TEKTRONIX®

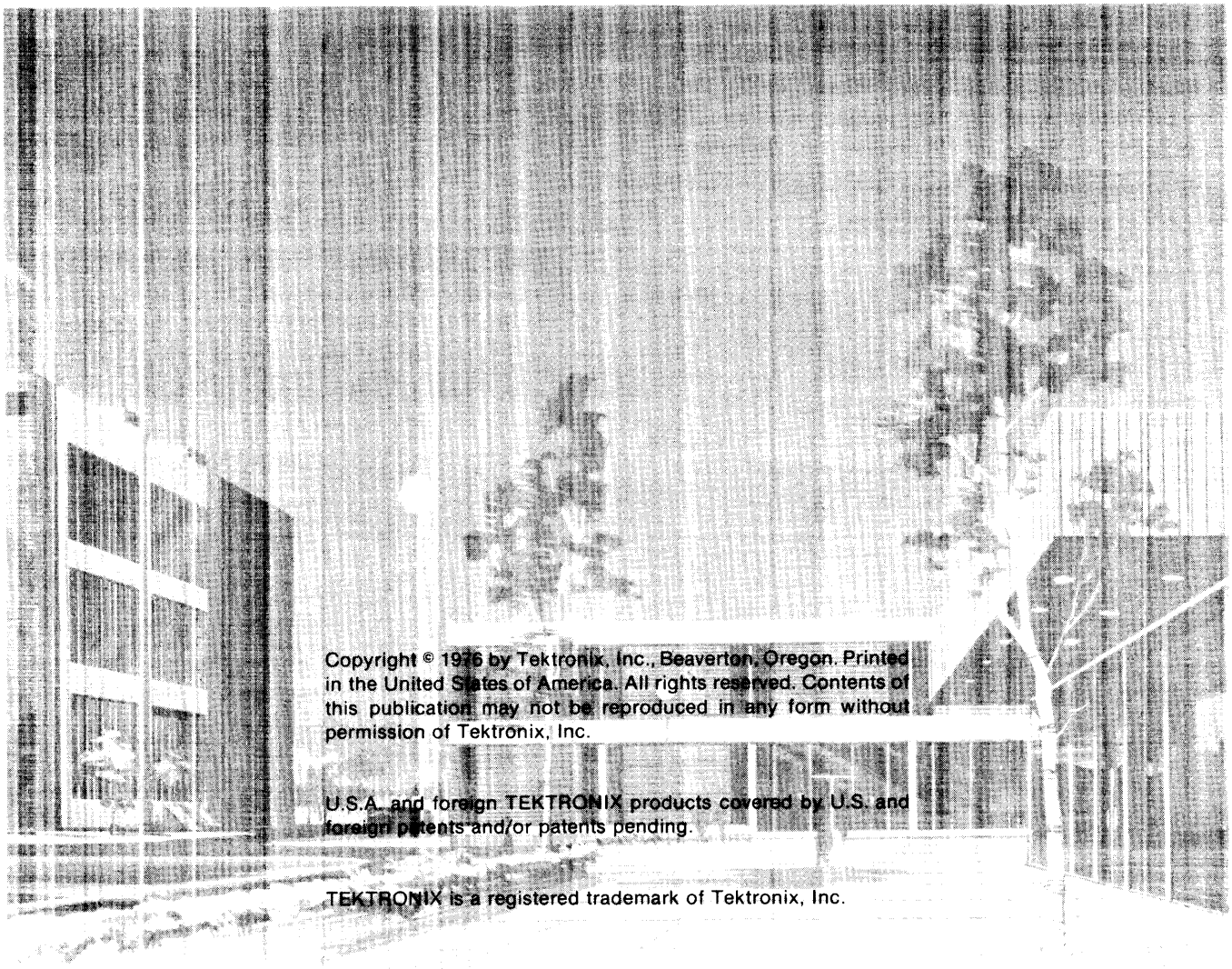
4924
DIGITAL CARTRIDGE TAPE DRIVE

OPERATORS

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

070-2128-00

First Printing SEP 1976



CONTENTS

CONTENTS (cont)

Section 2 OPERATION (cont) **Page**

CONTENTS (cont)

LIST OF ILLUSTRATIONS

LIST OF TABLES

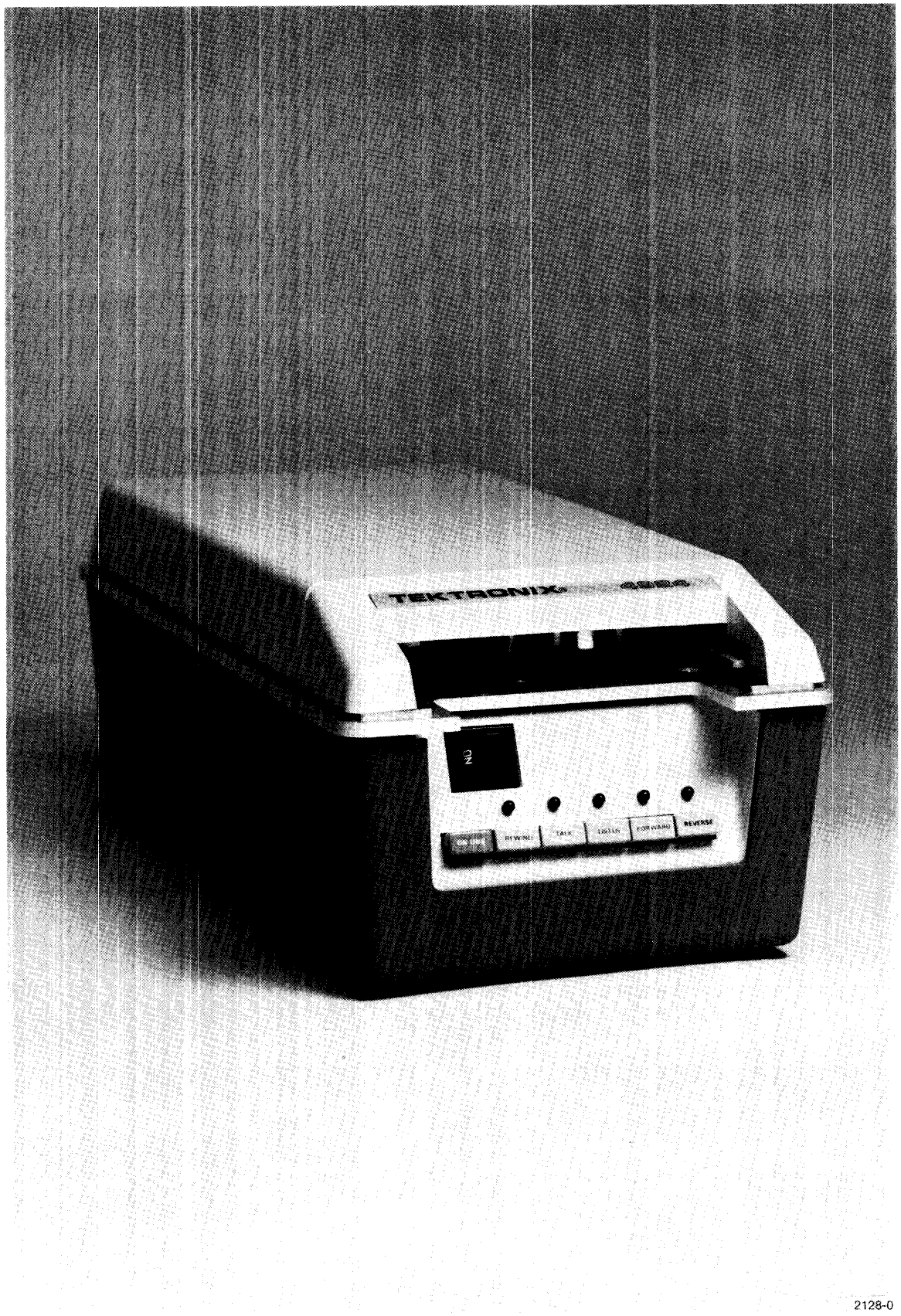


Fig. 1-1. 4924 Digital Cartridge Tape Drive.

Section 1
INTRODUCTION

GENERAL DESCRIPTION

The 4924 (Fig. 1-1) is a Digital Cartridge Tape Drive unit. By acting as a peripheral tape memory, it provides the capability for local storage of digitally-recorded data. The data is recorded on a 3M® DC-300-A type of data cartridge.

The 4924 is equipped with a GPIB (IEC)[1] interface for all input and output functions. This allows the 4924 to operate as an auxiliary storage device with systems that employ this type of interface. Such a system might include a system controller, such as a TEKTRONIX 4051 Graphic System, or might be a simpler instrumentation system containing only talkers and listeners. Refer to Appendix C for details on GPIB talkers and listeners.

There are two methods of controlling tape operations in the basic unit. One method employs commands issued over the GPIB. This method is typically used in GPIB systems that use a controller device, such as a TEKTRONIX 4051 Graphic System, to oversee system operation. The other control method employs front panel controls to perform basic tape operations. In addition, machines with Option 37 provide an alternate method of program-controlled operation. The operating method is selected by setting the front-panel ON LINE switch, and by the rear-panel switch on Option 37 units.

The methods of operating the 4924 are described in detail in the operation section of this manual.

SWITCHES and INDICATORS

Front-Panel Switches

With the exception of the POWER switch and the ON LINE switch, front-panel switches are used only when the unit is Off-Line to commands (not listening for them), in Manual mode. When the ON LINE switch is not depressed, the unit is in Manual mode. Refer to the Manual Operation discussion in the Operation section for details on the operation of the other switches.

[1]The GPIB Interface is defined in IEEE Standard 488-1975; IEEE Standard Digital Interface for Programmable Instrumentation. A description of interface characteristics is found in Appendix C.

POWER Switch. The POWER switch, when pressed to the right, applies power to the 4924 drive circuitry and internal electronics.

ON LINE Switch. The position of the ON LINE switch determines whether the 4924 is on-line (listening for commands on the GPIB), or off-line in Manual mode (responsive to front-panel controls only). When the switch is depressed, the unit is on-line.

Any time the condition of this switch is changed, an SRQ (Service Request) is generated.

Rear-Panel Switches

The Rear-Panel switches provide for selection of Device Address, Command Format, and Programmable Option status byte. These are described in further detail in the Installation section of this manual.

ACCESSORIES

Standard Accessories

Tape Cartridge (1)	
GPIB Interconnecting Cable, 2 meters long	012-0630-01
Operators Manual	070-2128-00

Optional Accessories

Tape Cartridges (package of five)	119-0680-01
Service Manual	070-2131-00
GPIB Interconnecting Cable, 3 meters long	012-0630-00

Section 2
OPERATION

ABOUT THIS SECTION

Operation of the standard 4924 falls into two basic categories, one using commands through the GPIB and one using front-panel controls. Option 37 units provide one more method of controlling the unit with commands through the GPIB. In addition, some operations (such as Loading the Tape Cartridge) are common to any operating system. This section is, therefore, divided into the four discussions listed below. Refer to the discussion appropriate for operation with the system to be used.

General Operation —	Operations common to any operating system (Loading the Cartridge, Cartridge care, etc.)
Program-Controlled — Operation using Secondary Address commands ("4051" Mode)	Operation with any system that uses Primary Addresses to address the device, followed by Secondary Addresses as commands (such as a system using the TEKTRONIX 4051 as a controller).
Program-Controlled — Operation using Alternate Format commands (Option 37, or "Alternate" Mode)	Operation with any system that uses separate primary addresses for commands and data, followed by a Command Verb to direct which operation is to take place. This optional mode is available only in Option 37 instruments.
Front-Panel Operation —	"Manual" operation using front panel controls, such as in a basic data-logging environment.

GENERAL OPERATION

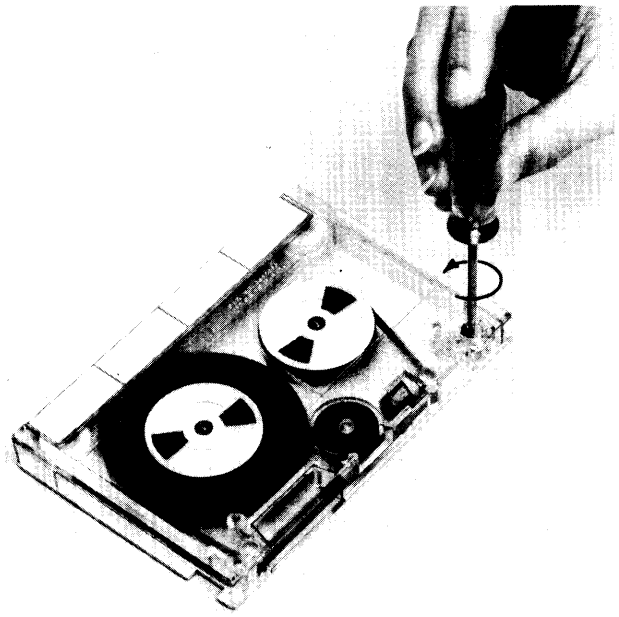
The following information pertains to the operation of the 4924 regardless of means of operation or the operating system.

APPLYING POWER

Power is applied to the 4924 using the POWER rocker switch on the front panel. Power is applied when the switch is pressed to the right.

ACTIVATING THE WRITE-PROTECT FEATURE

The cartridge has a screwdriver-activated Write-Protect feature built into the cartridge case as shown in Fig. 2-1. To Write-Protect a cartridge, use a screwdriver (or a coin) to turn the caret on the lockout plug to the SAFE position. This protects the cartridge from accidental erasure by writing over data on the cartridge. In this condition, the cartridge can be read in the normal manner, but may not be written upon.



1909-6

Fig. 2-1. Activating the Write-Protect feature.

INSTALLING THE TAPE CARTRIDGE

Insert the cartridge from the front of the unit (Fig. 2-2) pushing in against light spring resistance until the cartridge snaps forward into place. The protruding outer edges of the metal cartridge base serve as keys, to be aligned with the guide slots at the edges of the cartridge opening during insertion. Note that a cover over the head access opening in the tape cartridge opens automatically as the cartridge is inserted, and closes as the cartridge is removed.

ROUTINE MAINTENANCE

Occasional cleaning will preserve the appearance of the 4924. In addition, periodic cleaning of the Read/Write head is necessary to remove accumulations of oxide from the tape, along with other foreign matter, to prevent data errors which such deposits may cause.

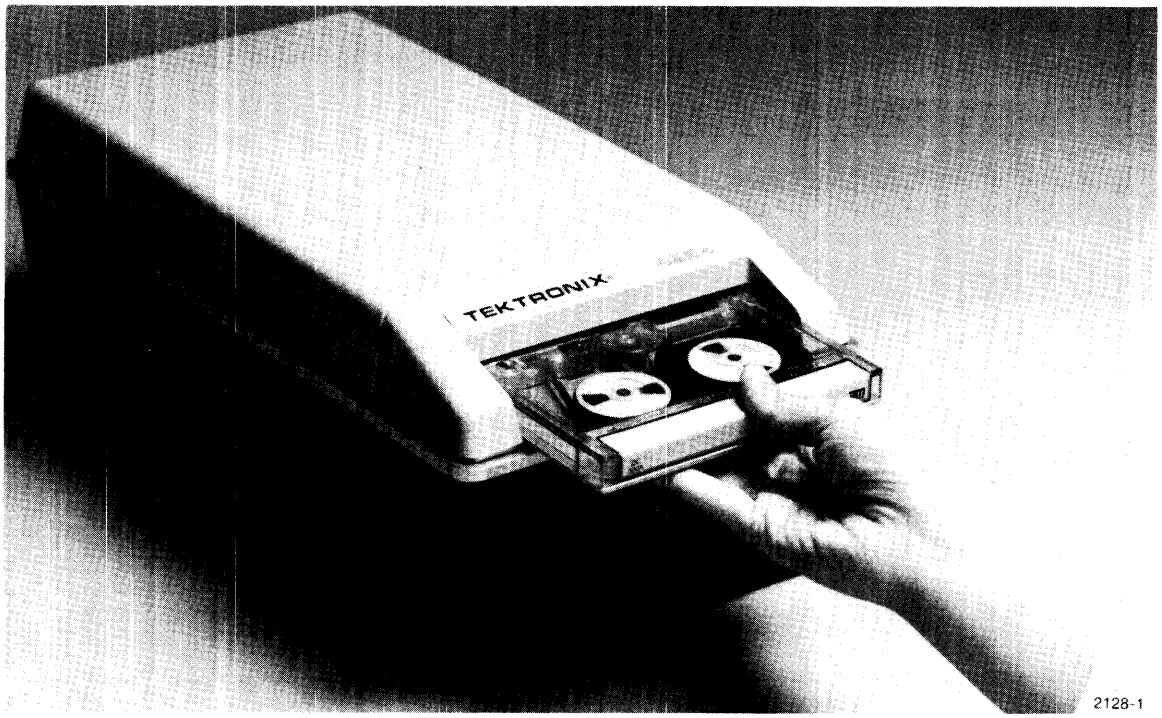


Fig. 2-2. Inserting the Tape Cartridge.

Cleaning the Case

The exterior of the unit may be cleaned by using the following procedure:

1. Turn the POWER switch off, then disconnect the power cord. Remove the cartridge, if one is installed.

2. Use a cloth dampened in a mild detergent solution to wash the upper and lower case. Abrasive cleaners (such as scouring power) and harsh chemicals must be avoided.

3. Wipe soap residue off with a clean damp cloth, then dry with a clean dry cloth.

4. Connect the power cord to the power source. The 4924 may again be operated normally.

Cleaning the Tape Head

The surface of the tape head (Fig. 2-3) must be kept clean in order to accurately read and write data to and from the tape. Tape head life and data reliability are directly related to Cartridge Care and tape head care. Oxide deposits from the tape, along with dust and other foreign particles, may be deposited on the tape head during operation. This alone may cause data errors by increasing the space between the tape and the head. In addition, these particles act as abrasives when propelled across the head by tape motion, thus increasing head wear and reducing head life.

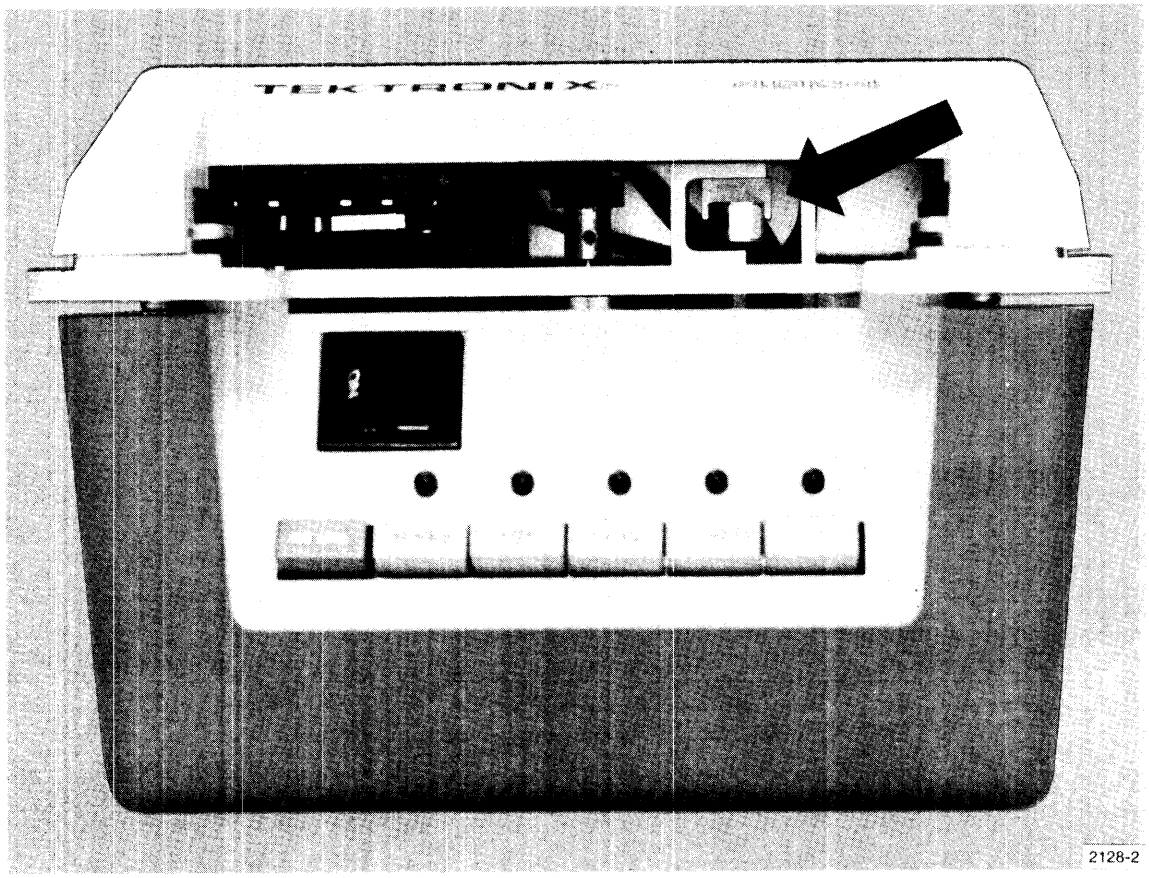


Fig. 2-3. Tape head location.

In order to minimize oxide and foreign matter accumulation, the tape head should be cleaned regularly. Frequency of cleaning depends upon frequency of use and upon the cleanliness of the area in which it is used. Recommended cleaning intervals are once weekly for units that are used moderately, to once daily for units that are used in areas where high foreign matter

accumulations occur. Cleaning may be required more frequently if data errors occur (indicated by rapid tape reversal and re-read). To clean the tape head, use the following procedure:

CAUTION

Do not use magnetic devices near the tape head. Do not contact the head with metal or other hard objects. To do so may damage the head and may result in damage to tape cartridges, resulting in lost data.

1. Inspect the head (Fig. 2-3) by shining a light, such as a penlight, across the surface of the head at an angle. This will reveal accumulations of foreign material, and will also reveal damage to the head. If the head is scratched, scored, or excessively worn (Fig. 2-4), it should be replaced. If the head is dirty, continue with this procedure.

2. Use a cotton swab moistened with isopropyl alcohol to rub off accumulated matter. Light accumulations of oxide will probably be readily removable, while heavy or long-term accumulations may require more cleaning with alcohol and clean swabs.

3. After removing the oxides and other foreign matter, use a clean, dry cotton swab to polish the head and remove alcohol residue.

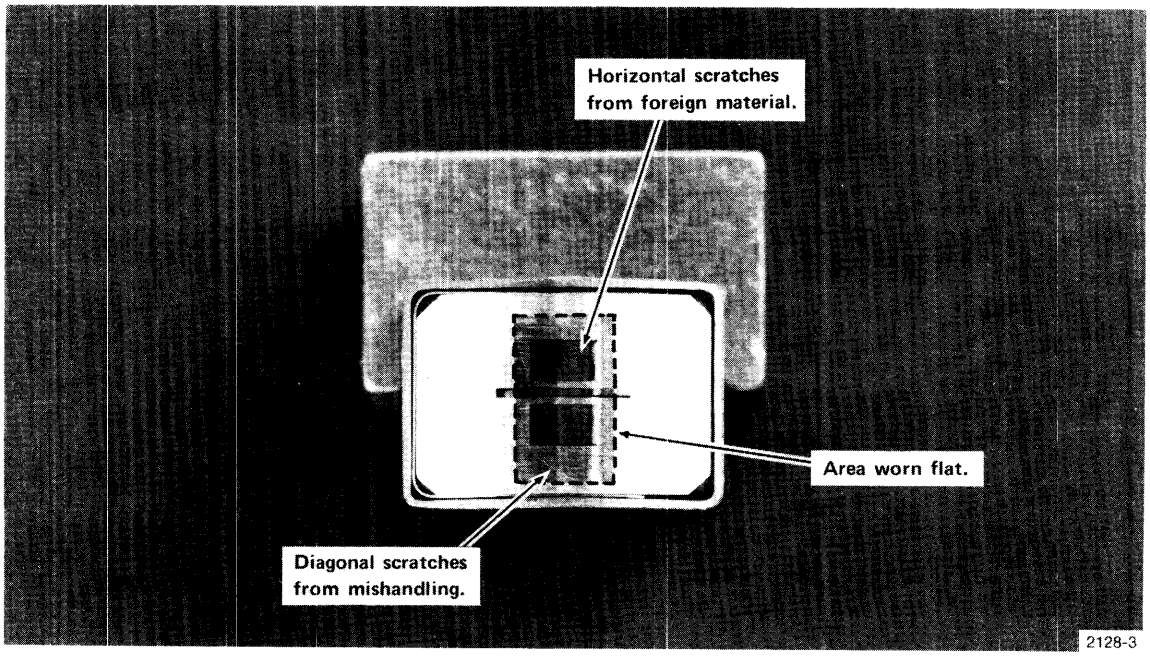


Fig. 2-4. Tape head damage.

Cartridge Care

Performance of the 4924 Digital Cartridge Tape Drive is partially dependent on the handling and care of the tape cartridge. Dust and other airborne contaminants can damage the tape and/or the tape head. The cartridge provides a door over the head access area, which is automatically opened and closed as the cartridge is inserted into or removed from the unit to prevent soiling of the tape. However, certain other precautions will aid in performance; they are as follows:

1. Keep the tape cartridge in a clean, dust-free area.

2. Do not allow the "windows" for the light-sensing mirrors (Fig. 2-5) to become soiled or dirty, as this may interfere with detection of the position markers (such as End-of-Tape). Under no circumstances should the windows be covered or coated.

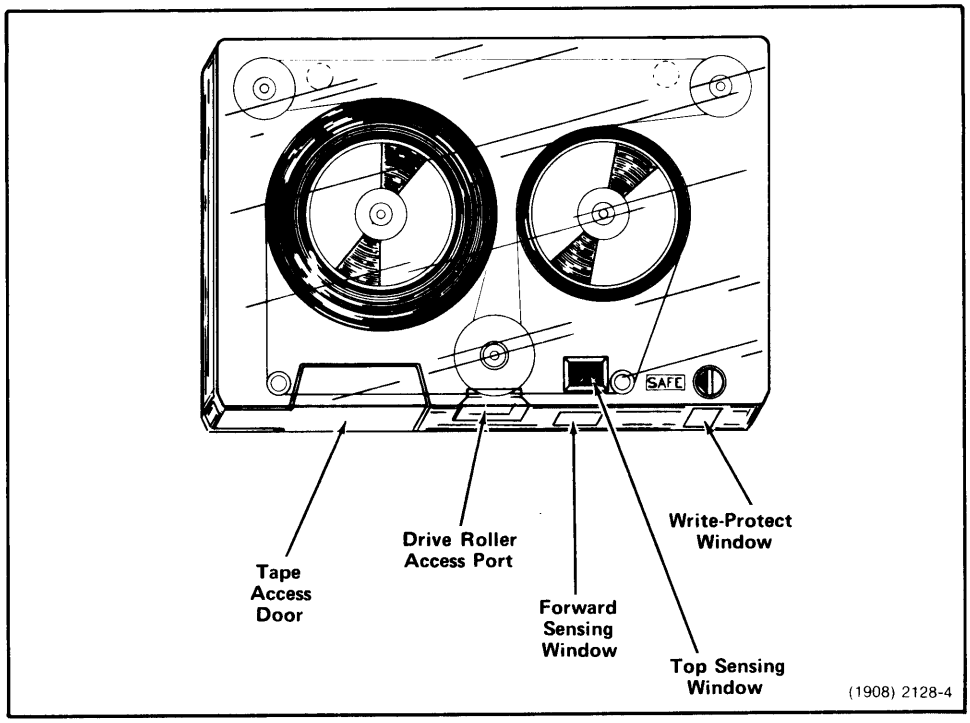


Fig. 2-5. Cartridge components.

3. Keep cartridges away from magnetic fields and from ferro-magnetic materials that might become magnetized. Strong magnetic fields can damage the magnetically-recorded data on the tape.

4. Use caution with cigarettes (cigars, pipes, etc.) around cartridges. Heat and contamination from a carelessly dropped ash can damage the tape and/or the Read/Write Head.

5. Do not expose the cartridges to heat or strong sunlight. (Environmental specifications are detailed in Appendix A.)

6. Do not leave the tape cartridge in the unit for extended periods when the unit is not in use (such as overnight). This could cause a temporary flat spot on the drive roller, which in turn causes the unit to be excessively noisy during the first few minutes of operation when the unit is operated again.

Cartridge Respooling

The data cartridge used in the 4924 is open-ended; that is, the tape ends are not secured to either of the spools. The unit relies on light-sensing of small holes at either end of the tape to stop tape motion before the physical end of the tape is reached. The tape may fail to stop in time (causing the tape to run off one of the spools) under certain conditions. These conditions are a possible circuit failure, a burned-out lamp, or an obstruction in the light path (such as a soiled cartridge or Lamp-Detector assembly). In the former cases refer to the optional Service Manual for circuit diagnosis; in the latter case, use the following procedure for respooling the cartridge. This *may* restore the tape to a readable condition.

1. Turn the cartridge over (metal side up) and remove the four screws that attach the metal base to the plastic cover (Fig. 2-6). Do not use a magnetic screwdriver.

2. Carefully remove the metal base plate, using caution not to lose the Write-Protect cylinder or the small metal spring between the cylinder and the metal base. Leave the plastic cover upside-down.

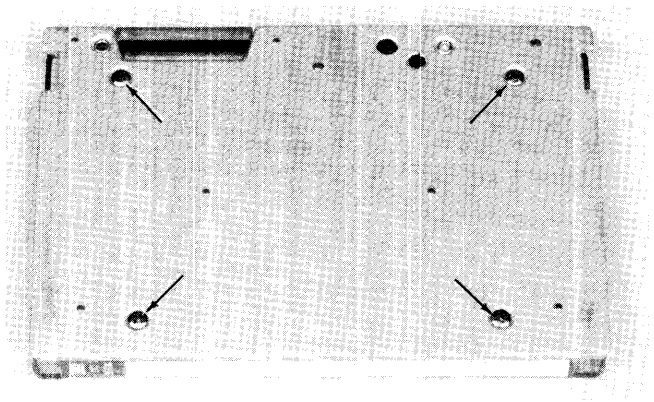


Fig. 2-6. Cartridge screws.

3. Place the loose end of the tape across the front of the cartridge, threading it through in front of the two guide posts. Now, keeping light tension on the tape, place the loose end of the tape around the outside edge of the take-up spool, to the point where the spool meets the tension band (Fig. 2-7).

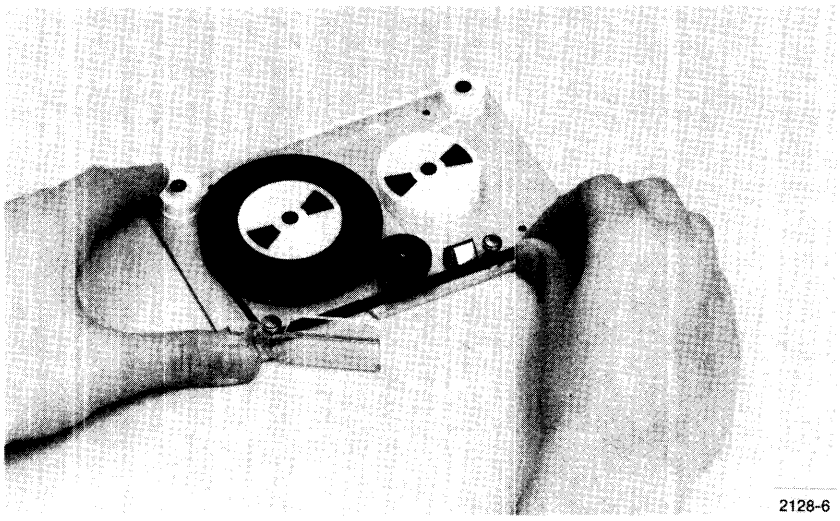


Fig. 2-7. Tape positioning within the cartridge.

4. Rotate the drive roller causing the tape to pass around the spool, with the loose end passing through the inside edge of the spool (Fig. 2-8). (Do not press down on the full spool.)

Fig. 2-8. Beginning the tape winding.

5. Hold the loose end of the tape against the spool, and continue to rotate the drive roller until the loose end passes under the continuing length of tape, then continue to rotate for a few more turns, until the first set of sensing holes is reached (Fig. 2-9). Make certain that these first windings stay evenly within the spool edges.

Fig. 2-9. Winding the tape.

6. Make certain that the Write-Protect cylinder is in position, with the spring washer between the cylinder and the metal cartridge base. Position the metal cartridge base over the plastic cover. Be careful not to catch and wrinkle the tape with the plastic case (Fig. 2-10). Install the four attaching screws.

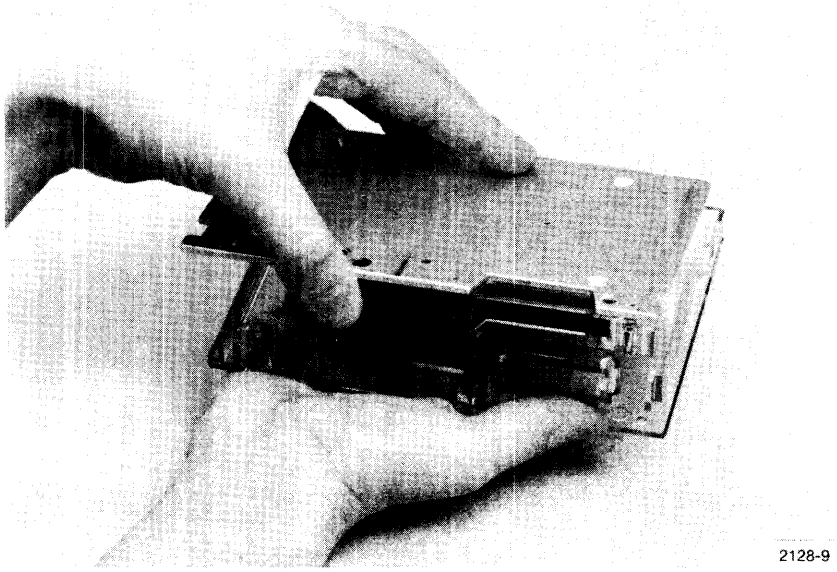


Fig. 2-10. Assembling the cartridge.

SUPPLEMENTAL INFORMATION

HEADER RECORDS

Header Records apply only to On-Line operation, not to Off-Line (manual) operation. A Header Record is the first physical record of each file. This record contains information about the contents of the file. This information, listed below, is automatically placed in the Header Record during record operations and checked during playback operations, as described in the operation descriptions.

File Number	The sequential number of the file from the beginning of the tape. The first file is 1.
File Type	The type of file. These can be ASCII, BINARY, NEW, or LAST.
File Usage	The storage usage of the file. These are normally PROGRAM or DATA; other usages such as LOG or TEXT are possible.
Secret	Records that a file has been marked SECRET, and causes "protection" as such. The program may be loaded and executed, appended, but cannot be listed or duplicated.
Records allocated	Records the number of physical records that were allocated by the MARK Command.

BINARY DATA

Binary data is transferred to and stored on the 4924 in a special form. Each binary item contains its own header which identifies the length of the item and the type. This header is generated by the talker sending the information, not by the 4924. The two-byte header is of the following form:

MSB							LSB	MSB							LSB
T3	T2	T1	L13	L12	L11	L10	L9	L8	L7	L6	L5	L4	L3	L2	L1
BYTE 1								BYTE 2							

T3, T2, T1 are the types of binary data, defined below.

L1 to L13 comprises the length of the item, including the header.

T3	T2	T1	TYPE	
0	0	0	Unassigned	Assume Binary for TYP command
0	0	1	Binary value	
0	1	0	Binary string	
0	1	1	Unassigned	
1	0	0	Unassigned	
1	0	1	Unassigned	
1	1	0	Unassigned	
1	1	1	EOF	

SERIAL-POLL STATUS BYTE

A serial poll occurs when a peripheral device issues an SRQ. The controller then polls specified devices to determine which one requested service. The status byte that is sent in response to a serial poll has the following form:

MSB LSB

8	7	6	5	4	3	2	1
UNUSED	SRQ	ERR	BUSY	ALT	LINE	EOT	EOF

The function described by each of these bits, when set, is described in Table 2-1.

Table 2-1

Serial-Poll Status Byte

BIT	NAME	FUNCTION
1	EOF	End of file has occurred.
2	EOT	End of tape has occurred.
3	Line*	4924 is on line.
4	Alt*	Command switch is in ALT (Option 37).
5	Busy	4924 is busy.
6	ERR	An error condition has occurred.
7	SRQ	4924 is requesting service.
8	-	Not used.

LOGICAL END-OF-FILE

The logical end-of-file character has all eight bits written as ones (hexadecimal FF). This must be avoided in undesired locations during recording as it has the effect of closing the file.

***Entering ALT mode in Option 37 units, or going Off-Line, will cause an SRQ to be generated.**

PROGRAM-CONTROLLED OPERATION USING SECONDARY ADDRESSES (4051 MODE)

This method of operating the 4924 may be employed in any system that can issue Primary Addresses to turn the 4924 logically on, followed by Secondary Addresses for commands and any qualifiers that might be required in conjunction with the command (a file number for instance). These address parameters and the qualifiers are issued over the GPIB as ASCII alphanumerics.

The general format of the commands (the sequence that must occur on the GPIB) is illustrated in Fig. 2-11. The Secondary Addresses used to control the 4924 are listed in Table 2-2.

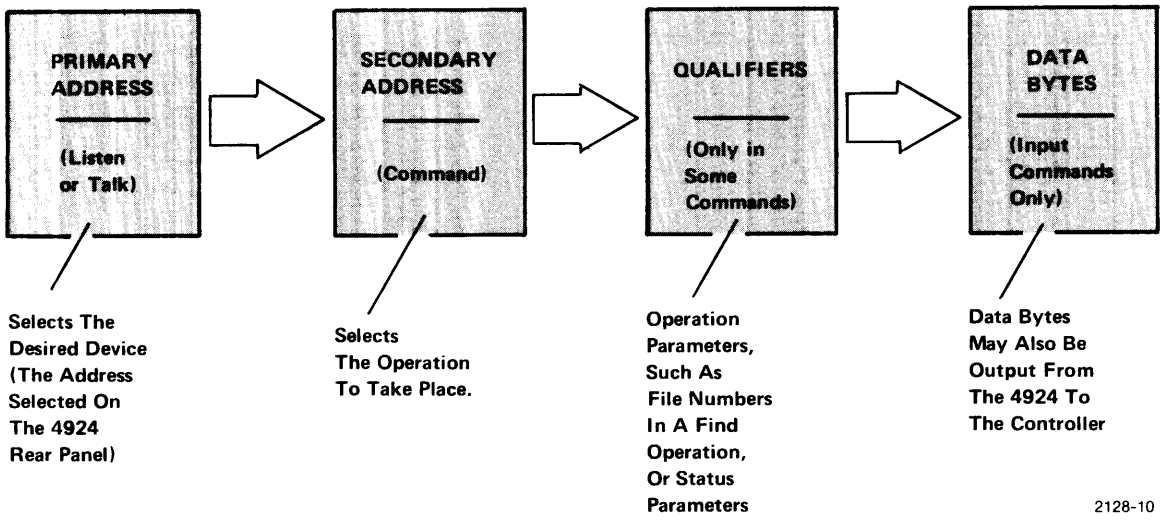


Fig. 2-11. GPIB command sequence using Secondary Address commands.

This method of operating the 4924 might typically be used when it is being operated as a peripheral device to the 4051 Graphic System. When used in this way, the 4924 simulates very closely the operation of the 4051 internal tape unit. By specifying (in the BASIC statement) the Primary Address selected for the 4924, the unit can be controlled in much the same way as the internal tape. This Primary Address change is all that is required to change tape operations to the 4924 when a BASIC keyword exists for the operation. (A BASIC keyword causes the Secondary Address for the operation to be issued over the GPIB automatically when a Primary Address for an external device is specified.) When no keyword exists, the Primary Address must be followed by a delimiter and the appropriate Secondary Address must be placed in the BASIC statement. These are, generally, the only changes required to perform tape operations on the 4924 in lieu of the 4051 internal tape.

Table 2-2 lists the 4924 commands, showing those for which keywords do and do not exist. If no keyword exists, an alternate statement may be used with the appropriate Secondary Address specified.

Further details on operating the 4924 in a system with the TEKTRONIX 4051 Graphic System are located in the 4051 Graphic System Reference Manual (070-2056-00), which describes the operation of the 4051 as a controller of GPIB peripherals such as the 4924. A list of 4051 examples is found at the end of this discussion, in Table 2-6.

Table 2-2

Commands and Secondary Addresses

COMMAND	SECONDARY ADDRESS	4051 BASIC Keyword
CLOSE	2	no
ERROR	30	no
FIND	27	yes
HEADER	9	no
INPUT	13	yes
KILL	7	yes
LISTEN	25	no
MARK	28	yes
OLD	4	yes
PRINT	12	yes
READ	14	yes
READ STATUS	0	no
SAVE	1	yes
SECRET	29	yes*
SET STATUS	0	no
TALK	26	no
TYPE	6	no
WRITE	15	yes

***Note that, although a BASIC keyboard exists for the SECRET command, the SECRET command operates somewhat differently in the 4924. Refer to the discussion of the SECRET command in this section.**

COMMAND VARIABLES

In the following descriptions of 4924 Operations, the command sequences are shown. The variables used in these sequences are defined as follows:

MLA — My Listen Address; the primary address used to address the 4924 to listen to the incoming data.

MTA	My Talk Address; the primary address used to address the 4924 to cause it to transmit data.
MSA	My Secondary Address; the secondary address, which may be used as the command to cause some operation to occur. For example MSA 12 is equivalent to secondary address 12, or a PRINT Command.
Delimiter	The delimiters are any character from the set ? = , ; CR (carriage return) and SPACE.

Further information on these variables may be found in IEEE 488-1975, which is the specification standard for the GPIB interface.

TAPE OPERATIONS AND COMMANDS

CLOSE Command

The CLOSE Command is used to close the file after a PRINT, SAVE, or WRITE operation. Most tape operations close automatically before they are executed; the CLOSE Command then becomes unnecessary. Data is stored in a buffer prior to be written onto the tape in records. The CLOSE Command is required to ensure that the last data transferred to the 4924, which may not have filled the buffer for the last record, is forced from the buffer onto the tape. A logical End-Of-File mark is then placed on the tape.

The secondary address (MSA) for the CLOSE Command is 2; it is output from the 4051 by using the PRINT statement with a secondary address of 2. The format is as follows:

(MLA) (MSA 2) (CR) (UNLISTEN)

ERROR Command

The ERROR Command causes the 4924 to return the error code (a numeric value) of the last error condition, if any. Execution of this command clears any pending SRQ that the 4924 has generated. (Note that all error conditions cause the 4924 to generate an SRQ. Refer to Error Conditions).

The errors indicated by the various numeric values (error codes) are shown in Table 2-3.

Table 2-3

4924 Error Messages

Error Code	Error Message
1	Domain Error or Invalid Argument
2	File Not Found
3	Mag Tape Format Error
4	Illegal Access
5	File Not Open
6	Read Error (10 re-reads)
7	No Cartridge Inserted
8	Over-read (illegal tape record length)
9	Write-protected
10	Read-After-Write Error
11	End of Medium
12	End of File

The secondary address (MSA) for the ERROR Command is 30. It is specified by using a secondary address of 30 in an INPUT statement. The format is as follows (italics represent data returned by the 4924):

(MTA) (MSA 30) (*Error Code*) (UNTALK)

FIND Command

The FIND Command transmits the requested file number, causing the 4924 to locate and open that file. The file number is represented as an ASCII number in floating-point or scientific notation. If the number is not roundable to an integer between 0 and 255, an error condition is generated. Before the search takes place, any open file is closed.

If the file number is zero, the tape will rewind. Any other valid number will cause the unit to search for that file. If the file is not found, an error condition is generated.

The secondary address (MSA) for the FIND Command is 27. This secondary address is automatically issued by the 4051 when a primary address (MLA) other than the default is used with the FIND Keyword. The format is as follows:

(MLA) (MSA 27) (File Number + CR) (UNLISTEN)

HEADER Command

The HEADER Command causes the 4924 to send an ASCII character string that reflects the header of the current file. If the file is open, it will be closed and its header transferred. If the file is closed, the next file is located and its header transferred. When the last file has been found, an end-of-tape condition is generated and the tape is rewound.

The secondary address (MSA) for the HEADER Command is 9. It is output from the 4051 by specifying the secondary address of 9 within an INPUT statement. The format is as follows (italics represent data returned by 4924):

(MTA) (MSA 9) (*Header*) (UNTALK)

INPUT Command

The INPUT Command causes the 4924 to transfer (input) data over the GPIB to the controller or another addressed listener device. The file header is checked prior to data transfer; if the header is not marked ASCII or if the file is not opened, an error condition is generated.

Once addressed as a talker to execute an INPUT operation, the 4925 continues to send data over the GPIB until it receives either the GPIB UNTALK or IFC (Interface Clear) command.

If the marked logical end of the tape file or the physical end of the tape is reached during execution of the INPUT Command, the EOF (End of File) character will be transferred over the GPIB along with the EOI line asserted. In addition, an EOF condition is generated.

The secondary address (MSA) for the INPUT Command is 13. This secondary address is issued automatically by the 4051 when a primary address (MTA) other than the default is used with the INPUT Keyword. The format is as follows (italics represent data returned from the 4924):

(MTA) (MSA 13) (*ASCII Data*) (UNTALK)

KILL Command

The KILL Command causes the 4924 to "wipe out" the specified magnetic tape file. Once killed, the tape file cannot be recovered; its header is marked "NEW".

The KILL Command transmits the requested file number to the 4924, causing the unit to initiate a high-speed search for that file. The file number can be a fractional number as long as it can be rounded to a positive integer between 1 and 255. When the file is found, the file header is marked NEW, making the file available for reassignment.

If the specified file does not exist, the tape rewinds and an error condition is generated.

The secondary address (MSA) for the KILL Command is 7. This secondary address is automatically issued by the 4051 when a primary address (MLA) other than the default is used with the KILL Keyword. The command format is as follows:

(MLA) (MSA 7) (File Number) (CR) (UNLISTEN)

LISTEN Command

The LISTEN Command causes the 4924 to write all incoming data into the current tape file. The header for that file is then marked ASCII LOG. The transfer continues until an EOI message is received by the 4924, unless the marked end of the file is reached first. If the end of the file is reached first, an EOF condition is generated.

The secondary address (MSA) for the LISTEN Command is 25. It is output from the 4051 using the WBYTE statement with the decimal equivalent of a secondary address of 25. The format is as follows:

(MLA) (MSA 25) (Data)

for example (assuming a GPIB address of "2"):

WBYTE @34,121:

when the controller has sent the desired data, the UNLISTEN Command must be issued.

MARK Command

The MARK Command is used to create tape files on the magnetic tape. These files must be created before programs or data can be stored on the tape. The MARK Command has two arguments, as follows:

Number—The number of files to be marked.

Size—The number of bytes of space to be reserved in each file.

Either argument may be an ASCII number in floating-point or scientific notation. The Number value must be roundable to an integer between 1 and 255, or an error condition is generated.

If the MARK Command causes the tape to pass the physical end of the tape, the MARK Command is terminated. In this case, the last file is not a valid file.

At the completion of the MARK Command, the 4924 will mark one additional file, and will mark the file header LAST. This file serves only as a place marker, and cannot be used for storage.

The secondary address (MSA) for the MARK Command is 28. This secondary address is automatically issued by the 4051 when a primary address (MLA) other than the default is used with the MARK Keyword. The format is as follows:

(MLA) (MSA 28) (NUMBER) (delim) (SIZE) (CR) (UNLISTEN)

OLD Command

The OLD Command causes the 4924 to transfer data from the current file over the GPIB to the controller or another addressed listener device. The file header is checked prior to data transfer; if the header is not marked ASCII or if the file is not opened, an error condition is generated.

Once addressed as a talker to execute an OLD operation, the 4924 continues to send data over the GPIB until it receives either the GPIB UNTALK or IFC (Interface Clear) command.

If the marked physical or logical end of the tape file is reached during execution of the OLD Command, the EOF (End of File) character will be transferred over the GPIB along with the EOI line asserted. In addition, an EOF condition is generated.

The secondary address (MSA) for the OLD Command is 4. This secondary address is automatically issued by the 4051 when a primary address (MTA) other than the default is used with the OLD Keyword. The format is as follows (italics represent data returned by the 4924):

(MTA) (MSA 4) (*ASCII Data*) (UNTALK)

PRINT Command

The PRINT Command causes the 4924 to write incoming data into the current marked tape file. Prior to writing into the file, the file header is checked to ensure that the file is not Binary or Secret. If the header is marked Binary or Secret, an error condition is generated. If the header is not marked Binary or Secret, the 4924 will mark it ASCII DATA, and the data will be written on to the tape.

Files are marked for a specific amount of space. If the physical end of the file is reached while data is being received, the file will be closed at its marked end, and an End of File (EOF) condition will be generated. The portion of the last record that was being received and that would not fit within the file is lost.
If the read-after-write condition had been established by setting the appropriate bit in the STATUS Command, the 4924 will read each record after it has been written onto the tape to ensure that it has been properly recorded. If after two tries the data is still incorrect, a write error is generated.

The secondary address (MSA) for the PRINT Command is 12; the secondary address is automatically issued by the 4051 when the PRINT Keyword is used with a specified primary address (MLA) other than the default. The command format is as follows:

(MLA) (MSA 12) (ASCII Data) (UNLISTEN)

READ Command

The READ Command, like the INPUT Command, causes the 4924 to transfer data from the current file over the GPIB to the controller or another addressed listener device. The file header is checked prior to data transfer; if the header is not marked BINARY or if the file is not opened, an error condition is generated.

Once addressed as a talker to execute an INPUT operation, the 4924 continues to send data over the GPIB until it receives either the GPIB UNTALK or IFC (Interface Clear) command.

If the marked physical or logical end of the tape file is reached during execution of the INPUT Command, the EOF (End of File) character will be transferred over the GPIB along with the EOI line asserted. In addition, an EOF condition is generated.

The Secondary Address (MSA) for the READ Command is 14. This secondary address is automatically issued by the 4051 when a primary address (MTA) other than the default is used with the READ Keyword. The format is as follows (italics represent data returned by the 4924):

(MTA) (MSA 14) (*Binary Data*) (UNTALK)

READ STATUS Command

The READ STATUS Command causes the 4924 to return its current programmable parameter settings. Four numeric variables are used to transfer the entire status. These variables are those set with the last SET STATUS Command, as shown in Table 2-4. The last returned variable will be a numeric value between 0 and 127, representing the interface status that would be sent during a Serial Poll.

The secondary address (MSA) for the READ STATUS Command is 0, and is output from the 4051 using the INPUT statement with a secondary address of 0. The format is as follows (italics indicate data returned by the 4924):

(MTA) (MSA 0) (*Status Parameters*) (UNTALK)

SAVE Command

The SAVE Command causes the 4924 to store all data being transmitted to it in the current marked tape file. Prior to writing into the file, the file header is checked to ensure that the header is marked NEW or ASCII. If the header is incorrect or the file is not opened, an error condition is generated. If the header is correct, it will be marked ASCII PROGRAM.

Files are marked for a specific amount of space. If the physical end of the file is reached before the file is closed that is, before a "logical end-of-file" is marked on the tape, an EOF condition will be generated. (The portion of the last record that was being received and that would not fit

within the file is lost. If the UNL (Unlisten) message or the EOI (End-or-Identify) message occurs prior to the physical end of the file, the 4924 will write a logical end-of-file mark onto the tape, thus closing the file.

If the read-after-write condition has been established by setting the appropriate bit in the STATUS Command, the 4924 will read each record after it has been written onto the tape to ensure that it has been correctly recorded, after two tries, if the data is not correct, a write error is generated.

The secondary address (MSA) for the SAVE Command is 1. This secondary address is automatically issued by the 4051 when a primary address (MLA) other than the default is used with the SAVE Keyword. The format is as follows:

(MLA) (MSA 1) (ASCII Data) (UNLISTEN)

SECRET Command

The SECRET Command causes the 4924 to mark the header of the current file as secret. If the header was not marked NEW or ASCII PROGRAM, an error condition is generated.

This command is valid only after a FIND Command and before a SAVE Command (when the file is open). This command is used to mark programs such that they may be saved and executed, but cannot be listed or saved again.

The secondary address (MSA) for the SECRET Command is 29. This secondary address is automatically issued by the 4051 when a primary address (MLA) other than the default is used with the SECRET Keyword. The format is as follows:

(MLA) (MSA 29) (File Number) (CR) (UNLISTEN)

The command sequences when using the SECRET Command in a system that uses the 4051 Graphic System as a controller are shown below. These sequences are necessary to inform the 4051 of the SECRET status, as well as the 4924. Note that once created, a secret file may only be APPENDed.

To Create	To Load
FIN @ Device Address: (File Number)	FIN @ Device Address: (File Number)
SEC @ Device Address:	SEC
SEC	(Line Number) REM line
SAV @ Device Address:	APP @ Device Address: (Line Number)

SET STATUS Command

The SET STATUS Command is used to set the programmable parameters of the 4924. The value (0 or 1) of each argument determines the setting of the programmable parameters, referred to here as A, B, C, D. The arguments are specified sequentially as part of the SET STATUS Command, as shown below. The SET STATUS parameters are shown in Table 2-4.

Table 2-4

SET STATUS Parameters

	Parameter			
Value	**A (First)**	**B (Second)**	**C (Third)**	**D (Fourth)**
0	256 bytes/record	Checksum	Header	No Read-After-Write
1	128 bytes/record	No Checksum	No Header	Read-After-Write

NOTE: Any value that is not zero implies a value of one. The default condition for the SET STATUS Command is all zeroes.

The secondary address (MSA) for the SET STATUS Command is 0, and is output from the 4051 using the PRINT statement with a secondary address of 0. The format is as follows:

(MLA) (MSA 0) (Status Parameters) (UNLISTEN)

TALK Command

The TALK Command causes the 4924 to transmit the entire contents of the current file (which must be an ASCII file) to any device listening on the GPIB. When the last byte in the file is transferred, the EOI message is generated and the operation is terminated. The EOF condition is also generated.

The secondary address for the TALK Command is 26. It is output from the 4051 using the WBYTE statement as described in the 4051 Graphic System Reference manual, with the decimal equivalent of a secondary address of 26. The format is as follows (italics indicate data returned by the 4924):

(MTA) (MSA 26) (*Data*)

For example (assuming a GPIB address of "2"):

```
WBYTE @66,122
```

when the controller has received the desired data (either the whole file or some desired portion), the UNTALK Command must be issued.

TYPE Command

The TYPE Command causes the 4924 to return an integer from 0 through 4. This integer indicates the type of data stored as the next data item in the current tape file.

There are two arguments in the TYPE Command used to request two variables that the 4924 returns. The first variable (A) returns an integer that indicates the type of the next data on tape. The values of the first variable are shown in Table 2-5. The second variable returns the length of the next item if it is Binary, otherwise a zero is returned.

Table 2-5

Type Values

0	Empty (new) File or File Not Open
1	End-of-File Character
2	ASCII File (Numeric or Character String)
3	Binary Numeric Data
4	Binary Character String

The secondary address for the TYPE Command is 6, and is output from the 4051 using the INPUT statement with a secondary address of 6. The format is as follows (italics indicate data returned by the 4924):

(MTA) (MSA 6) (*Type Number*) (*delim*) (*Item Length*) (*delim*) **(UNTALK)**

WRITE Command

The WRITE Command causes the 4924 to write incoming data into the current marked tape file. Prior to writing into the file, the file header is checked to ensure that the file is marked NEW or BINARY DATA. If the header is correct, the data is written onto the tape. If the header is marked other than NEW or BINARY DATA, an error condition is generated.

Files are marked to contain a specific amount of space. If the physical end of the marked file space is reached while data is being received, the file will be closed and an End of File (EOF) condition will be generated. The portion of the last record that was being received and that would not fit within the file will be lost.

If the read-after-write condition has been established by setting the appropriate bit in the STATUS Command, the 4924 will read each record after it has been written onto the tape to ensure that it has been properly recorded. If after two tries the data is still incorrect, a write error is generated.

The Secondary Address (MSA) for the WRITE Command is 15; this secondary address is issued automatically by the 4051 when a primary address (MLA) other than the default is used with the WRITE Keyword. The command format is as follows:

(MLA) (MSA 15) (Binary Data) (UNLISTEN)

Table 2-6

SUMMARY OF 4051 OPERATING COMMANDS FOR THE 4924

COMMAND	EFFECT
FIND @1:5	Positions the 4924 tape to the beginning of file 5.
PRINT @1: N	Transfers the value assigned to N to the 4924 in ASCII format. The data is recorded on the tape starting at the present tape position.
WRITE @1: N	Transfers the value assigned to N to the 4924 in binary format. The data is recorded on the tape starting at the present tape position.
INPUT @1: A$	Transfers the contents of the current 4924 tape file to the space allocated to A$, which must be dimensioned to accept the amount in the file. In this example, the data is in character string form.
INPUT @1: N	Transfers the contents of the current 4924 tape file to the space allocated to N. In this example, the data is in numeric form.
WBYTE @33,121:	The LISTEN command. This command causes the 4924 to write data that appears on the GPIB to the current tape file. 25 is the secondary address for the LISTEN command. After the data has been sent, an UNLISTEN command is required (WBYTE @63:).
MARK @1:1,2000	Causes the 4924 to mark one file 2000 bytes long, beginning at the present tape location.
KILL @1:5	Causes the 4924 to execute a high-speed search for file 5. When file 5 is found, its header is marked NEW, and the information located in the file cannot be recovered. This makes file 5 available for re-assignment.
PRINT @1,2:	The CLOSE command. This closes the current file on the 4924; it is normally used during a PRINT, WRITE, or SAVE operation. 2 is the secondary address for the CLOSE command.
SAVE @1:	A copy of the BASIC program currently in 4051 memory is transferred to the 4924. The program is recorded beginning at the current tape position.
OLD @1:	Causes the BASIC program at the present tape location to be transferred into the 4051 Random Access Memory.

Table 2-6 (cont)

COMMAND	EFFECT
READ @1:A$	Causes the 4924 to transfer the contents of the current tape file to the space allocated to A$. A$ must be dimensioned to accept the amount in the file (8192 bytes maximum); the data must be in machine dependent binary code.
WBYTE @66,122:	The TALK command. This command causes the 4924 to transfer the contents of the current tape file over the GPIB to any listening device(s). 26 is the secondary address for the TALK command. After data transfer, an UNTALK is required (WBYTE @95:).
INPUT @1,6:A,B	The TYPE command. This causes the 4924 to return an integer from 0 through 4, indicating whether the next item in a binary data file is numeric data, character string data, or an end-of-file mark. 6 is the secondary address for the TYPE command.
INPUT @1,30:A	The ERROR command. This causes the 4924 to return the error code of the last error condition, if any in variable A.
INPUT @1,9:A$	The HEADER command. This causes the 4924 to return an ASCII character string that reflects the header of the current file in A$.
PRINT @1,0: 0,0,0,0	The SET STATUS command. The four zeroes separated by commas set the status parameters; in this case, 256-byte records with checksum and headers and no read-after-write. 0 is the secondary address for the STATUS command.
INPUT @1,0: A,B,C,D	The READ STATUS command. This command causes the 4924 to return four integers (0 or 1) to the specified variables. These represent the status parameters presently in effect. 0 is the secondary address for the STATUS command.
SECRET @1:	Causes the 4924 to mark the header of the current file secret.
SEC	Informs the 4051 that the file is secret.
SAV @1:	Transfers the current program to the 4924 as a secret program after SECRET is set.

The above commands all assume that the 4924 is set to a Primary Address of 1.

OPERATION OF OPTION 37 UNITS: PROGRAM-CONTROLLED OPERATION USING PRIMARY ADDRESSES AND COMMAND VERBS (Alternate Mode)

This method of operating the 4924 is available in units that have Option 37 installed. It may be employed in any system that can issue one Primary Address for commands (CPA), another for data (DPA), and a Command Verb to determine the operation to take place. The command string received at the CPA may contain qualifiers that may be required in conjunction with the command (a file number, for instance). These Address parameters, Command Verbs, and qualifiers are issued over the GPIB as ASCII alphanumerics.
The general format of the commands is shown in Table 2-7, and further detailed in the description of each command. The sequence is illustrated in Fig. 2-12.

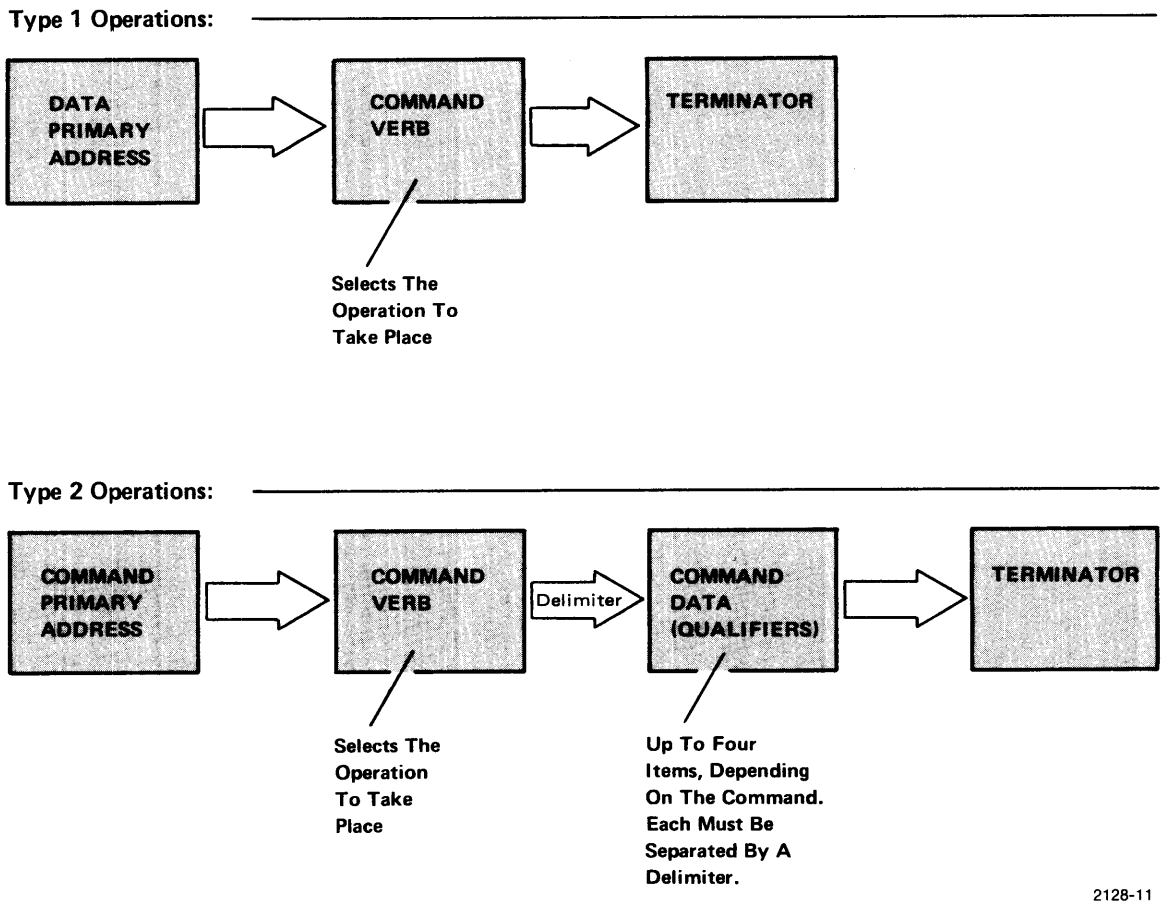


Fig. 2-12. GPIB Command Sequence using Alternate Mode commands.

This operation format uses two separate Primary Addresses, a CPA and a DPA. The addresses are defined by the address select switches (the sum of five address bits) on the rear panel. For the DPA, the low order bit is defined as a zero regardless of the switch position; likewise; for the CPA, the low order bit is defined to be a one. For example, a DPA of 2 implies a CPA of 3. A CPA of 1 and a DPA of 30 are not allowed, as their corresponding DPA and CPA are out of the allowable range of 1 through 30.

Table 2-7

ALTERNATE FORMAT COMMAND SEQUENCES

COMMAND	Command Verb	De-limiter	Command Data	De-limiter	Command Data	Termi-nator
Type 1 commands:						
INPUT	I					*
LISTEN	L					*
OLD	O					*
PRINT	P					*
READ	R					*
SAVE	S					*
TALK	Z					*
WRITE	W					*
Type 2 commands:						
CLOSE	C					*
ERROR	E					*
FIND	F	*	*			*
HEADER	H					*
KILL	K	*	*			*
MARK	M	*	*	*	*	*
READ STATUS	Y					*
SECRET	X					*
SET STATUS	Q	*	*[1]			*
TYPE	T					*

When using the CPA, command strings are received. The command string is an ASCII character string that contains a Command Verb followed by optional delimiter(s), command data, and a terminator.

The Command Verb is an undefined-length string of ASCII characters from the set A-Z and a-z. Only the first character of the verb is recognized as a command; if the first character is not a recognized Command Verb, it is discarded and the next character is checked.

The delimiters are defined as any character from the set:

? = , ; CR (Carriage Return) and SPACE

The Command Data is any valid ASCII representation of a number (such as a file number) in either fixed or floating point form. The terminator is always a Carriage Return (CR).

[1]**Four data items are needed, either Ø or 1 separated by commas.**

COMMAND TYPES

The commands to operate the 4924 using this format fall into two categories, Type I and Type II. Type I commands use the CPA to set the operation, then use the DPA to transmit data. Type II commands always communicate using the CPA. In a Type I command, the first part (set up using the CPA) is stored in the 4924 until the second part is received. Any number of Type II operations may be performed between the set up (CPA) part and the data transfer (DPA) part of the Type I command. The commands (CPA and DPA) have the letter L or T inserted to denote if it is a Listen or Talk operation, respectively.

TAPE OPERATIONS AND COMMANDS

CLOSE Command

The CLOSE Command is used to close the file after a PRINT, SAVE, or WRITE operation. Most tape operations close automatically before the data is written onto the tape; the CLOSE Command then becomes unnecessary. Data is stored in a buffer prior to being written onto the tape in records. The CLOSE Command is required to ensure that the last data transferred to the 4924, which may not have filled the buffer for the last record, is forced from the buffer onto the tape. A logical End-Of-File mark is then placed on the tape.

The command verb (CV) for the CLOSE Command is C; the command format is as follows:

(CPLA) (C) (CR) (UNLISTEN)

ERROR Command

The ERROR Command causes the 4924 to return the error code (a numeric value) of the last error condition, if any. Execution of this command clears any pending SRQ that the 4924 has generated. (Note that all error conditions cause the 4924 to generate an SRQ. Refer to Error Conditions).

The errors indicated by the various numeric values (error codes) are shown in Table 2-8.

Table 2-8
4924 Error Messages

Error Code	Error Message
1	Domain Error or Invalid Argument
2	File Not Found
3	Mag Tape Format Error
4	Illegal Access
5	File Not Open
6	Read Error (10 re-reads)
7	No Cartridge Inserted
8	Over-read (more than 256 bytes in the buffer)
9	Write-protected
10	Read-After-Write Error
11	End of Medium
12	End of File

The Command Verb (CV) for the ERROR Command is E. The command format for the ERROR Command is as follows (italics indicate data returned by the 4924):

(CPLA) (E) (CR) (UNLISTEN) (CPTA) (*Error Code CR*) **(UNTALK)**

FIND Command

The FIND Command transmits the requested file number, causing the 4924 to locate and open that file. The file number is represented as an ASCII number in floating-point or scientific notation. If the number is not roundable to an integer between 0 and 255, an error condition is generated. Before the search takes place, any open file is closed.

If the file number is zero, the tape will rewind. Any other valid number will cause the unit to search for that file. If the file is not found, an error condition is generated.

The Command Verb for the FIND Command is F. The command format is as follows:

(CPLA) (F) (Delimiter) (File Number) (CR) (UNLISTEN)

HEADER Command

The HEADER Command causes the 4924 to send an ASCII character string that reflects the header of the current file. If the file is open, it will be closed and its header transferred. If the file is closed, the next file is located and its header transferred. When the last file has been found, an end-of-tape condition is generated and the tape is rewound.

The Command Verb (CV) for the HEADER Command is H. The command format is as follows (italics indicate data returned by the 4924):

(CPLA) (H) (CR) (UNLISTEN) (CPTA) (*File Header + CR*) **(UNTALK)**

INPUT Command

The INPUT Command causes the 4924 to transfer (input) data over the GPIB to the controller or another addressed listener device. The file header is checked prior to data transfer; if the header is not marked ASCII or if the file is not opened, an error condition is generated.

Once addressed as a talker to execute an INPUT operation, the 4924 continues to send data over the GPIB until it receives either the GPIB UNTALK or IFC (Interface Clear) command.

If the marked logical end of the tape file is reached during execution of the INPUT Command, the EOF (End of File) character will be transferred over the GPIB along with the EOI line asserted. In addition, an EOF condition is generated.

The Command Verb (CV) for the INPUT Command is I. The command format is as follows (italics indicate data returned by the 4924):

(CPLA) (I) (CR) (UNLISTEN) (DPTA) (*ASCII Data*) **(UNTALK)**

KILL Command

The KILL Command causes the 4924 to "wipe out" the specified magnetic tape file. Once killed, the tape file cannot be recovered.

The KILL Command transmits the requested file number to the 4924 causing the unit to initiate a high-speed search for that file. The file number can be specified as a numeric expression as long as the expression can be rounded to a positive integer between 1 and 255. When the file is found, the file header is marked NEW, making the file available for reassignment.

If the specified file does not exist, the tape rewinds and an error condition is generated.

The Command Verb (CV) for the KILL Command is K. The command format is as follows:

(CPLA) (K) (Delimiter) (File number) (CR) (UNLISTEN)

LISTEN Command

The LISTEN Command causes the 4924 to write all incoming data into the current tape file. The header for that file is then marked ASCII LOG. The transfer continues until an EOI message is received by the 4924, unless the physical end of the file space is reached first. If the end of the file is reached first, an EOF condition is generated.

The Command Verb (CV) for the LISTEN Command is L. The format is as follows:

(CPLA) (L) (CR) (DPA) (Data) (UNLISTEN)

MARK Command

The MARK Command is used to create tape files on the magnetic tape. These files must be created before programs or data can be stored on the tape. The MARK Command has two arguments, as follows:

NUMBER — The number of files to be marked.

SIZE — The number of bytes of space to be reserved in each file.

Either argument may be an ASCII number in floating-point or scientific notation. The NUMBER value must be roundable to an integer between 1 and 255, or an error condition is generated.

If the MARK Command causes the tape to pass the physical end of the tape, the MARK Command is terminated. In this case, the last file is not a valid file.

At the completion of the MARK Command, the 4924 will mark one additional file, and will mark the file header LAST.

The Command Verb (CV) for the MARK Command is M. The command format is as follows:

(CPLA) (M) (Delimiter) (Number) (Delimiter) (Size) (CR) (UNLISTEN)

OLD Command

The OLD Command causes the 4924 to transfer data from the current file over the GPIB to the controller or another addressed listener device. The file header is checked prior to data transfer; if the header is not marked ASCII or if the file is not opened, an error condition is generated.

Once addressed as a talker to execute an OLD operation, the 4924 continues to send data over the GPIB until it receives either the GPIB UNTALK or IFC (Interface Clear) command.

If the marked physical end of the tape file is reached during execution of the OLD Command, the EOF (End Of File) character will be transferred over the GPIB along with the EOI line asserted. In addition, an EOF condition is generated.

The Command Verb (CV) for the OLD Command is O. The format is as follows (italics indicate data returned by the 4924):

(CPLA) (O) (CR) (UNLISTEN) (DPTA) (*ASCII Program*) (UNTALK)

PRINT Command

The PRINT Command causes the 4924 to write incoming data into the current marked tape file. Prior to writing into the file, the file header is checked to ensure that the file is not Binary or Secret. If the header is marked Binary or Secret, and error condition is generated. If the header is not marked Binary or Secret, the 4924 will mark it ASCII Data, and the data will be written onto the tape.

Files are marked for a specific amount of space. If the physical end of the file is reached while data is being received, the file will be closed at its marked end, and an End of File (EOF) condition will be generated. The portion of the last record that was being received and that would not fit within the file is lost.

If the read-after-write condition has been established by setting the appropriate bit in the STATUS Command, the 4924 will read each record after it has been written onto the tape to ensure that it has been properly recorded. If after two tries the data is still incorrect, a write error is generated.

The Command Verb (CV) for the PRINT command is P. The command format is as follows:

(CPLA) (P) (CR) (UNLISTEN) (DPLA) (ASCII Data) (UNLISTEN)

READ Command

The READ Command, like the INPUT Command, causes the 4924 to transfer data from the current file over the GPIB to the controller or another addressed listener device. The file header is checked prior to data transfer; if the header is not marked BINARY or if the file is not opened, an error condition is generated.

Once addressed as a talker to execute an INPUT operation, the 4924 continues to send data over the GPIB until it receives either the GPIB UNTALK or IFC (Interface Clear) command.

If the marked physical end of the tape file is reached during execution of the INPUT Command, the EOF (End of File) character will be transferred over the GPIB along with the EOI line asserted. In addition, an EOF condition is generated.

The Command Verb (CV) for the READ Command is R. The format is as follows (italics indicate data returned by the 4924):

(CPLA) (R) (CR) (UNLISTEN) (DPTA) (*Binary Data*) **(UNTALK)**

READ STATUS Command

The READ STATUS Command causes the 4924 to return its current programmable parameter settings. Four numeric variables are used to transfer the entire status. These variables are those set with the last SET STATUS Command, as shown in Table 2-9.

The Command Verb (CV) for the READ STATUS Command is Y. The command format is as follows (italics indicate data returned by the 4924):

(CPLA) (Y) (CR) (UNLISTEN) (CPTA) (*Status Parameters CR*) **(UNTALK)**

SAVE Command

The SAVE Command causes the 4924 to store all data being transmitted to it in the current marked tape file. Prior to writing into the file, the file header is checked to ensure that the header is marked NEW or ASCII. If the header is incorrect or the file is not opened, an error condition is generated. If the header is correct, it will be marked ASCII PROGRAM.

Files are marked for a specific amount of space. If the physical end of the file is reached before the file is closed, an EOF condition will be generated. (The portion of the last record that was being received and that would not fit within the file is lost. If the UNL (Unlisten) message occurs prior to the physical end of the file, the 4924 will write a logical end-of-file mark onto the tape and close the file.

If the read-after-write condition has been established by setting the appropriate bit in the STATUS Command, the 4924 will read each record after it has been written onto the tape to ensure that it has been correctly recorded. After two tries, if the data is not correct, a write error is generated.

The Command Verb (CV) for the SAVE Command is S. The format is as follows:

(CPLA) (S) (CR) (UNLISTEN) (DPLA) (Data) (UNLISTEN)

SECRET Command

The SECRET Command causes the 4924 to mark the header of the current file as secret. If the header was not marked NEW or ASCII PROGRAM, an error condition is generated.

This command is valid only after a FIND Command and before a SAVE Command (when the file is open). This command is used to mark programs such that they may be saved or executed, but cannot be listed or saved again.

The Command Verb (CV) for the SECRET Command is X. The command format for the SECRET Command is as follows:

(CPLA) (X) (CR) (UNLISTEN)

SET STATUS Command

The SET STATUS Command is used to set the programmable parameters of the 4924. The value (0 or 1) of each argument determines the setting of the programmable parameters, referred to here as A, B, C, D. The arguments are specified sequentially as part of the SET STATUS Command, as shown below. The SET STATUS parameters are shown in Table 2-9.

Table 2-9

SET STATUS Parameters

	Parameter			
Value	**A (First)**	**B (Second)**	**C (Third)**	**D (Fourth)**
0	256 bytes/record	Checksum	Header	No Read-After-Write
1	128 bytes/record	No Checksum	No Header	Read-After-Write

NOTE: Any value that is not zero implies a value of one. The default condition for the SET STATUS Command is all zeroes.

The Command Verb (CV) for the SET STATUS Command is Q. The command format is as follows:

(CPLA) (Q) (Delimiter) (Status Parameters*) (CR) (UNLISTEN)

***The Status Parameters, described above, are four data items that must be a 0 or a 1 separated by commas or other delimiters.**

TALK Command

The TALK Command causes the 4924 to transmit the entire contents of the current file to any device listening on the GPIB. When the last byte in the file is transferred, the EOI message is generated and the operation is terminated. If the function is ended prior to the file end (such as by pressing the front panel STOP button), the file is closed.

The Command Verb (CV) for the TALK Command is Z. The format is as follows (italics indicate data returned by the 4924):

(CPLA) (Z) (CR) (UNLISTEN) (DPTA) (*Data*) (UNTALK)

TYPE Command

The TYPE Command causes the 4924 to return an integer from 0 through 4. This integer indicates the type of data stored as the next data item in the current tape file.

There are two arguments in the TYPE Command used to request two variables that the 4924 returns. The first variable (A) returns an integer that indicates the type of the next data on tape. The values of the first variable are shown in Table 2-10. The second variable returns the length of the next item if it is Binary, otherwise a zero is returned.

Table 2-10
Type Values

0	Empty (new) File or File Not Open
1	End-of-File Character
2	ASCII File (Numeric or Character String)
3	Binary Numeric Data
4	Binary Character String

The Command Verb (CV) for the TYPE Command is T. The command format is as follows (italics indicate data returned by the 4924):

(CPLA) (T) (CR) (UNLISTEN) (CPTA) (*Type number*) (UNTALK)

WRITE Command

The WRITE Command causes the 4924 to write incoming data into the current marked tape file. Prior to writing into the file, the file header is checked to ensure that the file is marked NEW or BINARY DATA. If the header is correct, the data is written onto the tape. If the header is marked other than NEW or BINARY DATA, an error condition is generated.

Files are marked to contain a specific amount of space. If the physical end of the marked file space is reached while data is being received, the file will be closed and an End Of File (EOF) condition will be generated. The portion of the last record that was being received and that would not fit within the file will be lost.

If the read-after-write condition has been established by setting the appropriate bit in the STATUS Command, the 4924 will read each record after it has been written onto the tape to ensure that it has been properly recorded. If after two tries the data is still incorrect, a write error is generated.

The Command Verb (CV) for the WRITE Command is W. The format is as follows:

(CPLA) (W) (CR) (UNLISTEN) (DPLA) (Data) (UNLISTEN)

MANUAL OPERATION

The 4924 is in Manual mode whenever the ON LINE switch on the front panel is not depressed. When the unit goes into Manual mode, an SRQ is generated. While in this mode, the unit does not recognize commands that occur on the GPIB, but can respond to front-panel manual controls. This allows the unit to perform data-logging functions while not under program control. (Note: tapes to be used in Manual mode must be pre-marked.)

The switches that are activated, and the associated operation, are described in the following paragraphs.

REWIND

This switch, when depressed, causes the 4924 to rewind the tape. The LED indicator above the switch will be on until the tape is rewound. Any open file will be closed.

TALK

This switch, when pressed places the 4924 in the TALK Mode. The LED indicator above the switch will remain illuminated until the entire file is transmitted. If no listeners are on the GPIB, the operation is terminated.

TALK Mode causes the 4924 to transmit the entire contents of the current file to any device listening on the GPIB. When the last byte in the file is transferred, the EOI message is generated and the operation is terminated and the LED goess off. If the function is ended prior to the file end, the file is closed.

LISTEN

The switch, when pressed, places the 4924 in the LISTEN Mode. The LED indicator above the switch will remain on until the file is closed. If the physical end-of-file is reached, the file will be closed but no EOF condition will be generated. If no other devices are on the GPIB, the operation is terminated.

LISTEN Mode causes the 4924 to write all incoming data into the current tape file. The header for that file is then marked ASCII LOG. The transfer continues until an EOI message is received by the 4924, unless the physical end of the file space is reached first. If the end of the file is reached first, an EOF condition is generated.

SKIP FORWARD

Depressing this switch will cause the 4924 to find the next sequential file. The corresponding indicator will remain on until the file is found. If the 4924 finds the last file in this manner, further depressions of this switch will be ignored. Any open file will be closed before the file is skipped. If an unmarked tape is used, the tape will run to the end of the tape and stop.

SKIP BACK

Depressing this switch will cause the 4924 to find the preceding sequential file. The corresponding indicator will remain on until the file is found. If the 4924 finds the first file in this manner, further depressions of this switch will be ignored. Any open file will be closed before the file is skipped.

STATUS SELECT

On the rear panel of the 4924, two rocker switches define the status byte in Off-Line Mode. These two switches have three different selections, which are described in the Installation section.

The switch settings and their meanings are shown in Table 2-11.

Table 2-11

Status Switch Selections

SWITCH 1	SWITCH 2	MEANING
OFF	OFF	PROGRAMMABLE
OFF	ON	4051
ON	OFF	4923
ON	ON	PROGRAMMABLE

Section 3
INSTALLATION

GENERAL INFORMATION

This section describes installation of the 4924 into a GPIB system. This information includes interconnecting information, Line Voltage Selection, AC Power Requirements, and Switchable Options.

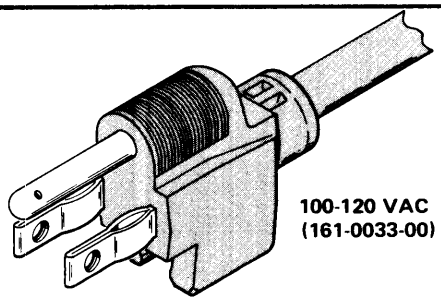
LINE VOLTAGE SELECTION

CAUTION

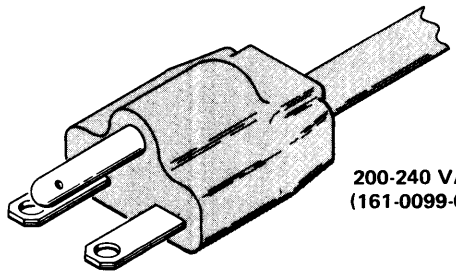
The 4924 is intended to operate on a single phase power source which has one of its current-carrying conductors (grounding) connected to Safety Earth (ground potential). Operation from other power sources which have both current-carrying conductors live with respect to ground (such as phase-to-phase on a multi-phase system or across the legs of a 117-234 volt single-phase three-wire system) is not recommended since only the line conductor has over-current (fuse) protection within the instrument.

The unit is designed to operate on a 115 or 230 volt nominal line voltage source with a frequency of 50 to 60 Hz. In addition, any of several voltage ranges for the 115 or 230 Vac may be selected.

The ac power connector is a three-wire polarized plug with one lead connected directly to the instrument frame to provide electric shock protection. Connect this plug only to a three-wire outlet which has a safety ground. If the unit is connected to any other power source, the 4924 frame must be connected to a safety ground system. The connector configuration and color coding is shown in Fig. 3-1. Replace the power cord only with another of the same polarity.



100-120 VAC
(161-0033-00)



200-240 VAC
(161-0099-00)

LINE	(UNGROUNDED)	BLACK (USA & CANADA), BROWN for IEC
NEUTRAL	(GROUNDED)	WHITE (USA & CANADA), BLUE for IEC
SAFETY EARTH	(GROUNDING)	GREEN WITH YELLOW STRIPE

Fig. 3-1. USA standard power cord plugs.

The appropriate line voltage is selected by the use of jumpers on the Power Supply within the 4924. To select a line voltage other than the factory-wired selection shown on the rear panel, turn off power to the 4924 and disconnect the power cord, then proceed with the following instructions.

REMOVING AND REPLACING THE COVER

WARNING

Dangerous voltages exist at several places inside the unit, unless the power cord is disconnected from the power source. (If the POWER switch is off, power may still be applied to the switch or transformer connections unless the power cord is disconnected.)

1. Turn the 4924 over, resting it on the unit's top. Remove the four screws that attach both the unit's feet and the bottom cover (Fig. 3-2) then remove the bottom cover. This is the only procedure necessary prior to changing line voltage selection. To complete the operation, place the unit upright on a work area, then proceed to selecting Line Voltages.

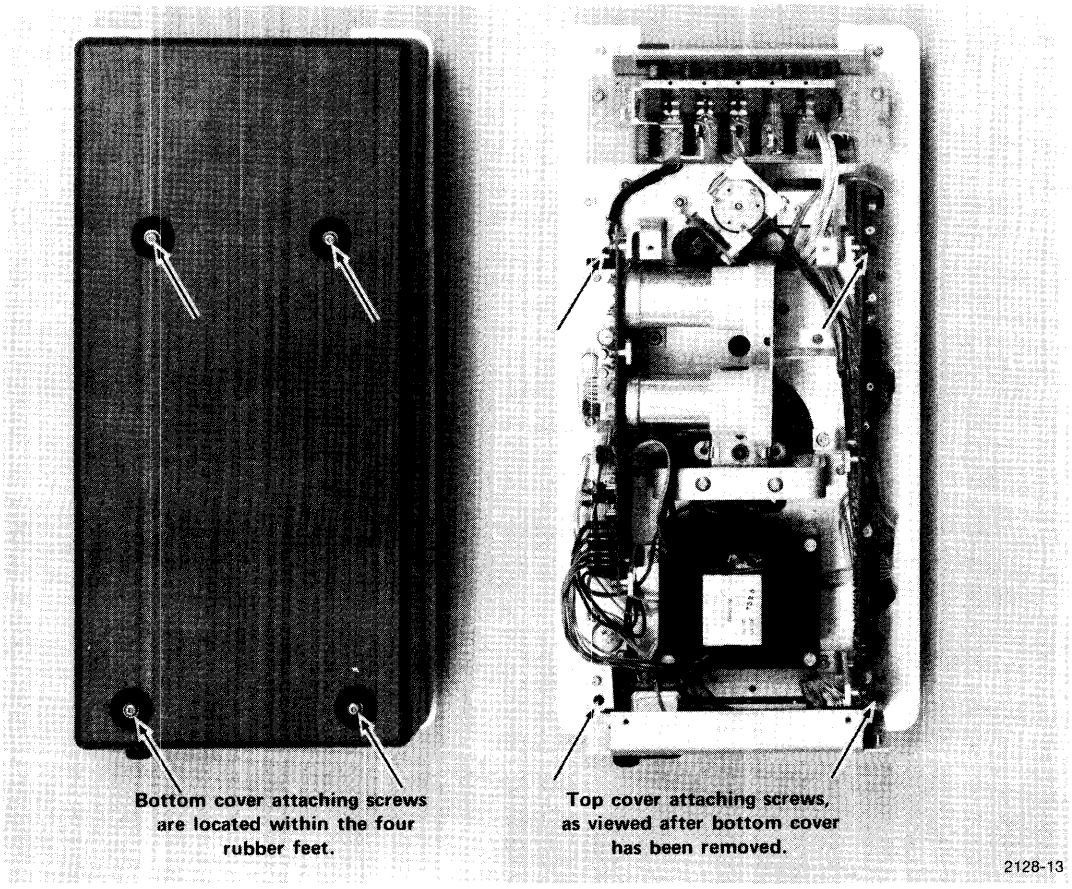


Fig. 3-2. Cover attaching screws.

2. If the top cover is to be removed, leave the unit on its top. Remove the four black internal screws that attach the top cover (Fig. 3-2), then lift the chassis out of the top cover and place it upright on a work area.

3. To replace the covers on the unit, turn the chassis over, place it back into the top cover, then follow steps 1 and 2 in reverse order.

SELECTING LINE VOLTAGES

The 4924 is designed to operate from a 115 volt nominal line voltage source that has a frequency of 50 to 60 Hz. In addition, any of three voltage ranges for 115 Vac may be selected. Voltage, current and range limitations are listed in Table 3-1.

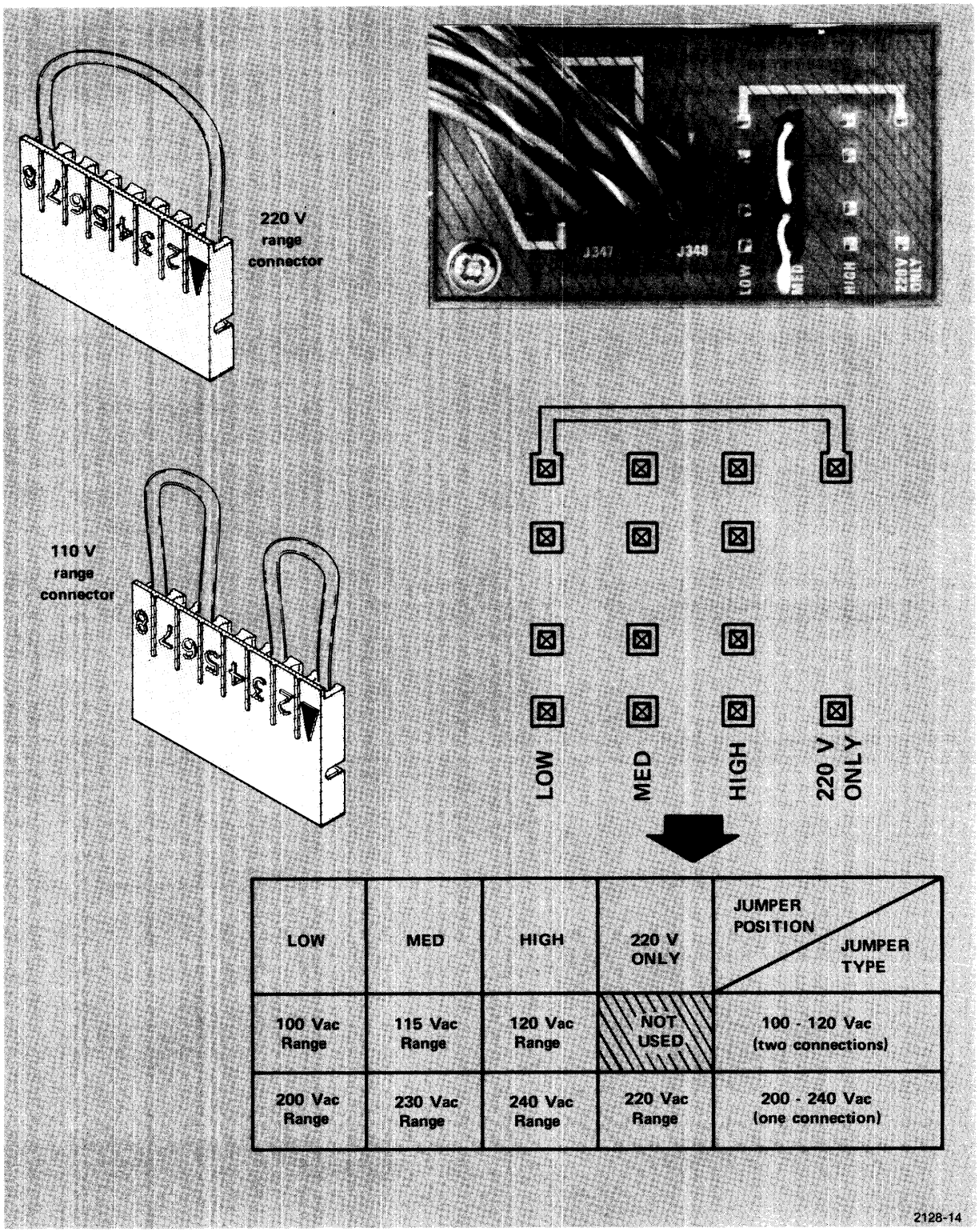
Table 3-1

4924 Operating Voltages

Nominal Voltage	Tol-erance	Voltage Range	Fre-quency	Line Fuse Value
100 Vac	±10%	90 to 110 Vac	50 to 60 Hz	1.0 A slow-blow
115 Vac		104 to 126 Vac		
120 Vac		108 to 132 Vac		
200 Vac		180 to 220 Vac		0.6 A slow-blow
220 Vac		198 to 242 Vac		
230 Vac		207 to 253 Vac		
240 Vac		216 to 264 Vac		

A fuse change and a transformer jumper arrangement permit the 4924 to be modified to suit the voltage supply. A tag on the back panel identifies the internal voltage setting for which the unit is wired when shipped from the factory. If the jumper arrangement is changed for any reason (changing the internal voltage setting) cross out the old setting and attach a tag with the new setting in its place.

The line voltage selection strap is located on the lower left side of the unit on the Power Supply board. To change line voltage selection, position the strap to the desired location. The jumper location is shown, and the various jumper positions explained, in Fig. 3-3. An alternate jumper connecting only the two outside pins, is used to select line voltages in the 220 Vac ranges.



LOW	MED	HIGH	220 V ONLY	JUMPER POSITION / JUMPER TYPE
100 Vac Range	115 Vac Range	120 Vac Range	NOT USED	100 - 120 Vac (two connections)
200 Vac Range	230 Vac Range	240 Vac Range	220 Vac Range	200 - 240 Vac (one connection)

Fig. 3-3. Line Voltage selection.

AC Power Cord and Grounding Requirements

This instrument has a three-wire power cord with a three-wire terminal polarized plug for connection to the power source and safety earth. See Fig. 3-4 for USA standard plugs. The safety earth terminal of the plug is directly connected to the instrument frame for electric-shock protection. Insert this plug only in a mating outlet with a safety earth contact or otherwise connect the frame of the unit to a safety earth system. The color coding of the cord conductors is in accordance with recognized standards, as shown. In other jurisdictions, replace the USA standard plug with a plug that satisfies local authorities. Replace the cord only with another cord of the same polarity.

Line Voltage Fuse

There is one line voltage fuse, located on the 4924 back panel (Fig. 3-4). This fuse is a 1.0 A slow-blow fuse for operation in the 100-120 Vac range. It is changed to a 0.6 A slow-blow fuse for operation in the 200-240 Vac range.

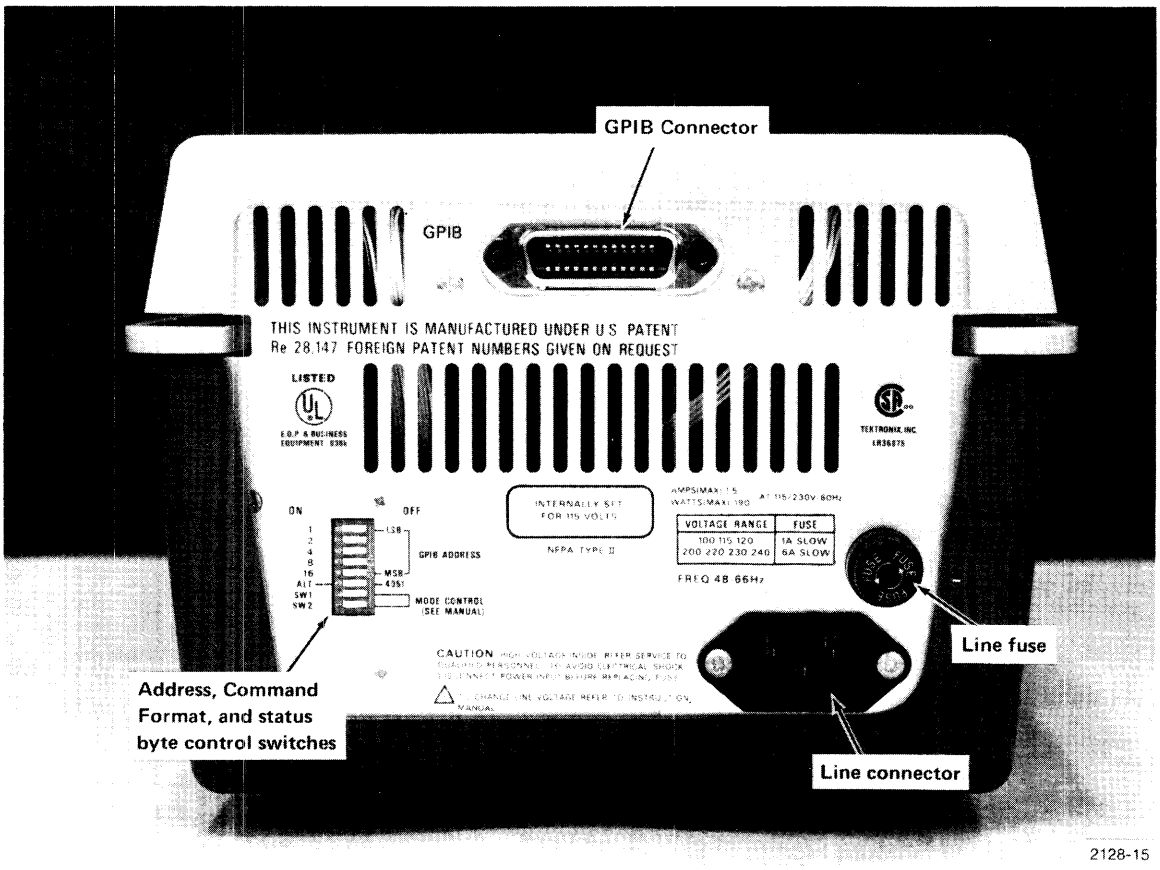


Fig. 3-4. Rear panel components.

INSTALLING THE 4924 IN A GPIB SYSTEM

Installing the 4924 in a General Purpose Interface Bus (GPIB) system requires selection for the available line voltage (described earlier), connection to the appropriate power outlet, selection of the desired switchable options, and connection to the General Purpose Interface Bus.

The standard GPIB Interconnecting cable allows devices to be linked together sequentially or branched out from a central controller, as shown in Fig. 3-5. Connect the GPIB cable between the 4924 and the controller (or other GPIB device) as shown in Fig. 3-6. A 4051 Graphic System is shown as a controller in the example.

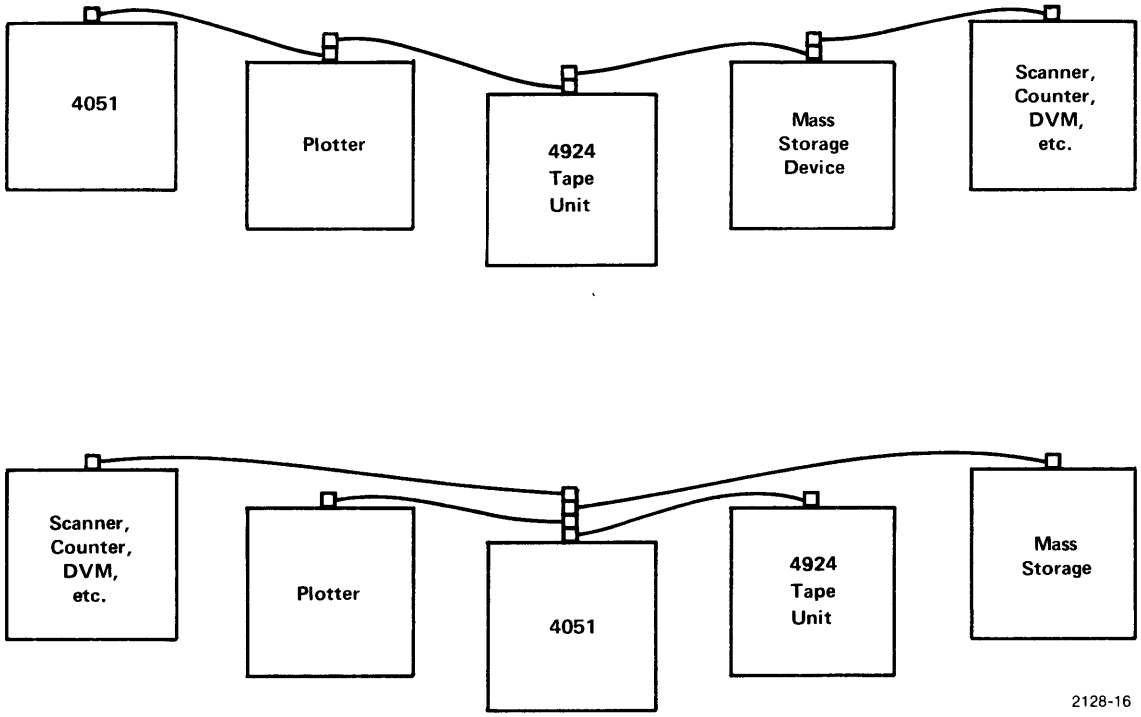


Fig. 3-5. GPIB system configurations.

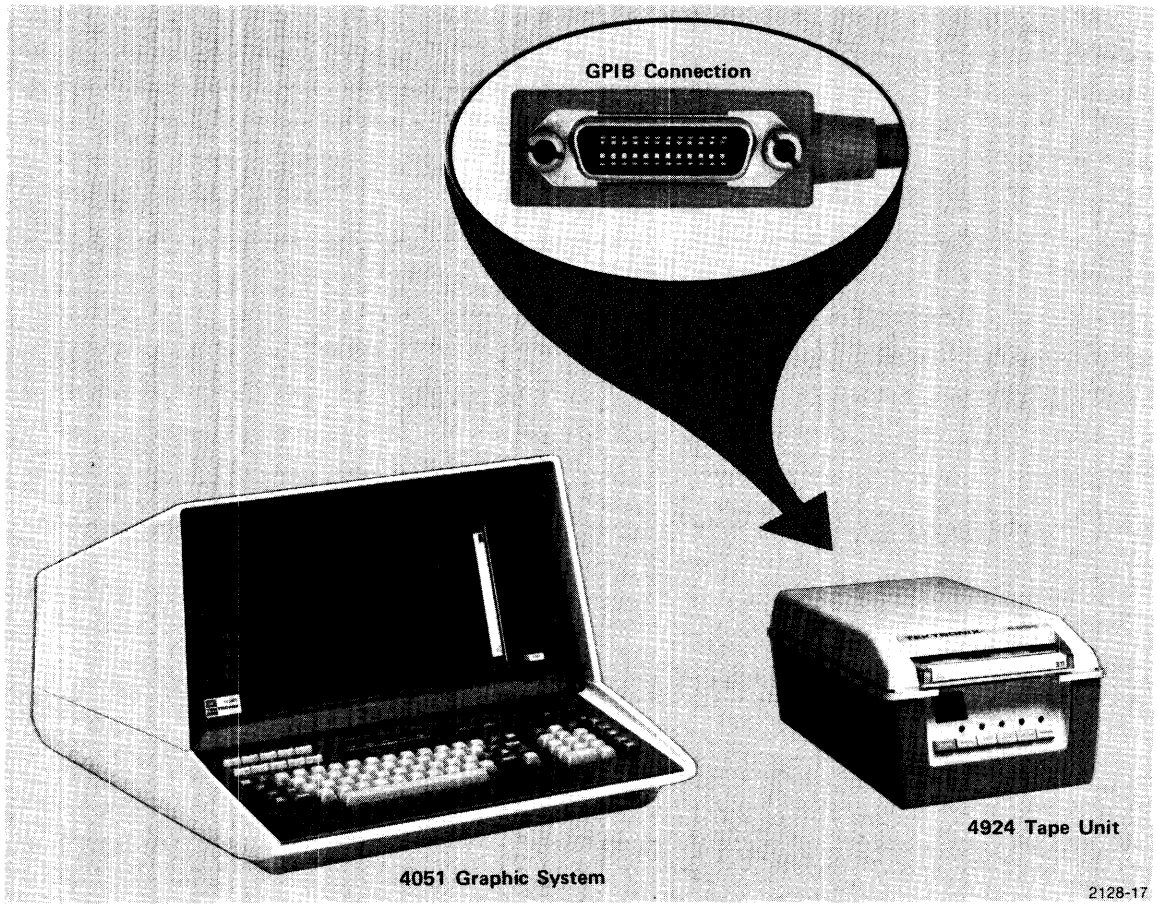


Fig. 3-6. GPIB connection.

SWITCH OPTIONS

A series of eight small rocker switches on the rear panel of the 4924 (Fig. 3-7) control a number of selectable parameters for the unit. These parameters are described in the following paragraphs.

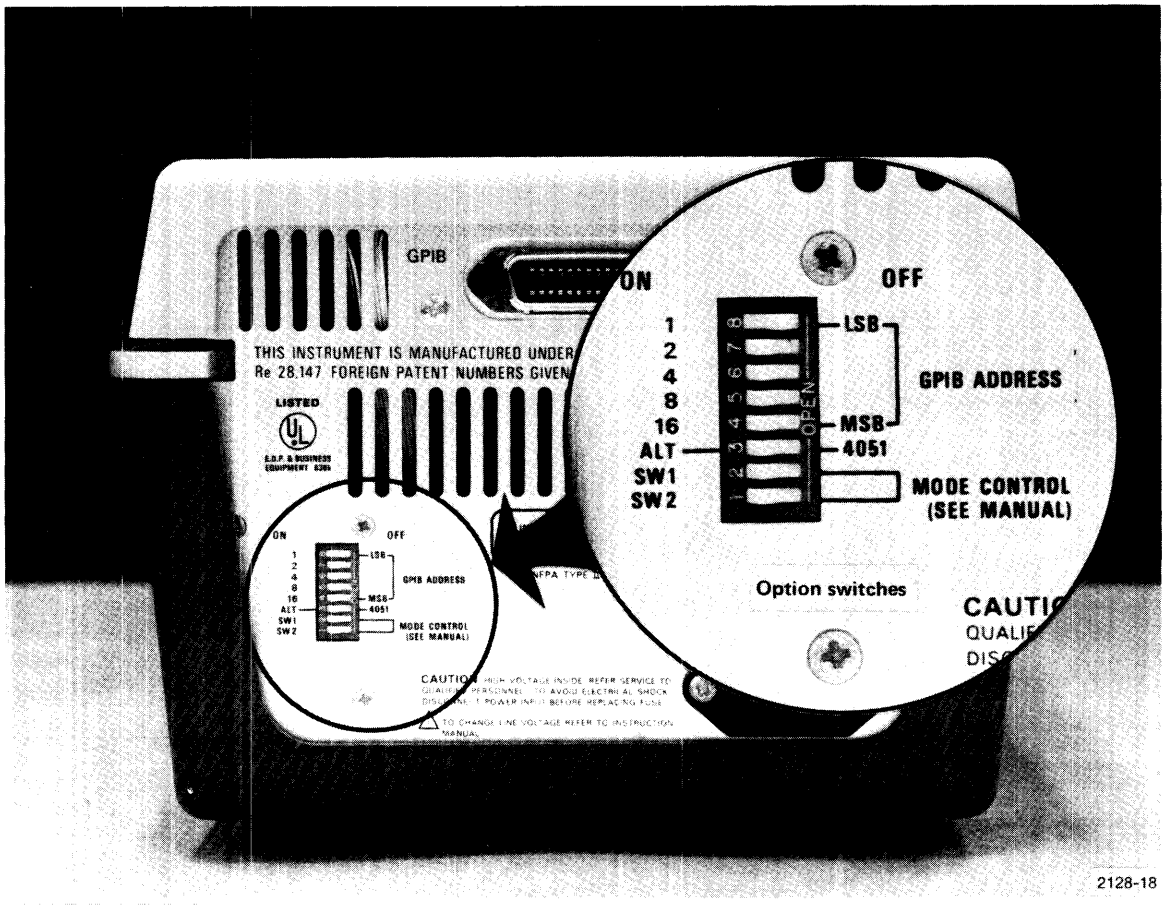


Fig. 3-7. Option switch location.

Device Address

The top five rocker switches select the Device Address that is used to address the 4924 when it is on-line to the GPIB. The switches have weighted values as shown in Table 3-2 below. The Device Address is the sum of the values of the switches place in the "on" position.

Table 3-2
Address Switch Values

Switch Number	Value
8	1*
7	2
6	4
5	8
4	16

***When Alternate Format commands are used, the position of switch 4 is disregarded. It's value is defined to be zero for the DPA and one for the CPA. The effect is to set the CPA to a value one higher than the DPA, as set by the other four switches.**

Mode Select

The Mode Select switch is number 3 in the set. When this switch is pressed on the left side, Secondary Address commands are in effect. When pressed on the right side, Alternate Format commands are in effect. Note the effect of Alternate Format selection on the Device Address above.

Anytime the setting of this switch is changed, an SRQ is generated.

Status Select

Switch 1 and Switch 2 define the status byte in the Off-Line Mode. There are three possible selections with the two switches, as shown in Table 3-3. The meanings of the status selections are shown below.

4051 — In this position, the status byte in the Off-Line Mode is compatible with the TEKTRONIX 4051 Graphic System. The unit is set to operate with 256-byte records with checksums and headers. The Read-after-Write option is not selected.

4923 — In this position, the status byte in the Off-Line Mode is compatible with the TEKTRONIX 4923 tape unit. The unit is set to operate with 128 byte records with no checksums or headers. The Read-after-Write option is not selected.

Programmable — In this position, the Off-Line status byte is the one last set in the On-Line Mode.

Table 3-3

Status Selection

Switch 1	Switch 2	Selection
Off	Off	Programmable
Off	On	4051
On	Off	4923
On	On	Programmable

APPENDIX A
CHARACTERISTICS

Recording Format

Character Format	8-bit serial with LSB (least significant bit) first, MSB (most significant bit) last.
Characters per Record	Selectable—256 8-bit bytes or 128 8-bit bytes with optional following checksum byte.
Records per File	Variable. The file length is the number of Records between the start of the Write operation and the time when the STOP button is pressed.
Characters per Cartridge	200,000 characters nominal.
Tracks	Two data tracks (1's and 0's), combined into one data channel.
Head Type	Single Read/Write head.

Drive Characteristics

Drive Speed	
Normal	30 inches per second.
Fast Forward/Rewind	90 inches per second.
Drive Type	Servo-controlled dc motor with tachometer.
Drive Method	Single capstan drive against cartridge drive roller.

Cartridge Characteristics

Cartridge Type	3M® DC-300A type Data Cartridge.
Weight	8 ounces.
Cartridge Dimensions (outside)	4 inches by 6 inches by 0.665 inch.
Tape Length (usable storage)	300 feet.
Data Markers (light sensing holes)	EOT (End Of Tape). BOT (Beginning Of Tape). Load Point. Early Warning.

Physical Dimensions

Width	8.75 inches (22.2 cm).
Depth	17.25 inches (43.8 cm).
Height	6 inches (15.2 cm).
Weight	17 pounds (7.7 kg).

Environmental Specifications

Temperature

Operating (with tape installed)	10°C (50°F) to 40°C (104°F).
Storage (without tape installed)	−40°C (−40°F) to +65°C (149°F).

Altitude

Operating	Up to 15,000 feet (4500 m).
Storage	Up to 50,000 feet (15000 m).

Cartridge Environmental Specifications

Temperature

Operating and Storage (with data)	+5°C (41°F) to +45°C (113°F).
Transportation	−40°C (−40°F) to +45°C (113°F).
Humidity	20% to 80% NON-CONDENSING.
Conditioning	The cartridge must be conditioned to the operating environment for a time equal to the time away from the environment, not to exceed eight hours.

Power Requirements

The 4924 requires 62 watts at 115 Vac, 60 Hz.

Line Fuse

When operating in the 100-120 Vac range, the line fuse is a 1.5 A slow-blow. When operating in the 200-240 Vac range, the fuse is a .75 A slow-blow.

APPENDIX B
ASCII CODE CHART

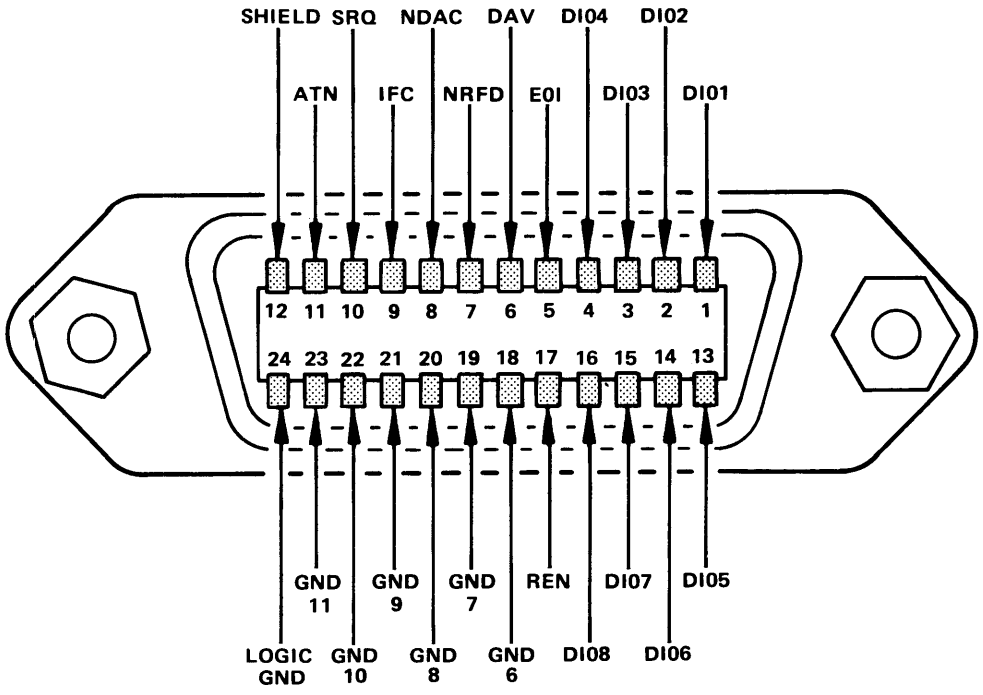
B I T S B4 B3 B2 B1	ø ø ø	ø ø 1	ø 1 ø	ø 1 1	1 ø ø	1 ø 1	1 1 ø	1 1 1
ø ø ø ø	0 NUL	16 DLE	32 SP	48 ø	64 @	80 P	96 `	112 p
ø ø ø 1	1 SOH	17 DC1	33 !	49 1	65 A	81 Q	97 a	113 q
ø ø 1 ø	2 STX	18 DC2	34 "	50 2	66 B	82 R	98 b	114 r
ø ø 1 1	3 ETX	19 DC3	35 #	51 3	67 C	83 S	99 c	115 s
ø 1 ø ø	4 EOT	20 DC4	36 $	52 4	68 D	84 T	100 d	116 t
ø 1 ø 1	5 ENQ	21 NAK	37 %	53 5	69 E	85 U	101 e	117 u
ø 1 1 ø	6 ACK	22 SYN	38 &	54 6	70 F	86 V	102 f	118 v
ø 1 1 1	7 BEL BELL	23 ETB	39 '	55 7	71 G	87 W	103 g	119 w
1 ø ø ø	8 BS BACK SPACE	24 CAN	40 (	56 8	72 H	88 X	104 h	120 x
1 ø ø 1	9 HT	25 EM	41)	57 9	73 I	89 Y	105 i	121 y
1 ø 1 ø	10 LF	26 SUB	42 *	58 :	74 J	90 Z	106 j	122 z
1 ø 1 1	11 VT	27 ESC	43 +	59 ;	75 K	91 [	107 k	123 {
1 1 ø ø	12 FF	28 FS	44 ,	60 <	76 L	92 \	108 l	124 ¦
1 1 ø 1	13 CR RETURN	29 GS	45 -	61 =	77 M	93]	109 m	125 }
1 1 1 ø	14 SO	30 RS	46 .	62 >	78 N	94 ^	110 n	126 ~
1 1 1 1	15 SI	31 US	47 /	63 ?	79 O	95 _	111 o	127 RUBOUT (DEL)

APPENDIX C
GPIB DESCRIPTION

THE GENERAL PURPOSE INTERFACE BUS (GPIB)

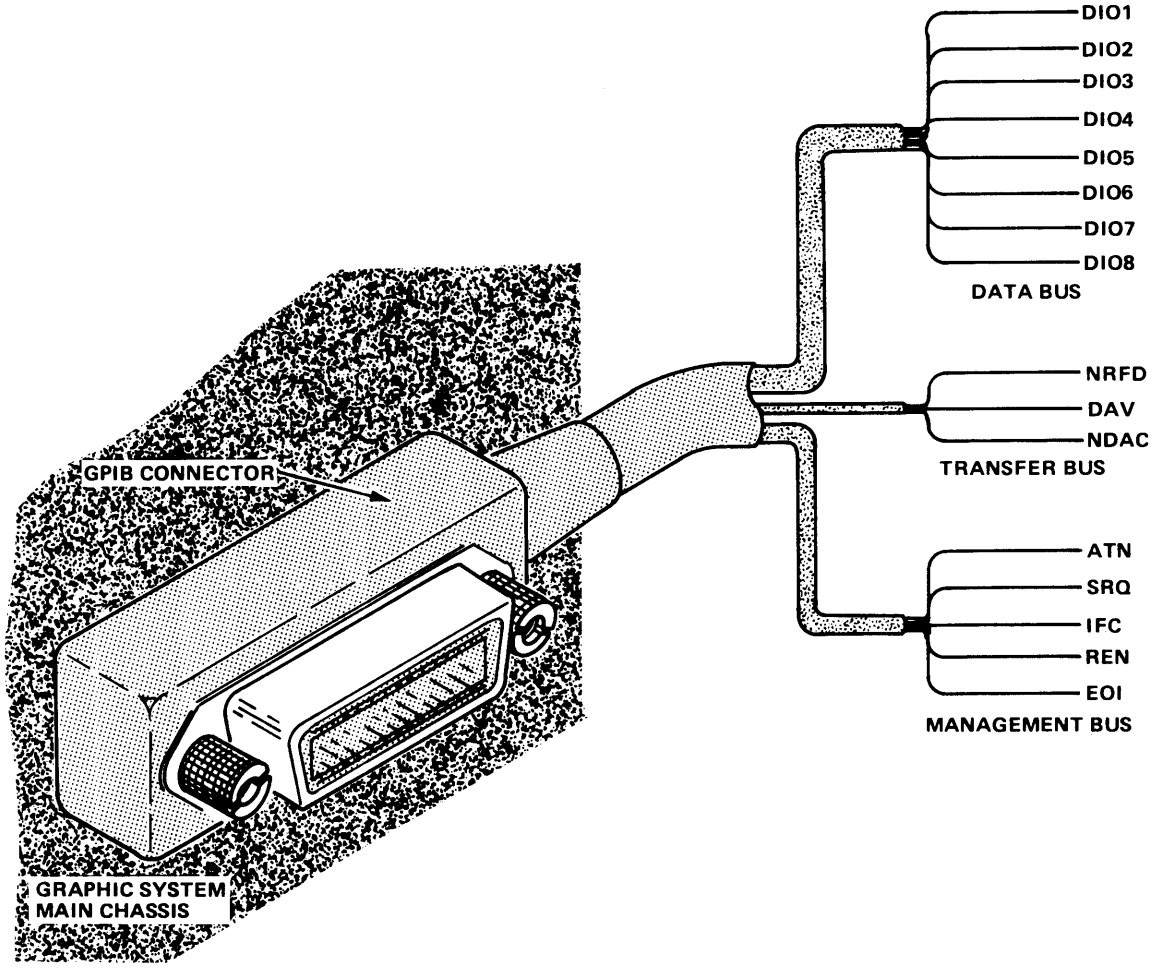
The GPIB Connector

The GPIB connector is located on the rear panel of the unit. This connector allows external peripheral devices to be connected into a system. The devices must conform to IEEE Standard #488-1975 which describes a byte-serial, bit-parallel interface system for programmable measuring apparatus. The GPIB connector is a standard 24-pin connector such as an Amphenol Micro-Ribbon® connector, with sixteen active signal lines and eight interlaced grounds. The cable attached to the GPIB connector must be no longer than 2Ø meters maximum with no more than 15 peripheral devices connected at one time. The connector pin arrangement and signal line nomenclature is shown below:



The GPIB Interfacing Concept

The GPIB is functionally divided into three component busses; an eight-line Data Bus, a three-line Transfer Bus, and a five-line Management Bus for a total of 16 active signal lines. This bus structure is shown in the diagram below:



The transfer rate over the Data Bus is a function of the slowest peripheral device taking part in a transfer at any one time. Both peripheral addresses and data are sent sequentially over the Data Bus. Once peripheral addresses are established for a particular transfer, successive data bytes may be transmitted in a burst for higher effective data rates.

Peripheral Devices on the GPIB are designated as talkers and listeners. When the 4924 is used with a TEKTRONIX Graphic System, the Graphic System acts as the controller to assign peripheral devices on the bus as listeners and talkers. The Graphic System further assumes that it is the only controller on the bus and it has complete control over the direction of all data transfers. There is no provision for other devices on the GPIB to take turns as controller-in-charge.

A talker is a device capable of transmitting information on the Data Bus. There can be only one talker at a time. The 4924 has the ability to assume the role of the talker when it is programmed to do so.

A listener is a device capable of receiving information transmitted over the Data Bus. There may be up to 14 listeners taking part in an I/O operation at any one time. The 4924 has the ability to assume the role of a listener any time it is programmed to do so.

GPIB Signal Definitions

Data Bus. The Data Bus contains eight bidirectional active-low signal lines, DI01 through DI08. One byte of information (eight bits) is transferred over the bus at a time. DI01 represents the least significant bit in the byte; DI08 represents the most significant bit in the byte. Each byte represents a peripheral address (either primary or secondary), a control word, or a data byte. Data bytes can be formatted in ASCII code, with or without parity or they can be formatted in machine dependent binary code.

Management Bus. The Management Bus is a group of five signal lines which are used to control data transfers over the Data Bus. The signal definitions for the Management Bus are as follows:

Signal	Definition
Attention (ATN)	This signal line is activated by the controller when peripheral devices are being assigned as listeners and talkers. Only peripheral addresses and control messages can be transferred over the Data Bus when ATN is active low. After ATN goes high, only those peripheral devices which are assigned as listeners and talkers can take part in the data transfer.
Service Request (SRQ)	Any peripheral device on the GPIB can request the attention of the controller by setting SRQ active low. The controller responds by setting ATN active low and executing a serial poll to see which device is requesting service, or by sending the ERROR command.
Interface Clear (IFC)	The IFC signal line is activated by the controller when it wants to place all interface circuitry in a predetermined quiescent state.
Remote Enable (REN)	The REN signal line is activated whenever the system is operating under program control. REN causes all peripheral devices on GPIB to ignore their front panel controls and operate under remote control via signals and control messages received over the GPIB. The 4924 does not recognize the REN message.

End of Identify (EOI)	The EOI signal can be used by the talker to indicate the end of a data transfer sequence. The talker activates EOI as the last byte of data is transmitted. When the controller is listening, it assumes that a data byte received is the last byte in the transmission, if EOI is activated. When the controller is talking, it always activates EOI as the last byte is transferred.

The Transfer Bus. A handshake sequence is executed by the talker and the listeners over the Transfer Bus each time a data byte is transferred over the Data Bus. The Transfer Bus signal lines are defined as follows:

Signal	Definition
Not Ready for Data (NRFD)	An active low NRFD signal line indicates that one or more assigned listeners are not ready to receive the next data byte. When all of the assigned listeners for a particular data transfer have released NRFD, the NRFD line goes inactive high. This tells the talker to place the next data byte on the Data Bus.
Data Valid (DAV)	The DAV signal line is activated by the talker shortly after the talker places a valid data byte on the Data Bus. An active low DAV signal tells each listener to capture the data byte presently on the Data Bus. The talker is inhibited from activating DAV when NRFD is active low.
Data Not Accepted (NDAC)	The NDAC signal line is held active low by each listener until the listener captures the data byte, NDAC goes inactive high. This tells the talker to take the byte off the Data Bus.

GPIB Data Formats. Any series of bit patterns can be transmitted over the GPIB. This allows both numeric data and alphanumeric data to be transmitted.

Transferring ASCII Data. ASCII numeric data can be transferred in either standard (free) format or scientific format, and must be transmitted most significant digit first. Valid ASCII characters are digits Ø through 9,E,e,+,−, and decimal point. ASCII character strings can be transmitted as any sequence of valid ASCII characters. ALL ASCII data transfers, both numeric and alphanumeric are terminated with a Carriage Return character or by activating the EOI *signal line* of the Management Bus, or both.

GPIB to IEEE Compatibility

Introduction. The following text describes the interfacing compatibility of the Graphic System's General Purpose Interface Bus with IEEE Standard #488-1975 which describes a byte-serial, bit-parallel interface system for programmable measuring apparatus.

In general, the 4924 acts as a standard talker and listener.

GPIB Interfacing Compatibility in Detail

Reference: IEEE Standard #488-1975.

The Graphic System GPIB falls into the following interface function subsets as defined in the IEEE Standard #488-1975 document:

Interface Function	4051 Mode	Subsets Supported Alternate Mode	Manual Mode
Source Handshake	SH1	SH1	SH1
Acceptor Handshake	AH1	AH1	AH1
Talker	TE6	T6	T3
Listener	LE4	L4	L1
Service Request	SR1	SR1	SRØ
Remote Local	RLØ	RLØ	RLØ
Parallel Poll	PPØ	PPØ	PPØ
Device Clear	DCØ	DCØ	DCØ
Device Trigger	DTØ	DTØ	DTØ
Controller	CØ	CØ	CØ