING THE SYSTEM VERIFICATION TAPE

1. Turn the 4041 power on. The self-test should begin.
2. Put the DC-100 tape cartridge labeled System Verification Tape into the tape drive. The cartridge should be inserted metal side down and label out. The tape eject button will pop out when the tape is properly inserted.

CAUTION

Do not press the tape eject button or try to remove the tape while the program is running, unless prompted to do so. Removing the tape while it is being read or written to or while files are open can damage the tape or the information on the tape.

3. If the system verification tape is installed before the self-test completes, the system automatically loads the file "AUTOLD" from the tape after the self-test finishes. If the READY prompt and cursor are displayed before the tape is installed, install the tape and press the AUTO LOAD system control key. The tape should start winding.

NOTE

When the Program Development Keyboard is used, use the numeric keypad or alphanumeric keyboard for responses. Do not use the user-definable function keys to answer prompts in this program.

4. If any tests failed when the self-test last ran, the console and printer show:

   SELFTEST ERROR
   (failed test codes)
   SELFTEST END

   The console prompts:

   ERROR (1-OK, 0-EXIT)?

   A 0 entry ends further execution of programs on the System Verification Tape while a 1 attempts to continue program execution. If no self-test tests failed, no message is issued.

NOTE

The failed test codes are hexadecimal numbers that indicate which test in the self-test failed. Call your service technician.

5. The display will ask "TERMINAL CONFIG(1-YES,0-NO)?". This prompt asks if a terminal on the RS-232 port (COMM 0) is used as the system console. If it is, the programs are run from and report to the terminal, rather than the front panel of the 4041. If you want to use a terminal, press the "1" key then <PROCEED> on the front panel keypad and turn to the instructions in Table 4-4. Refer to the guidelines given in Section 2. If you use the front panel as the system console, press "0" on the front panel keypad and continue.

NOTE

From this point, the term **console** *refers to the 4041 front panel if TERMINAL CONFIG is answered no, and to the RS-232 terminal display if CONFIGURE is answered yes and the configuration is properly entered. The term* **display** *always refers to the display on the 4041 front panel.*

<ABORT> refers to the <ABORT> key on the front panel or Program Development Keyboard. When a terminal is used as the console, Control-C also issues an <ABORT>.

6. The following message is printed on printer:

   RESPOND TO QUESTIONS
   0 FOR NO, 1 FOR YES
   FOLLOW W/ <PROCEED>
   PRESS <PROCEED> WHEN
   A REQUESTED ACTION
   HAS BEEN COMPLETED
   <ABORT> EXITS A TEST

7. SYSVER Vn.n (Vx.Lx) shows on the console. "n.n" is the version of the verification tape in use and Vx.Lx is the version and level of firmware in use. This message is shown for three seconds; pressing the <ABORT> key during this three-second period causes the verification program to skip the Group 1 primary I/O tests (Step 8) and wait for a command selection (Step 9).
8. The four Group 1 — Primary I/O Tests are automatically executed, one after the other. Refer to Table 4-3.
9. COMMAND(99= HELP)? is displayed on the console. Which of the tests in Table 4-2 should be run? Use one of the following responses:
   - n <PROCEED> where n is the desired test number, or
   - 0 <PROCEED> or <ABORT> to terminate the verification test programs.

NOTE

When the front panel is the system console, <PROCEED> refers to the front panel <PROCEED> key, and, if the optional Program Development Keyboard is used, also to the <RETURN> key. When a terminal is used as the system console, <PROCEED> refers to the <RETURN> key.

Table 4-3 describes each of the tests on the System Verification Tape. The table shows actual prompts from the display or console capitalized. The Explanation column describes the normal progression of each test. The Notes column describes special exceptions or error conditions which may arise in each test.

In all tests, if the actual test results differ from results described in the Explanation column, the test has failed.

NOTE

The <ABORT> key (and Control-C on terminal keyboards) stops any test. Pressing <ABORT> while in a test causes the program to exit the test and return to COMMAND mode (see Step 8 above.) <ABORT> is the only way to exit certain tests.

Table 4-3

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 0 — SYSVER Exit	Exits SYSVER command mode to monitor mode	
Test 1 — Display Test		
DISPLAY TEST	Display shows: 1. 0**********0 (bell) 2. *0000000000000000000* (bell) 3. Single asterisk 'walks' the display, right to left. 4. Rapidly alternating *'s and 0's flash in all character positions	
DISPLAY TEST EXIT		
Test 2 — Keypad Test		
KEYPAD TEST	Display shows: PRESS "0" Respond by pressing the 0 key on the front panel. Get similar prompts and give responses for: .,-,1,2,3,4,5,6,7,8,9,<CLEAR>, <EEX>,<AUTO LOAD>,<PROCEED>, and <ABORT>. Use Test 20 to test the <PAUSE> key.	If a different key is detected, display shows: AGAIN -- "0" Press the 0 key. If a different key is still detected, display shows: ONCE MORE -- "0" Press the 0 key. If a different key is detected again, display shows: ERROR -- "0" KEY The ERROR message is also displayed on the printer.
KEYPAD TEST EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 3 — Printer Test		
PRINTER TEST	Printer prints: !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz	If the paper moves but nothing is printed, check that the paper is not loaded upside down.
PRINTER TEST EXIT		
Test 4 — Tape Test		
TAPE TEST REPORT SOFT ERRORS? ANOTHER TAPE?	The tape test can write in a file on the system verification tape or in a file on a different tape. The other tape, if used, must be correctly formatted. If a different tape is used, change tapes before answering this prompt.	If answer is yes, console prompts: INSTALL TAPE. If answer is no, go to SHORT TEST?
SHORT TEST?	If answered yes, 384 bytes are written to TPTEST file. If answered no, long test is executed.	Long test writes to the largest available free block on the tape.
READING DIRECTORY	The test looks for a file named TPTEST. If the file is not found, it is created.	If a formatted tape is not found, the console prompts: USE FORMATTED TAPE. If the file must be created and the file is write-protected, the console prompts: WRITE PROTECTED, CONTINUE? Change tapes or write-enable the current tape.
	If the file named TPTEST already exists, the console indicates: CHECKING HEADER	If the file used for this test, TPTEST, has an incorrect or different header, the console prompts: DELETE TPTEST? 0 ends this test, while 1 causes the program to delete the TPTEST file, create a new file named TPTEST, and continue.
WRITING TO TAPE	Test bytes are written to the TPTEST file.	If the tape is write-protected, the console prompts: WRITE PROTECTED, CONTINUE? If "1" is chosen, test resumes with READING DIRECTORY.

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 4 — Tape Test (cont)		
UPDATING DIRECTORY		If the tape is removed, the console prompts: REINSTALL TAPE.
READING FROM TAPE	The test reads and verifies the bytes written above.	If the file header is incorrect, the console reports: TAPE TEST INVALID If there is a discrepancy between written and read data, the console reports and printer prints: DATA DISAGREES POSITION IN ERROR and gives the byte position of the first disagreement. Repeat the test with a different tape.
	If the tape in the drive is not the System Verification tape, the console will prompt: INSTALL SYSVER TAPE.	
XXX SOFT ERRORS FOUND	Reports number of soft errors detected if REPORT SOFT ERRORS? was answered yes.	
TAPE TEST EXIT		
Test 10 — Repeat Primary I/O Tests	Tests 1,2,3, and 4 are run automatically.	

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 11 — RS-232 Loopback Test		
STANDARD I/O TEST	Attach the RS-232 test adaptor (standard accessory) to the standard (lower) RS-232 connector on the back panel.	
	The display prompts: INSTALL TEST ADAPTOR.	
	The RS-232 control lines are checked. The test toggles DSR, CTS, and DCD, and monitors the status of DTR and RTS.	The printer reports control line status if DTR or RTS differ from expected values. The adaptor connects DSR to DTR, and DCD and CTS to RTS. A table is printed only for failed test conditions. For comparison, the correct test states are listed below.
		DSR DTR CTS DCD RTS ON ON — — — OFF OFF — — — — — ON ON ON — — ON OFF ON — — OFF ON ON — — OFF OFF OFF
	The entire ASCII character set is sent in order, one character at a time, and read back.	ASCII characters that do not loop back correctly are printed on the printer. Total number of errors is printed. TIMEOUT — INPUT is printed if no characters are received.
	The display prompts: REMOVE TEST ADAPTOR.	
I/O TEST EXIT		
Test 12 — Option 01 RS-232 Test		
OPTIONAL I/O TEST	Refer to Test 11. The procedures, prompts, and error actions are the same as Test 11, except that the optional (upper) RS-232 COMM1 is used.	
I/O TEST EXIT		
Test 13 — Timer Test		
TIMER TEST <PROCEED> TO START	Press the <PROCEED> key on the 4041 front panel and at the same time start a stop watch. The elapsed time will continually display on the front panel. To stop, press the <ABORT> key on the front panel and stop the stop watch. The front panel displays the elapsed time, and the printer prints: ELAPSED TIME: nn.nn SECS	To resume program operation following a keystroke of the BREAK key, press CONTINUE. BREAK key operation is thus checked.
TIMER TEST EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 14 — Program Development Keyboard Test		
PD KEYBOARD TEST	This test checks Option 31, the Program Development keyboard. The display prompts: PRESS KEY When a keystroke is received, the display reports the ASCII decimal value followed by NEXT? for each key associated with standard ASCII characters. Function keys must be followed by a carriage return, and are reported as "FK number NEXT?" Program control keys and edit keys are reported as "key name NEXT?" Keys not titled are reported "Decimal number NEXT?" Press <ABORT> to stop the test and check its operation. At the end of the test, all the characters tested are printed in a string on the 4041 printer.	
PD KEYBD TEST EXIT		
Test 15 — Standard GPIB Test		
STANDARD GPIB TEST	This test checks the GPIB drivers. An active GPIB listener device must be attached. Any address may be used as long as the listener can handshake properly. The sequence of commands is not a typical or realistic GPIB transaction, and GPIB devices may react unpredictably. The sequence is intended only to toggle all GPIB lines. (An oscilloscope must be used to check signal toggling.) Data lines, EOI, ATN, and DAV are tested only as outputs. NRFD and NDAC are checked only as inputs. Press <ABORT> to stop the test.	Stuck lines are not reported; they can be detected with the logic probe or oscilloscope. The presence or absence of NRFD and NDAC depend on the handshaking, and are not necessarily a fault of the 4041. Improper handshaking may leave the test hanging with only ATN being toggled.
GPIB TEST EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 16 — Option 01 GPIB Test		
OPTIONAL GPIB TEST	The optional GPIB test proceeds like the standard GPIB test (15). The Option 01 port is used.	
GPIB TEST EXIT		
Test 17 — GPIB Standard-to-Option 01 Test		
GPIB LOOPBACK TEST INSTALL GPIB CABLE	Attach a GPIB cable from the standard GPIB port to the Option 01 GPIB port. Data is transferred from the standard port to the optional port, and vice versa, using DMA (Direct Memory Access) transfer.	If any discrepancies are found, including loss of handshaking, the console displays: ERROR IN TRANSFER The printer prints: DATA SENT: THIS IS A TEST OF TH E STANDARD TO OPTI ONAL GPIB LOOPBACK DATA RECEIVED: xxxxxxxxxxxxxxxxxxxx xxxxx.....xxxxx (x represents garbled message).
TRANSFER COMPLETE REMOVE GPIB CABLE. GPIB TEST EXIT		
Test 18 — GPIB Communication Test		
GPIB CONVERSATION	This test uses two 4041's connected with a GPIB cable on their standard ports. The test must be run concurrently on both 4041's.	Master 4041 may be selected and program loaded, but do not press <PROCEED>/carriage return until slave has been selected and has test routine running.
INSTALL GPIB CABLE. SLAVE MUST BE STARTED FIRST MASTER(0)/SLAVE(1)?	One 4041 must be specified as master, the other as slave. The following conversation appears on displays: Master Display Slave Display MASTER CALLING SLAVE ACKNOWLEDGE REQUEST TO CONFIRM CONFIRMED TRANSACTION DONE ACKNOWLEDGED SLAVE COMPLETE MASTER COMPLETE	If 1 is entered, console will prompt: INSTALL SYSVER IN MASTER. Following prompt with pressing <PROCEED> on slave. If answered "0", do not press <PROCEED> on master until slave is running.
CONVERSATION EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 19 — Repeat Power-Up Self-Test	The self-test is started as if the 4041 was turned off and on again. After the self-test finishes, the verification tape will AUTO LOAD if the tape is still in the drive. Start over.	
Test 20 <PAUSE> Test		
<PAUSE> TEST	An incrementing series of numbers shows on the display. Press the <PAUSE> key on the front panel or the Program Development Keyboard to stop the sequence. The <PROCEED> key (or Program Development Keyboard <CONTINUE> key) resumes the sequence. Press <ABORT> to stop the test.	Do not press <ABORT> when sequence is stopped. If pressed, system exits to monitor mode.
<PAUSE> TEST EXIT		
Test 31 — Tape Calibration		
TAPE CALIBRATION	This test does a continuous read for 300 blocks of tape. Any formatted tape may be used. The data read is ignored by the test, and the test does not affect the contents of the tape. The test exercises the tape drive so that a service technician can calibrate the tape unit.	
ANOTHER TAPE?	The test will read and reread the same 300 blocks. Press <ABORT> to stop. If tape in the drive is not the system verification tape, the console will prompt: INSTALL SYSVER TAPE.	If answered yes, console prompts: INSTALL TAPE. If answered no, routine begins execution.
TAPE CALIBRATION EXIT		
Test 32 — Printer Calibration		
PRINTER CALIBRATION	Lines of "8"s are printed on the printer. The display shows the time taken to print each line. Press <ABORT> to stop the test. The average lines per second shows on the display and the printer.	
PRINTER CALIBRATION EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 41 — Tape Format Utility		
TAPE FORMAT DATA WILL BE LOST INSTALL TAPE	The inserted tape is rewound and formatted.	If tape was not changed console shows: DATA WILL BE LOST followed by INSTALL TAPE. If the tape is write-protected, the console prompts: WRITE PROTECTED, CONTINUE
VOLUME NAME?	Enter the volume name (tape identification) for the tape (10 character maximum).	
INSTALL SYSVER TAPE. FORMAT EXIT		
Test 42 — Test Pattern Utility		
TEST PATTERN DEVICE OPTION?	The test pattern is a sequence of ASCII characters starting with SPACE (ASCII 32) that may be sent to test or calibrate a device. Choose the device or port to be tested: 1 — Standard RS-232 port 2 — Standard GPIB port 3 — Front panel display 4 — Front panel printer 5 — Optional RS-232 port 6 — Optional GPIB port If a GPIB port is selected, the console asks: WHAT GPIB ADDRESS? Enter the primary address of the device.	
WHAT LINE LENGTH?	Specify the number of characters in the test pattern. A stream of characters in ASCII sequence, starting with SPACE, is sent to the target device. Press the <ABORT> key to stop the test pattern utility.	
TEST PATTERN EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 43 — Option Utility		
OPTION UTILITY CURRENT ROMPACKS	The names of all recognized ROM packs and internal ROM are listed on the console and printer. ROM should be: IO,XO (in all 4041s) PD (Option 30) Additional ROM packs are listed if they are installed.	
MEMORY OPTION:	The memory option and resulting amount of RAM are listed. One of the following is shown on the console and printer: STANDARD — 32K OPTION 20 — 64K OPTION 21 — 96K OPTION 22 — 128K OPTION 23 — 160K	
OPTION UTILITY EXIT		
Test 44 — Option 2 Utility		
OPTION 2 UTILITY	Press <ABORT> key to stop Option 2 utility	
OPTION 2 UTILITY EXIT		

Table 4-3 (cont)

VERIFICATION TEST PROCEDURES

Console Prompt	Explanation	Notes
Test 99 — Help		
HELP UTILITY HELP TO CONSOLE?	Help file is displayed on console.	Press <ABORT> to exit help file.
HELP TO PRINTER?	Help file is printed on printer.	
	RESPOND TO QUESTIONS 0 FOR NO 1 FOR YES FOLLOW W/ <PROCEED> PRESS <PROCEED> WHEN A REQUESTED ACTION HAS BEEN COMPLETED <ABORT> EXITS A TEST	
	SYSVER COMMANDS NUMBER NAME 0 EXIT 1 DISPLAY 2 KEYPAD 3 PRINTER 4 TAPE 10 REPEAT 1-4 11 STD RS-232 12 OPT RS-232 13 TIMER 14 PD KEYBOARD 15 STD GPIB 16 OPT GPIB 17 GPIB LOOPBK 18 GPIB COMM 19 SELF-TEST 20 <PAUSE> 31 TAPE CAL 32 PRINTER CAL 41 FORMAT UTIL 42 TEST PATTERN 43 OPTION UTIL 44 OPT 2 UTIL 99 HELP	
HELP UTILITY EXIT.		

TERMINAL CONFIGURATION

Before the 4041 is able to communicate with a terminal connected to its RS-232-C ports it must be configured so that it and the terminal are transferring the same type and format of data. For additional information concerning the data types and data formats capable of being transferred via the RS-232-C ports refer to Section 2. To configure the 4041 so that it transfers the same type and format, perform the procedures of Table 4-4.

Table 4-4 describes the procedures to configure a terminal at the standard RS-232-C port (COMM 0). The procedure uses a program stored on the System Verification Tape to establish the configuration. When the procedure is complete, a file that contains the newly established configuration parameters is stored on the System Verification Tape (if writing is enabled) and the 4041 enters the monitor mode. This file is used only to make a AUTOLD file for subsequent 4041 configurations. It is not read if the configuration program is executed again.

MAKING AN AUTOLD FILE FOR TERMINAL CONFIGURATION

An AUTOLD file that contains the desired configuration information is a more convenient method of configuring your 4041. Once established, you only need to apply power, insert the tape that contains the AUTOLD file, and press the <AUTO LOAD> key on the front panel. In order to create an AUTOLD file verify that Option 30 is installed in your 4041 and perform the following procedure. Note that this is not the only way to create an AUTOLD file.

1. Insert the System Verfication Tape that contains the configuration file that you wish to use in your AUTOLD file.
2. At the console enter LOAD "CONFIG". This loads another program created by performing configuration procedure into the 4041.
3. Insert tape on which the AUTOLD file is to be created. Ensure that RECORD switch is in record position.

CAUTION

Data will be lost when step 4 is performed. Do not use the System Verification Tape or any other tape that contains data that must be saved.

4. At console enter FORMAT. Tape is formatted.
5. At console enter SAVE "AUTOLD (OPEN= NEW, SIZE= 1000)". AUTOLD file is written to tape.
6. At console enter DIR and note that AUTOLD file exists.

Table 4-4

TERMINAL CONFIGURATION

Console Prompt	Explanation	Notes
TERMINAL CONFIG(1-YES,0-NO)?	Refer to the RS-232 Configuration description in Section 2 for an explanation of terms, parameters, and possible settings. In following settings, the <PROCEED> key leaves the parameter in its default setting.	If answered yes, continue with terminal configuration. If answered no, refer to verification test procedure. <ABORT> exits to monitor. If <ABORT> is pressed anytime during parameter entry, go to TERMINAL CONFIG(1-YES,0-NO)?
BAUD?	Default is 2400	
EDIT(1-RASTER,0-STORAGE)?	Default is RASTER	
MORE CHANGES(1-YES,0-NO)?	Do the following parameters need to be changed? If not, go to IS TERMINAL ONLINE?	In general, the next parameters require in depth knowledge of RS-232 interface. Use caution when changing default value.
ECHO(1-YES,0-NO)?	Default is YES.	
CONTROL(1-YES,0-NO)?	Default is YES.	
PARITY(1-NO,2-ODD,3-EVEN,4-LOW,5-HIGH)?	Default is NO.	
STOP(1 OR 2)?	Default is 2.	
BITS(5,6,7,8,9)?	Default is 8.	
CR(1-CR,2-CRLF,3-LFCR)?	Default is CRLF.	
LF(1-LF,2-CRLF,3-LFCR)?	Default is LF.	
CTS(1-ON,0-OFF)?	Default is ON.	
DCD(1-ON,0-OFF)?	Default is ON.	
DSR(1-ON,0-OFF)?	Default is ON.	
IS TERMINAL ONLINE?	Enter "1" followed by <PROCEED> when terminal is connected and powered up. The following is printed on printer: TO CONFIGURE COMM THE FOLLOWING STATEMENTS SHOULD BE ENTERED IN YOUR AUTOLD FILE: SET DRIVER <PARAMETERS> SET CONSOLE <PARAMETERS> IF TERMINAL DISPLAYS "ARE RESULTS OK?" THEN TYPE "1" IN RESPONSE. OTHERWISE, PRESS <ABORT>.	

Table 4-4 (cont)

TERMINAL CONFIGURATION

Console Prompt	Explanation	Notes
The following is displayed on terminal connected to COMM0: ARE RESULTS OK?		If "1" is typed on terminal within 15 seconds, terminal becomes console. Otherwise, go to BAUD. <ABORT> go to BAUD.
The following is displayed on front panel: CONSOLE IS AT COMM0:	This message displayed in response to "1" typed at terminal and signals end of procedure.	If SYSVER tape is not load, the console prompts: INSERT TAPE(1-YES,0-NO). If answered no, system exits to monitor mode. If SYSVER tape is write protected, the console prompts: WRITE PROTECTED WRITE ENABLE(1-YES,0-NO)? If answered no, system exits to monitor mode.
CONFIG FILE WRITTEN	Configuration file was written on SYSVER tape.	
TERMINAL CONFIG EXIT	System is now in monitor mode.	

Section 6

PROGRAM DEVELOPMENT KEYBOARD (OPTION 31)

The Program Development Keyboard (Figure 6-1) is supplied as 4041 Option 31. This keyboard can be used for alphabetic and numeric input to the 4041. When the 4041 is also equipped with Option 30, the Program Development option, the keyboard may also be used for program and command entry and for system control.

The Program Development Keyboard looks like a standard typewriter keyboard with a ten-key keypad for numeric entries at the right side and a series of special function keys above the alphanumeric keyboard.

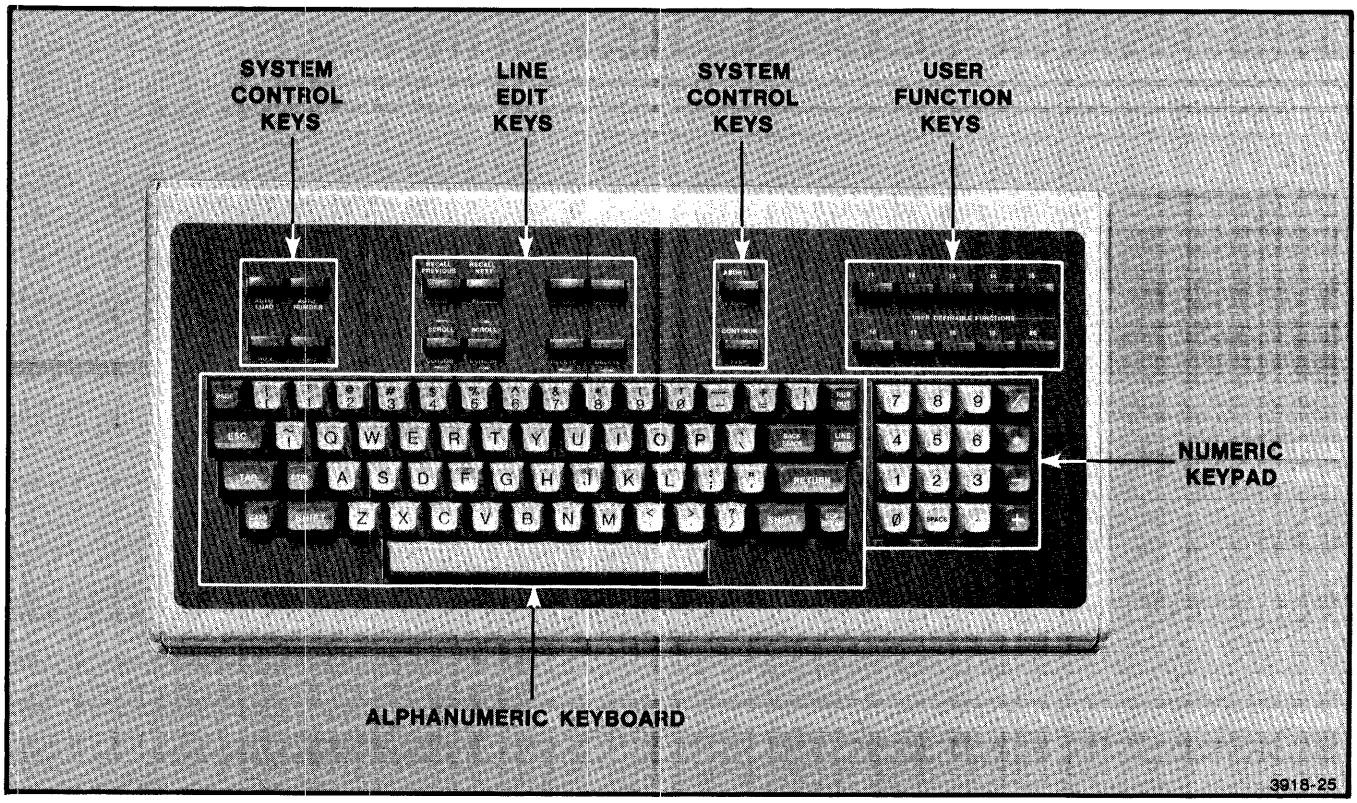


Figure 6-1. The Program Development Keyboard.

Install the Program Development Keyboard by plugging its cord into the special socket on the 4041 front panel (Figure 6-2). Be sure that the pins are lined up correctly. The connector is held in place by a sliding latch. To remove the keyboard connector, pull the connector itself.

CAUTION

Do not pull the cord to remove the Program Development Keyboard connector. The connector is held in place by a sliding latch. Remove the Keyboard by pulling on the connector barrel.

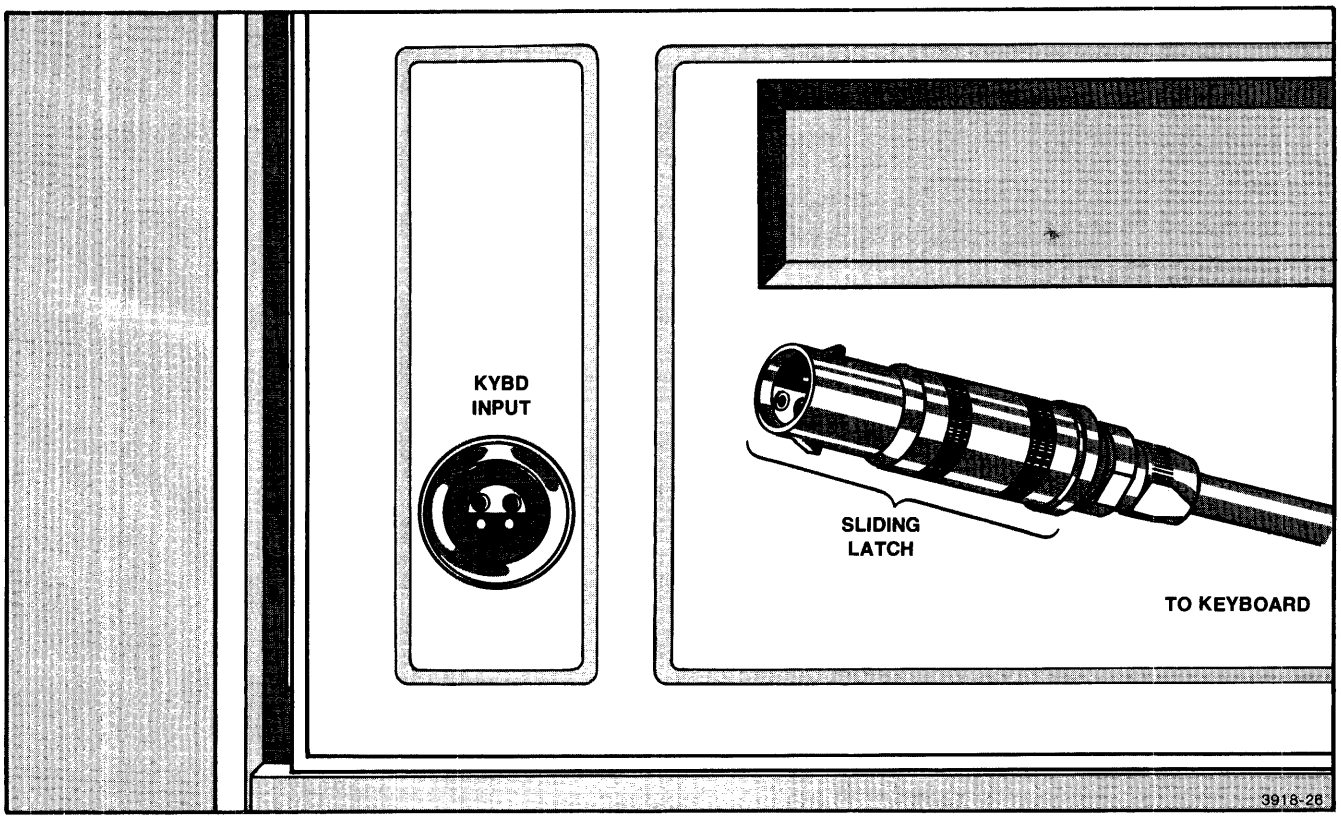


Figure 6-2. Installing the Program Development Keyboard.

SPECIAL FUNCTION KEYS

The special function keys are arranged in two rows along the top of the keyboard. These keys are edit keys and program control keys. Refer to Figure 6-3.

Seven of the special function key functions only work when the 4041 is equipped with Option 30, Program Development. These keys are labeled LIST, AUTO NUMBER, RECALL, RECALL PREVIOUS, RECALL NEXT, STEP, and DELETE. These seven functions (and the other keyboard keys) are explained in the 4041 Programmer's Reference Manual and the 4041 Programmer's Reference Guide, supplied with Option 30.

PROGRAM CONTROL KEYS

The AUTO LOAD Key

The AUTO LOAD key functions just like the AUTO LOAD key on the 4041 front panel. It loads the "AUTOLD" file from the DC-100 tape.

The AUTO LOAD key only functions when the 4041 is idle (not executing a BASIC program) and when the front panel is the system console. Pressing the AUTO LOAD key at any other time has no effect.

The RUN Key

The RUN key starts or restarts execution of the program currently loaded in memory.

The PAUSE Key

Pressing the PAUSE key halts execution of a running program. The 4041 remembers the point at which the program was halted. Execution can be continued from this point by pressing the CONTINUE key or the front panel PROCEED key. The program can be started over by pressing the RUN key.

If a program is not being executed, pressing the PAUSE key has no effect.

This key has the same effect as the BREAK key.

The ABORT Key

Pressing the ABORT key (shift-PAUSE) halts execution of the current program and generates an interrupt. If the program designates a special ABORT handler, pressing the ABORT key passes control to that handler. Otherwise, a SYSTEM ABORTED message appears on the front panel display and the program execution is ended.

The CONTINUE Key

Pressing the CONTINUE key (shift-STEP) restarts execution of a PAUSEd program from the point at which it was halted.

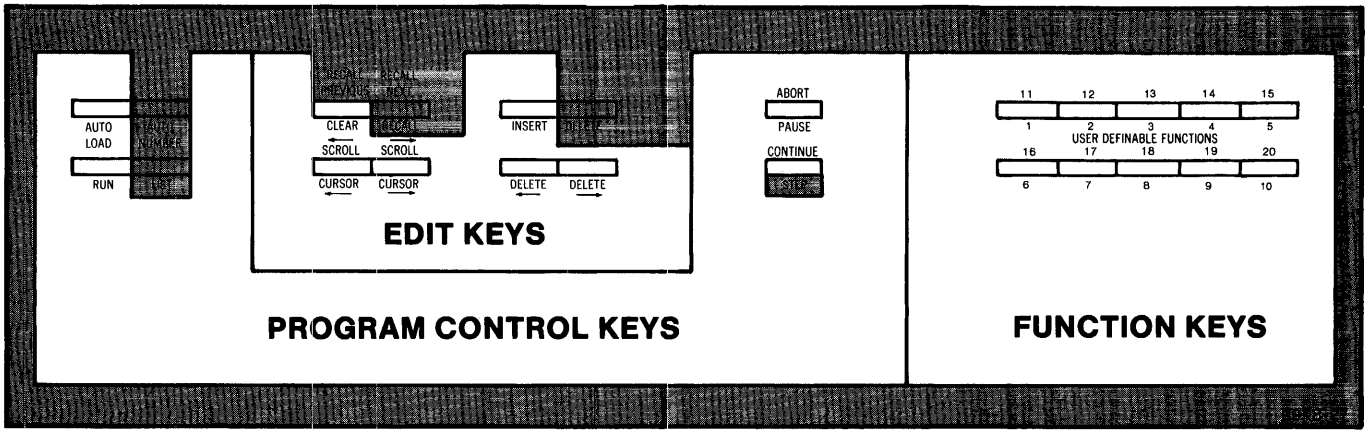


Figure 6-3. The Special Function Keys.

USER-DEFINABLE FUNCTION KEYS

The user-definable function keys allow the user to select up to twenty different program options. These options may be given within specific programs.

Functions 1 through 10 are obtained by pressing the corresponding user-definable function key alone. Functions 11 through 20 are selected by pressing the SHIFT key and the corresponding user-definable function key.

Functions 1 through 10 on the Program Development Keyboard are also obtainable by pressing function keys 1 through 9 and 0 on the front panel. (Function key 10 on the Program Development Keyboard corresponds to function key 0 on the front panel.)

EDIT KEYS

The edit keys only work when a front panel input is requested. This input could be a program response, or, with Option 30, a program line entry or command entry. The edit keys are ignored at any other time.

The CLEAR Key

Pressing the CLEAR key clears the alphanumeric display on the front panel during input.

The CURSOR < Key

Pressing the CURSOR < key moves the display cursor left. When the cursor is in a display position also occupied by a character, the cursor and the character are displayed alternately.

If the display cursor is in the first position of the display, pressing the CURSOR < key scrolls the contents of the display to the right.

If the first position of the display contains both the first character of the line being displayed and the cursor, pressing the CURSOR < key has no effect.

The CURSOR > Key

Pressing the CURSOR > key causes the cursor to move one position to the right in the display.

If the cursor occupies the rightmost position of the display, pressing the CURSOR > key causes the contents of the display to "scroll" one space to the left.

If the cursor is to the right of the rightmost character in the current line, pressing the CURSOR > key has no effect.

The SCROLL < Key

Pressing the SCROLL < key (shift-cursor <) causes the contents of the display, including the position of the cursor, to move one space to the left. The first character currently in the display moves off the display to the left, while the character following the rightmost character on the display moves into the display from the right.

The cursor retains its position relative to the message being displayed (i.e., if it shared a display position with the first character of a word, it continues to share that position after the SCROLL < key is pressed).

If the cursor is in the first (leftmost) position of the display, however, pressing the SCROLL < key causes the contents of the display to move one space to the left, but the cursor remains in the first position. Only in this case does pressing the SCROLL < key cause the cursor to change its position within the message. The SCROLL < key can never move the cursor off the display.)

If the last character of the current line occupies the rightmost display position, pressing the SCROLL < key has no effect.

The SCROLL > Key

Pressing the SCROLL > key (shift-cursor >) causes the contents of the display to move one character position to the right.

The cursor retains its position relative to the message being displayed, (i.e., if the cursor shares a position with the first character of a word, the cursor shares that position after the SCROLL > key is pressed).

If the cursor is in the rightmost position of the display, however, pressing the SCROLL > key causes the contents of the display to move one space to the right while the cursor remains in the rightmost position. Only in this case does pressing the SCROLL > key change the position of the cursor within the message. (The SCROLL > key can never move the cursor off the display.)

If the first character of the the current line is in the leftmost display position, pressing the SCROLL > key has no effect.

The INSERT Key

Pressing the INSERT key places the 4041 in Insert mode from Replace mode.

Replace Mode. The 4041 is said to be in Replace mode whenever it is not in Insert mode. The 4041 powers-up in Replace mode.

In this mode, the cursor, a " ⊦" symbol, replaces characters already in the display with new characters entered from the keyboard. If the display contained the characters:

DEF

with the cursor in the same display position as the letter "D," typing the characters "ABC" with the 4041 in Replace mode yields the following display:

ABC

The cursor then occupies the display position to the right of the letter "C." The contents of the original display have been replaced, hence the name Replace mode.

Insert Mode. Pressing the INSERT key puts the 4041 into Insert mode. Pressing the INSERT key again when the 4041 is in Insert mode returns the 4041 to Replace mode.

When the 4041 is placed into Insert mode, characters in the same position as and to the right of the cursor are shifted right one space. The cursor, a "△" symbol, always occupies a blank space when the 4041 is in Insert mode.

Entering a character when in Insert mode causes the character just entered to appear at the position previously occupied by the cursor. The cursor and all characters to the right of it are shifted one space to the right as each character is entered.

If the cursor occupies the rightmost position of the display, then the cursor remains stationary when characters are entered, while all characters to the left of the cursor are shifted left.

The DELETE > Key

Pressing the DELETE > key when the 4041 is in Insert mode deletes the character to the right of the cursor. Display contents to the right of the deleted character are shifted left one space.

Pressing the DELETE > key when the 4041 is in Replace mode deletes the character in the display position occupied by the cursor. Display contents to the right of the deleted character are shifted left one space; the cursor then shares a display position with the character following the deleted character.

In Insert mode, pressing the DELETE > key has no effect if the cursor is in the rightmost display position. The DELETE > key never deletes a character that the user cannot see (i.e., one not currently in the display).

If the cursor is to the right of the rightmost character in the current line, pressing the DELETE > key has no effect.

The DELETE < Key

Pressing the DELETE < key deletes the character to the left of the cursor.

If the cursor is in the leftmost position of the display, pressing the DELETE < key has no effect. The DELETE < key will not delete characters that the user cannnot see on the alphanumeric display.

ALPHANUMERIC KEYBOARD

The alphanumeric keyboard is the typewriter-like keyboard section of the board. It is used to enter all of the 128 characters in the ASCII character set. Special keys on the alphanumeric keyboard are described below.

BREAK — halts execution of a running program. The 4041 remembers the point at which the program was halted. Execution can be continued from the BREAK point by pressing the CONTINUE key or the front panel PROCEED key.

This key has the same effect as the PAUSE key.

SHIFT — determines whether alphabetic characters are sent as upper or lower case. For keys with more than one associated function, the SHIFT key determines which function is to be performed.

CONTROL — Similar to the SHIFT key; it changes the value of characters it is used with, and has no effect by itself. Instead of changing case, the CONTROL key selects ASCII control characters corresponding to the letters entered with it. Refer to the ASCII Code Chart in Appendix B.

RUBOUT — Backspaces and erases the previous character.

RETURN — Ends a line of input and sends input to the 4041. Equivalent to the front panel PROCEED key.

CAPS LOCK — Lights to indicate that all letters are sent as uppercase, regardless of the SHIFT KEY. This key has no effect on characters or keys other than the twenty-six letters.

The following keys send ASCII control characters. The characters are displayed as described below during input. The description also shows how these characters are ordinarily output or executed. However, the program being run may affect character expressions.

PAGE — Displayed as "^@." Ignored as output.

ESCAPE — Displayed and output as "^[" (or as "[" on the printer).

TAB — Displayed as "^I." Output as a single space.

BACK SPACE — Displayed and executed as "^H" (or as "H" on the printer).

LINE FEED — Displayed as "^J." Output as a line feed; subsequent characters are displayed on the following line.

NUMERIC KEYPAD

The numeric keypad, located in the lower right corner of the Program Development Keyboard, is used to enter numerals, as well as operators for addition, subtraction, multiplication, and division. The numeric keypad does not select user-definable functions.

Appendix A

SYSTEM ERROR CODES

ERROR HANDLERS

An error is any discrepancy between an expected or required condition and the actual or observed condition during program or command execution. Errors can arise from faults or failures in hardware (either the 4041 or peripheral devices). Errors can also arise through faults, unexpected conditions, or illegal operations within the executing program.

The 4041 features flexible error handling procedures. When the 4041 detects an error, it interrupts execution and looks for a *handler* for the error. A *handler* is a section of the current program that instructs the system what to do when the corresponding error is detected. A handler might give the 4041 alternate instructions for the operation that caused the error. A handler might attempt to fix the condition that caused the error. A handler might send a prompt instructing the operator in how to fix the error condition. A handler might simply notify the operator of the error. Error handlers are a part of the program, and they are written by the programmer.

If the system does not find an error handler for the detected error, or if the handler so directs, the system displays a system error message. A system error message is of the form:

ERROR # n — LINE x

where n is the system error number and x is the line number that the system attempted to execute when it detected the error. If the error arose during a command execution rather than during program execution, the message does not include a line number.

This appendix lists possible system error code groups and numbers.

NOTE

In some cases, the error code will indicate a solution to the problem that does not require a programming change. Errors that an operator might be able to correct are described fully in the following list. In most cases, however, programming changes are required to correct the error. The system must be equipped with Option 30, Program Development, to change a program These errors, briefly described here, are more fully detailed in the 4041 BASIC Programmer's Reference Manual.

Group I (1-19) Translation errors. These errors can not be handled by programmed error handlers. They arise during program entry or program development, and should not be seen in a completed applications program unless the program did not load from tape correctly. Reload the tape.

Error #	Cause
1	Syntax error.
3	Subprogram syntax error.
4	End statement error.
5	Label error.
6	Subprogram name error.
7	Parameter label error.
8	Symbol table full.
9	Local label error on subprogram edit.
10	Statement too complex.
11	Too many tokens in statement.
12	Edit of active subprogram statement.

Group II (20-49) Immediate mode errors. These errors cannot be handled by programmed error handlers. They only arise during program entry or program development when Option 30 is present.

Error #	Cause
20	Unable to continue.
21	Subprogram not found.
22	Illegal variable trace.
23	Illegal syntax for renumber.
24	Line limit reached in renumber.
25	Break point on non-executable statement.
26	Function in immediate mode.
27	Program statement in immediate mode.
28	Immediate mode statement during append or load.
40	Run time stack full.
41	Branch not into main.

Group III (50-69) Common (utility routine) errors. These errors also usually only arise during program development.

Error #	Cause
50	Number expected, string found.
51	Invalid logical unit/error number.
52	Undefined variable.
53	Zero or minus subscript.
54	Scalar variable subscript.
55	Wrong number of subscripts.
56	Invalid combination of operands.
57	Numeric expected, something else found.
58	Array reference without required subscripts.
60	Different size arrays specified in implied operation.
61	String expected but not found.
62	Subscript exceeds dimensioned value.
63	Value or variable expected.
64	String truncated on assignment and read.

Group IV (70-79) Program structure errors.

Error #	Cause
70	Incomplete subprogram.
71	Invalid line number.
72	Label error.
73	PD ROMs not available. A requested action requires Option 30, Program Development, which is not available.
74	Invalid use of subprogram name.
75	Main program incomplete.

Group V (80-99) Mathematical and numeric function errors.

Error #	Cause
80	Overflow.
81	Underflow.
82	Divide by zero.
83	Logarithm error.
84	Exponential overflow.
85	Trigonometric range error.
86	Exponentiation error.
87	Square root of negative number.
88	Tangent overflow.
89	Integer overflow.
90	Sum function error.
91	Ask function error.

Group VI (100-109) String function errors.

Error #	Cause
100	Error in ASC function. A null string was passed as an argument to the function.
101	Error in VAL function. No number was found in the string argument passed to a VAL or VALC.
102	Rep$ result length error. The call to Rep$ resulted in a string longer than 32767 characters.
103	Concatenation error. The concatenation of two strings resulted in a string longer than 32767 characters.

Group VII (110-119) Memory errors.

Error #	Cause
110	Memory full.
111	String allocation failure.
112	Insufficient memory to complete a Save or List.
113	Input or print token stack full.
114	Memory fragmented.

Group VIII (120-139) User-defined function invocation errors.

Error #	Cause
124	Function assignment error.
125	Scalar function error.
126	Invalid function use.

Group IX (140-159) Handler activation and return.

Error #	Cause
140	Interrupt error.
141	Gosub handler existence error.
142	Gosub handler segment error.
143	Call handler in use error.
144	Call handler completion error.
145	Call handler defined error.
146	Call handler type error.
147	Failure on return.
148	Improper return.

Group X (200-579) Basic statement errors.

Error #	Cause
201	Append line limit reached.
202	Append file format in error.
211	Subprogram in use.
212	Expression passed to variable parameter.
213	Call name not subprogram.
214	Call name not defined.
215	Subprogram incomplete.
216	Parameter not defined.
217	Subprogram passed as value parameter.
218	Wrong number of arguments.
219	Parameter types don't match.
251	Deleted subprogram active.
252	Delete of Sub statement.
261	Illegal dim type.
262	Illegal dim value.
311	Invalid level count on Exit.
321	For not local.
322	Control variable error.
323	For statement deleted.
324	Invalid flow of control on For.
325	Error in nested For loop.
351	Line number not found.
352	Line number not local.
381	Input item not recognized.
391	Invalid target variable.
401	Line cannot be listed.
402	Invalid line number.
451	Bad primary address in Poll list.
452	Bad secondary address in Poll list.
491	ROM pack doesn't exist. The ROM pack that defines a function referenced in an Rcall statement is not available to the system.
501	End of read data.
522	Restore line not data statement.
523	Restore line number not local.
531	Incomplete subprogram error.
532	Bad item file format.
551	Error in set statement.
552	Set argument out of range.
553	Invalid fuzz argument.
554	Bad date and time string.
561	Wait value not valid.
571	Wbyte operand invalid.

Group XI (700-769) I/O errors.

Stream spec errors

Error #	Cause
700	Specified driver not present on the system.
701	Too many left parenthesis characters.
702	Too many right parenthesis characters.
703	Unrecognized parameter.
704	Missing parameter right half.
705	Boolean parameter has bad value.
706	Integer parameter has bad value.
707	Real parameter has bad value.
708	Clock tick parameter has bad value.
709	Stream spec ended with a quote character.
710	Stream spec ended inside a string value.
711	Too many colon characters in stream spec.
712	Right parenthesis encountered in bracket.
713	Non-numeric encountered in numeric value.
714	Not enough characters in stream spec.
715	No number found by OS call.

Clause and image errors

Error #	Cause
750	Using error.
751	Data type and format do not match.
752	GPIB data did not match Using format.
753	Logical unit not open when it should be.
754	No logical unit open when data transfer attempted.

Group XII (770-799) GPIB function errors.

Error #	Cause
770	Bad data byte value in ATN function.
771	Missing DIO operand in PPC function.
772	Missing SENSE operand in PPC function.
773	Invalid DIO operand in PPC function.
774	Invalid SENSE operand in PPC function.
775	Invalid listen address.
777	Invalid address in an addressed command function.
778	Invalid operand in SRQ function.
779	Invalid use of GPIB function.

Group XIII (800-839) GPIB driver errors.

Error #	Cause
800	Invalid MA value in stream spec.
801	Invalid SC value in stream spec.
802	Invalid PRI value in stream spec.
803	Invalid SEC value in stream spec.
804	Invalid TRA value in stream spec.
805	Interface does not support DMA transfer mode.
806	Invalid IST value in stream spec.
810	Operation attempted which is not supported.
811	Data transfer operation timed out.
812	No listener on the bus. This indicates either no instruments on the bus, or no instrument at the particular address specified.
814	Serial poll attempted when interface not the controller in charge.
815	Autopoll attempted when SRQ not true.
816	Autopoll failed to detect SRQ source.
817	Instrument failed during autopoll.
818	Explicit poll of nonexistent instrument. If a list of addresses is supplied in the poll statement, all addresses must respond with status bytes when polled.
820	Wbyte tried to send IFC when interface not SC.
821	Wbyte tried to send REN when interface not SC.
822	Wbyte tried to send ATN when I/F not CIC.
823	Wbyte tried to output when I/F not talk addressed.
824	Rbyte tried to input when I/F not listen addressed.
825	Wbyte tried to send SRQ when I/F not TL.
826	Parallel poll attempted when I/F not CIC.
827	Wbyte sent TCT when no talker addressed.
830	Interface unable to take control of bus. The attention message was false even after the interface tried to take control asynchronously. This indicates a hardware problem.
835	IFC enable/disable error.
836	SRQ enable/disable error.
837	DCL enable/disable error.

Group XIV (840-879) Tape driver errors.

Error #	Cause
840	Lamp/Servo failure. The hole detect lamp has burned out or the servo could not get the tape up to speed in allotted time.
841	End of tape detected. An attempt to locate a record on the tape has caused the end of tape to be detected. This normally means that an inter-record gap was not detected.
842	Cartridge not in place. An attempt was made to access the tape drive without a tape cartridge in the drive.
843	Write-protected tape. An attempt was made to write to the tape while the write-protect tab was set to write-protect.
844	Data overflow. The data service for the tape was not made in the time required and data was lost.
845	Additive checksum failure. The additive checksum for a header did not match the calculated checksum. This means the record data was read incorrectly.
846	Incorrect record header.
847	Cyclic Redundancy Check failure.
848	Gap detected.
849	Timeout failure. The tape drive did not respond within the time expected.
850	File exists. An attempt was made to create a new file that already exists on the tape.
851	No space available. An attempt was made to create a file larger than the available space on the tape.
852	Illegal record number. An attempt was made to do a physical read/write to a nonexistent record number for the tape being used.
853	No file exists. An attempt was made to open a file name that does not exist on the tape.
854	Write after read. An attempt was made to write to a tape file after one or more reads were made to a file.
855	End of file reached. The end of file was reached while accessing a tape file.
856	Illegal command. An illegal command was given to the tape drive (firmware error).
857	File not open. An attempt was made to access a tape file when the tape file had not been opened.
858	Wrong data type. An attempt was made to access a tape file with the wrong data type. A binary file was passed ASCII data or an ASCII file was passed binary data.
859	Cannot access directory in physical mode.
860	File access failure. An attempt was made to open a tape file for writing while it was already open for reading.
861	Invalid tape. The tape inserted in the tape drive is not the original tape for the file being accessed.
862	Reserved.
863	Directory read error. The directory could not be read without detecting an error.
864	Invalid tape. An attempt was made to close an updated file with a different tape inserted in the drive.
865	Read after write failure. The read after write function detected an error.

Group XV (880-899) RS-232 driver errors.

Error #	Cause
880	Invalid request in item format. The EOM parameter may specify one or two characters, each must have an ASCII code in the range 0 to 127.
884	Invalid driver request.
885	Timeout limit exceeded. The operation was not completed within the time specified by the timeout parameter.
886	Typeahead buffer overflowed.
887	Invalid combination of BITS and PARITY parameters.
888	Invalid baud rate specified.
889	Overrun error. A received character was lost because a second character was received before the first could be placed in the typeahead buffer.
890	Parity error.
891	Framing error. The 4041 did not detect the correct stop bit or bits (as specified by the STOP parameter) following a received character.

Group XVI (900-919) Front panel driver errors. Generally these errors are hardware or firmware related. Repeat the self-test.

Error #	Cause
900	Interrupt output routine mistakenly called.
901	ACIA overrun error.
902	ACIA framing error.
903	ACIA fatal error.
904	Unwanted query response.
905	Front panel printer problem.
906	Illegal wakeup message.
907	Flush task code.
908	Unable to allocate memory.
909	Illegal request message.
910	Illegal driver request.

Group XVII (920-939) Printer driver errors. Generally these are hardware or firmware related errors. Repeat the self-test.

Error #	Cause
920	Interrupt output routine mistakenly called.
921	ACIA overrun error.
922	ACIA framing error.
923	ACIA fatal error.
924	Unwanted query response.
925	Front panel printer problem.
926	Illegal wakeup message.
927	Flush task code.
928	Unable to allocate memory.
929	Illegal request message.
930	Illegal driver request.

Special Errors (999-1000).

Error #	Cause
999	Proceed mode error.
1000	User invoked error code.

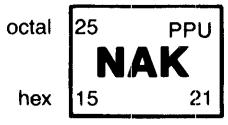
ROM Pack Errors (2000-32699). Based on address of ROM pack.

Appendix B

ASCII & GPIB CODE CHART

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

KEY



* ¦ on some keyboards or systems

Appendix C

GLOSSARY

abort
To terminate the execution of a program or command. The terminated program or command can be restarted, but cannot be continued from the termination point.

ASCII
A standardized code for a character set that includes uppercase and lowercase letters, numbers, common symbols, and special "control" characters. Each of the 128 characters in the ASCII character set is uniquely represented by a seven-bit binary code and a decimal equivalent. ASCII is an acronym for American Standard Code for Information Interchange.

BASIC
A high-level programming language that uses English-like instructions. BASIC is an acronym derived from Beginner's All-Purpose Symbolic Instruction Code.

baud
A unit of signaling speed; the number of signal events per second. When binary information is transferred, and each signal is a bit, baud rate is equivalent to bits per second.

binary
Information represented in a base 2 number system, commonly by a sequence of 1's and 0's. In electronic systems, these 1's and 0's translate to electric pulses which are ON or OFF, HIGH or LOW.

bit
A binary digit. A unit of data in the binary numbering system; a 1 or 0.

buffer
Storage area used to hold data to compensate for a difference in data flow rates when data is transferred from one device to another.

bus
A pathway for transmitting signals.

byte
A group of consecutive binary digits (bits) operated on as a unit. One ASCII character, for example, is represented by one binary byte.

carriage return
The operation of moving the cursor to the first character position of the same line or (as sometimes implemented) of the next line. May also refer to the RETURN key on an alphanumeric keyboard.

console
The part of the computer used for communication between the operator and the computer.

control character
A special character that initiates, alters, or stops a specific operation. In ASCII code, decimal values 0 through 31 are assigned to 32 control characters.

controller
The device on a GPIB bus that controls other devices on the bus and assigns listener and talker status.

CPU
Central processing unit. A portion of the computer hardware that controls the interpretation and execution of instructions.

cursor
A display symbol that shows the position where the next character entered will be shown on a display.

data
Facts, concepts, or instructions which may be communicated by humans or by machines.

data communications equipment (DCE)
Traditionally a device such as a modem or acoustic coupler for transmitting data between DTE devices. In RS-232, a device with a female connector and a specified connector wiring.

data terminal equipment (DTE)
A device capable of originating or accepting data transmission through a data communications link. In RS-232, a device with a male connector and a specified connector wiring.

debug
The process of locating and correcting errors in a program; also, the process of testing a program to ensure that it operates properly.

default
The property of a computer that enables it to assign substitute values for statement parameters when none were specified.

device
An instrument or piece of equipment used to input data to the computer or to output data from the computer. Devices may be external, attached through the GPIB, RS-232, or TTL interface; or they may be internal. In the 4041, the printer, display, and tape drive are internal devices.

direct memory access (DMA)
A 4041 optional feature (Option 01) which allows data transfer directly from the GPIB bus to memory without processor intervention. This allows a very high-speed transfer burst.

driver
A special firmware program that controls an external device or the interface between devices.

error
A discrepancy between an expected or required condition and the observed condition; a fault or failure.

error handler
Instructions within a program that determine what action is taken when an error is detected.

execute
To perform the operations indicated by a statement or group of statements.

file
A collection of data or records or a program that is handled by I/O drivers and by storage devices as a single unit.

firmware
Software instructions that are permanently loaded in the read-only memory; the operating system, drivers, and BASIC interpreter.

GPIB
General purpose interface bus. An eight-bit parallel interface which meets ANSI/IEEE 488-1978 specifications.

handshake
Greeting protocol between two devices. Each device must send and respond to this series of signals prior to data transfer.

hardware
The physical equipment and parts used in the computer system.

initialize
To set all parameters to their initial power-up or default values.

integer
A whole number between −32768 and 32767. It cannot contain a decimal.

interface
A common boundary between two devices or systems. This boundary may be physical, referring to the connection, or logical, referring to the software instructions that allow the devices or systems to communicate.

interrupt
To stop execution of a program in such a way that execution can be resumed from the point at which it was stopped.

keyboard
A device that encodes data when keys are pressed.

keyword
An alphanumeric code that the computer recognizes as a function to be performed.

memory
Generally refers to the random access memory, RAM, used to store programs and data, as opposed to the read-only memory, ROM.

modem
A device that modulates and demodulates digital signals so that they can be transmitted through a data communication system (commonly over telephone lines). A DCE device.

operating system
Firmware that controls the execution of computer programs.

parameter
A quantity whose value affects the way program statements are executed.

parity bit
A check bit that may be appended to a byte transferred across the RS-232 interface. The parity bit is added to output bytes, and input bytes are checked to ensure that the appended bit has the expected value. Errors in parity can indicate transmission errors.

peripheral
Any equipment, aside from the computer itself, that can be attached to the computer to supply additional communications or facilities.

physical record
A collection of physical data (e.g., bytes on a disk) that may be treated as a unit.

polling
Interrogation of devices to determine status or to avoid contention.

port
An interface connection.

program
A series of instructions in a form understandable to a computer.

protocol
A code or precedence that must be strictly adhered to.

RAM
Random access memory. The memory used as temporary programs and data storage and workspace during program execution.

ROM
Read-only memory. That portion of the system memory that cannot be changed by the user. The 4041 BASIC operating system and firmware resides in ROM.

ROM pack
A portion of ROM supplied in a form that can be added to or removed from the 4041. It generally supplies additional instructions or features to the standard ROM.

record
A collection of related data or words that is treated as a unit.

routine maintenance
Actions that must be done at regular intervals, and that are designed to prevent faults from occurring.

scientific notation
A format representing numbers as a fractional part (or mantissa) and a power of 10. The number 123.4 is represented as 1.234E2.

serial transmission
Signals transmitted sequentially on one line. Bit serial transmission, for example, transfers each bit, one after the other, using the same line.

software
Instructions, procedures, and rules that the computer can understand and that concern the operation of the computer.

static-sensitive
Describes components, such as ROM chips, that may be damaged by slight static charges. Such charges may be carried by tools or fingers.

stop bit
A signal that indicates the end of a byte during bit-serial transmission.

switch
A device or program parameter for making a selection.

system
The computer, all attachments and peripheral devices, and software, that work together to accomplish a set of purposes.

terminal
A peripheral device that an operator can use to enter information and instructions into the computer and that can display information output from the computer. The RS-232 interface is frequently used to attach a terminal to a computer.

toggle
To switch between two settings or states.

user-definable function
A program option or routine that can be selected during program execution. The selection is made by pressing a user-definable function key on the system console.

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