Tektronix®

4050 SERIES OPTION 10

RS-232 PRINTER INTERFACE 4051F10 and 4052F10

INSTRUCTION MANUAL

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4050 SERIES OPTION 10

RS-232 PRINTER INTERFACE 4051F10 and 4052F10

INSTRUCTION MANUAL

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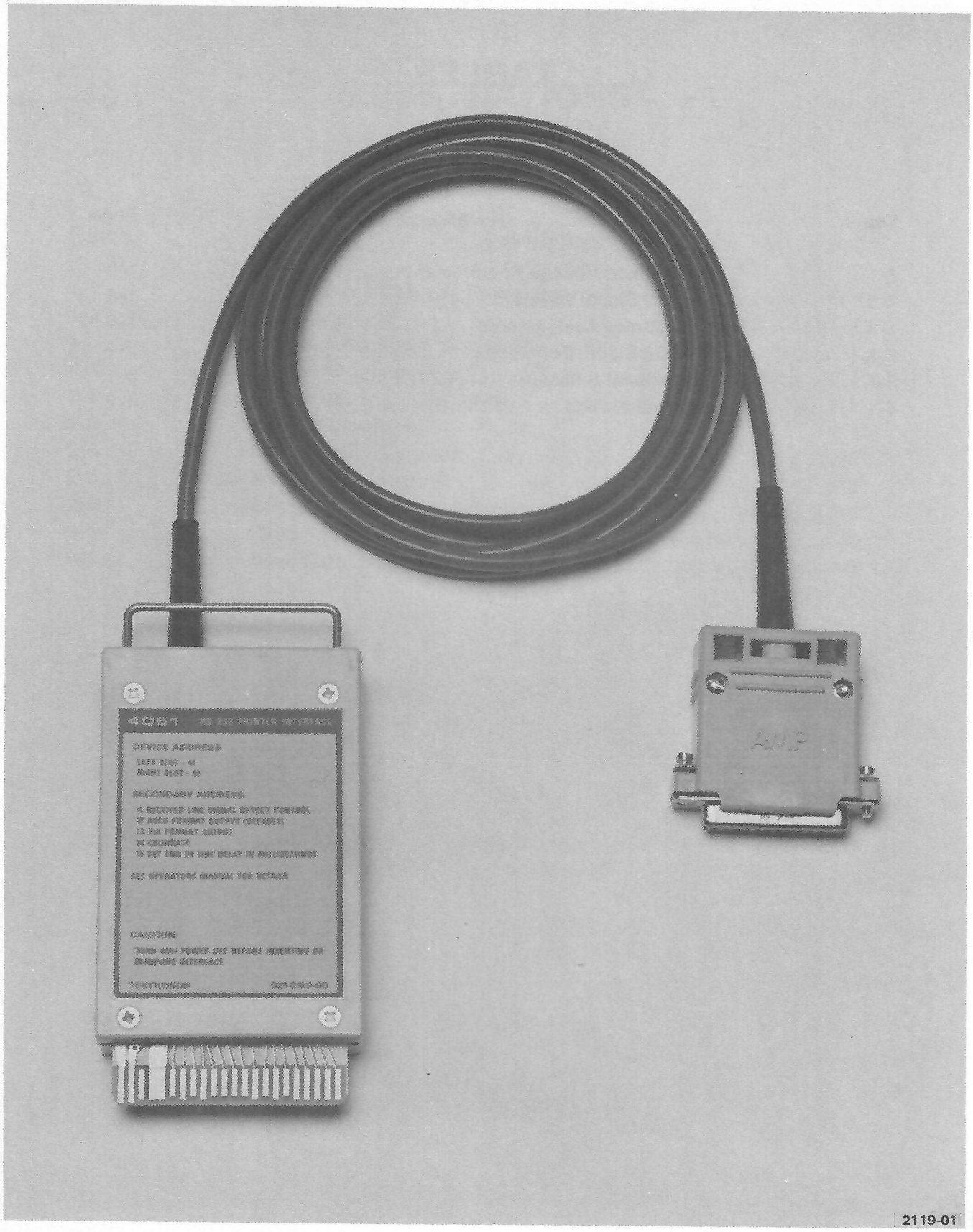


Figure 1-1. A 4050 Series RS-232 Printer Interface.

Section 1

GENERAL DESCRIPTION

INTRODUCTION

The TEKTRONIX 4050 Series RS-232 Printer Interfaces are used with the TEKTRONIX 4050 Series Graphic Systems to send data to a printing device. There are two versions of the interface: one for 4051 Graphic Systems and another for other 4050 Series Graphic Systems. When ordered with a 4051, the interface is referred to as the 4051 Option 10 RS-232 Printer Interface. When ordered separately, the interface is called the 4051F10 RS-232 Printer Interface. When ordered with a 4052 or a 4054, the interface is referred to as the 4052 Option 10 RS-232 Printer Interface. When ordered separately for either of these two instruments, it is called the 4052F10. Information in this manual that applies to all three instruments; 4051, 4052, and 4054, is listed as applying to the 4050 Series Graphic System or simply GS. Information that does not apply to all three is listed by individual instrument type.

The interface, shown in Figure 1-1, is packaged in a plastic case called a ROM Pack. The ROM Pack fits into a slot in the Graphic System's backpack. The 4051 can also use a ROM Expander Unit which connects via the backpack. The 4051 RS-232 Printer Interface can then be plugged into the ROM Expander Unit.

The two printer interfaces are similar, but the connector on the 4052 unit is "keyed." The 4051 RS-232 Printer Interface will not fit into a 4052 or 4054 backpack and is not electrically compatible with these instruments. The 4052 interface is not compatible with the 4051. A 10-foot cable extends out of the top of the ROM Pack and plugs into the RS-232 connector on the printing device. Any device which conforms to the EIA RS-232-C Standard for receive-only data terminal equipment or the EIA RS-244A Standard for receiving EIA Numerical Machine Control characters can be connected to the interface cable. The primary purpose for the interface is to output program listings and alphanumeric data listings to a TEKTRONIX 4641 Printer. The printer interface and the 4641 Printer are plug-to-plug compatible.

OUTPUT STATEMENTS

Data and BASIC programs stored in the GS (Graphic System) memory are sent to the printer interface by executing the statements PRINT, LIST, TLIST and SAVE. The statements work the same as they do when sending information to the GS display. The only difference is that an I/O address must be specified after the keyword to tell the BASIC interpreter to send the information to the interface. For example, if the RS-232 Printer Interface is in the left backpack slot, then executing the statement LIST @ 41: sends a list of the current BASIC program to the interface. If the interface is in the right slot, then executing the statement LIST @ 51: sends a copy of the program to the interface. A complete list of the primary addresses for each ROM Pack slot is given in the specifications section following this introduction.

After the printer interface receives information from the BASIC interpreter, the information is converted to a bit serial data stream and transmitted through the interface cable to the printer. The printer then reconstructs the data bits into characters and prints the information.

ENVIRONMENTAL STATEMENTS

In addition to the BASIC output statements which transfer data over the interface, four special PRINT statements are provided to set environmental parameters within the interface and to place the interface into a calibration mode. These statements, like the four BASIC output statements, can be executed directly from the GS keyboard or under program control. The special PRINT statements are used to select the End of Line Delimiter, the minimum End of Line Delay period, and the control state of the RLSD signal line on the RS-232 bus. Another special PRINT statement places the interface into a calibration mode to adjust the baud rate (4051 only).

SPECIFICATIONS

Power Requirements

The RS-232 Printer Interface draws its power from the Graphic System. Connections to the power supplies are made through the backpack on the rear panel of the main chassis. The printer interface must be inserted into a ROM Pack slot before power is applied to the system.

Table 1-1

CURRENT AND VOLTAGE REQUIREMENTS

Voltage Supplies	Current Limit
+5 Vdc	278 mA
+12 Vdc	25 mA
−12 Vdc	20 mA

Interfacing Standard

EIA Standard RS-232-C

Communications Protocol

Receive Only, Asynchronous

Data Format

One start bit, 8 data bits, two stop bits

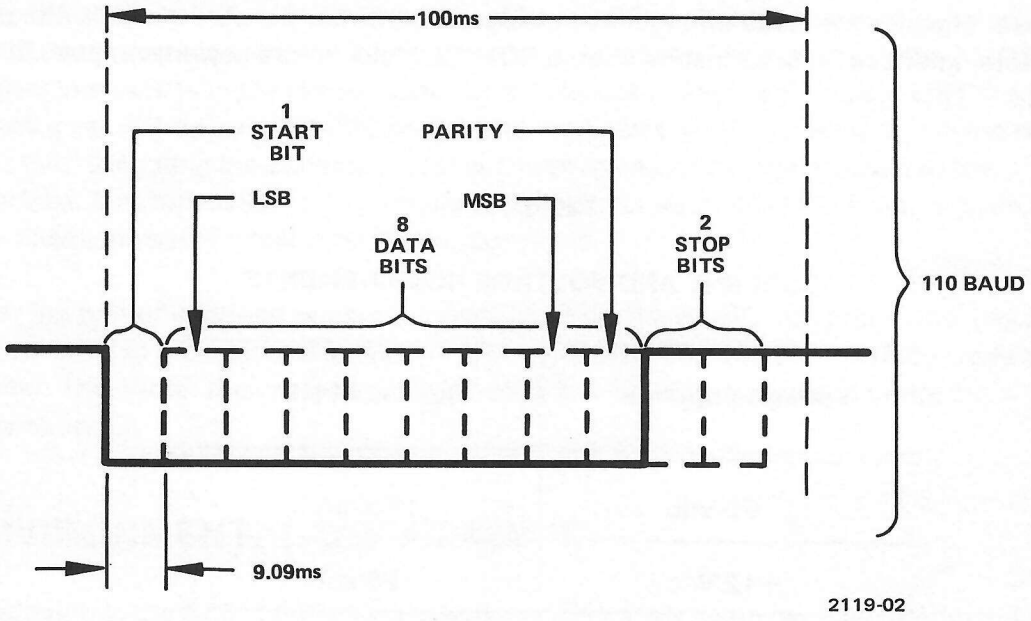


Figure 1-2. Data Format.

Character Format

7-bit ASCII characters with even parity or 8-bit EIA machine control characters

Table 1-2

RS-232 SIGNAL LEVELS

OFF, Binary 1, or MARK			ON, Binary 0, or SPACE		
Lo −25V	Nominal −9 V	Hi −3 V	Lo +3 V	Nominal +9 V	Hi +25 V

Temperature

Non-operating:	−40°C to +65°C
Operating:	+10°C to +40°C

Altitude

Non-operating:	50,000 feet maximum
Operating:	15,000 feet maximum

Humidity

95% non-condensing (storage)
80% non-condensing (operating)

Vibration (Non-Operating)

0.015". DA-10-50-10

Shock (Non-Operating)

1/2 Sine 11 ms duration, 30 G's

Physical Dimensions (Including Edge Connector, Excluding Cable)

Length:	4.662"
Width:	2.620"
Depth:	0.875"

Weight (Including Cable)

8 oz.

Cable Length

10 feet ±1/2 ft.

Standard Accessories

1 — Instruction Manual

Table 1-3

I/O ADDRESS ASSIGNMENTS (2 SLOT BACKPACK)

BACKPACK	LEFT ROM EXPANDER UNIT							
LEFT SLOT @41:	SLOT #1 @41:	SLOT #2 @42:	SLOT #3 @43:	SLOT #4 @44:	SLOT #5 @45:	SLOT #6 @46:	SLOT #7 @47:	SLOT #8 @48:
BACKPACK	**RIGHT ROM EXPANDER UNIT**							
RIGHT SLOT @51:	SLOT #1 @51:	SLOT #2 @52:	SLOT #3 @53:	SLOT #4 @54:	SLOT #5 @55:	SLOT #6 @56:	SLOT #7 @57:	SLOT #8 @58:

NOTE

With a ROM Expander Unit installed, a backpack slot cannot be accessed, and the I/O address for that slot is assigned to the first slot in the ROM Expander Unit.

Refer to Figure 1-3 for address assignments on a four-slot backpack (does not apply to 4051).

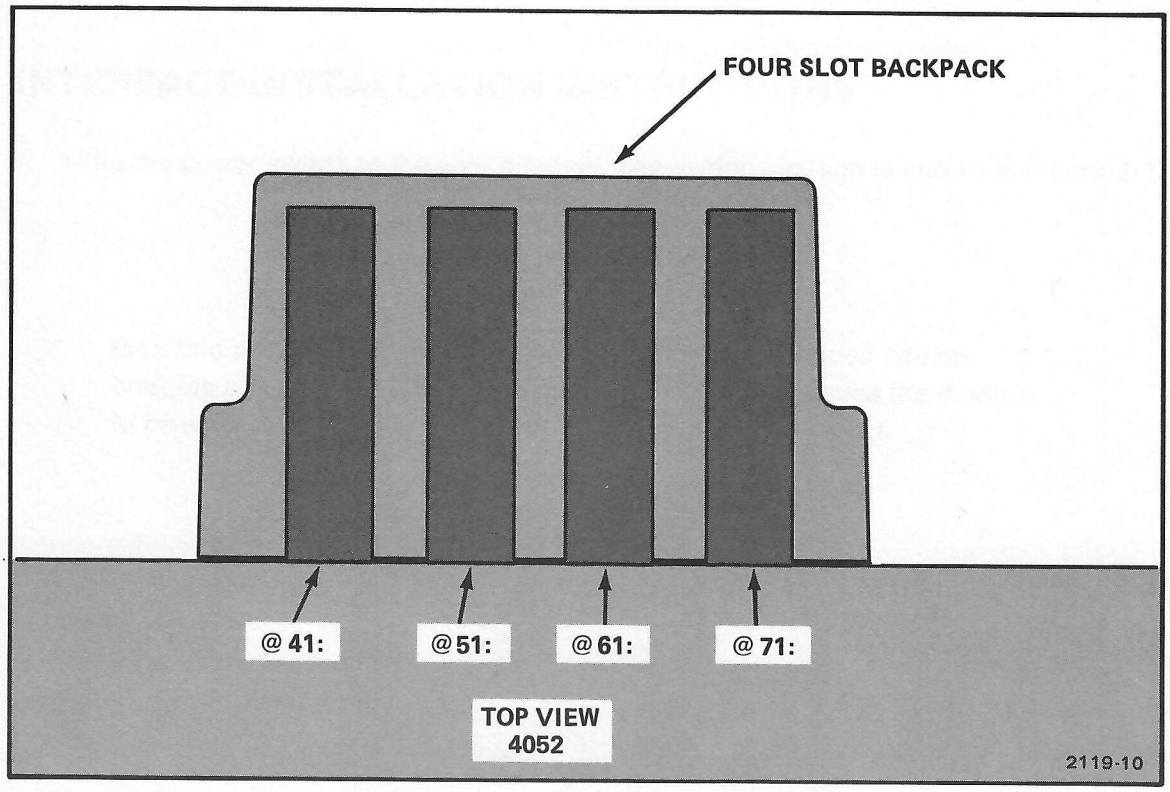


Figure 1-3. Four-Slot Backpack Outline and Addresses.

Section 2

INSTALLATION

INTERFACE INSTALLATION INSTRUCTIONS

1. Flip the power switch to the OFF position. The switch location is shown in Figure 2-1.

CAUTION

Inserting a ROM Pack into the backpack with power applied causes bridging between the edgeboard connectors and may cause the memory to be erased. Make sure the power is OFF before proceeding.

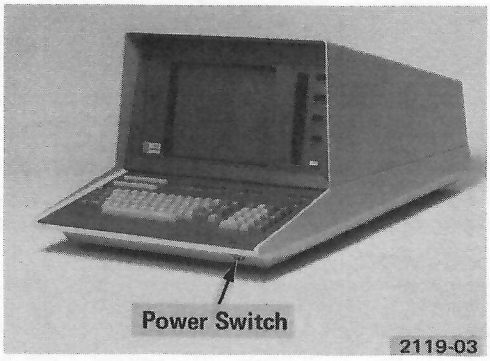


Figure 2-1. Power Switch Location.

NOTE

If you want to connect two printer interfaces to your 4051, you must use a ROM EXPANDER UNIT for the additional interface. Do not insert two interfaces into the 4051 backpack at the same time. (This note applies to the 4051 only.)

2. With the power removed from the system, insert the printer interface into a ROM Pack slot as shown in Figure 2-2. Press down and at the same time gently rock the plastic housing from side to side until the ROM Pack edgeboard connector firmly seats into the receptacle connector.

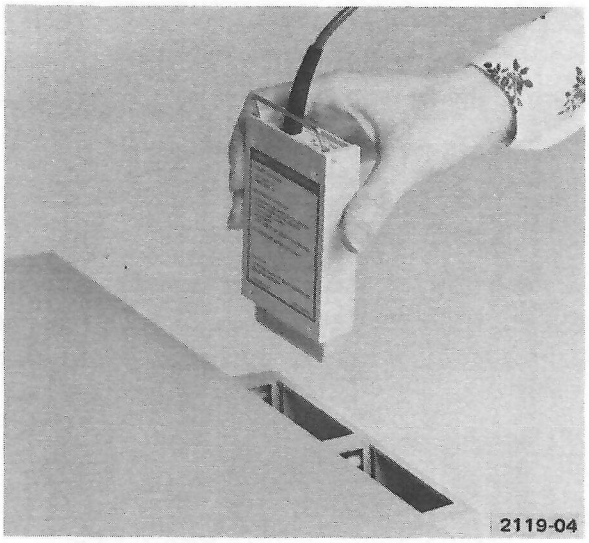


Figure 2-2. Printer Interface Installation.

3. Plug the printer interface RS-232 female connector into the male connector from the printer, terminal, or modem, etc. as shown in Figure 2-3.

NOTE

Make sure the RS-232 connectors are pin-to-pin compatible before turning on the power. Refer to the following page for RS-232 connector information.

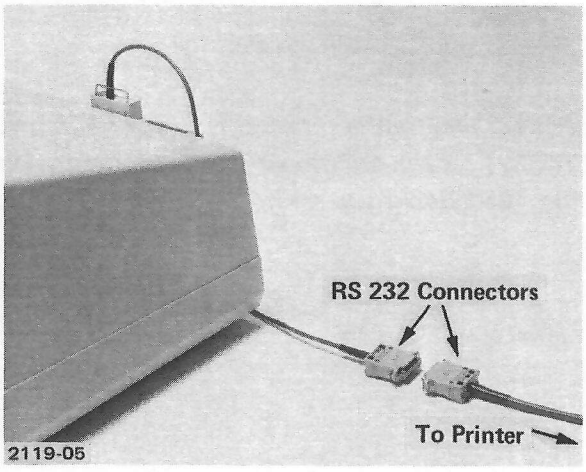


Figure 2-3. RS-232 Connectors.

4. After making sure the RS-232 connectors are pin-to-pin compatible, flip the power switch to the On position, allow a few minutes for warm-up, and the system is ready.

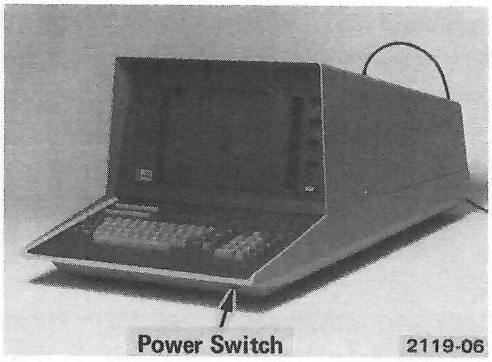


Figure 2-4. Power Switch Location.

THE RS-232 CONNECTOR

The RS-232 connector, shown in Figure 2-5, is a standard 25-pin Amphenol female connector with a circuit ground, a chassis ground, and four active signal lines. The pin assignments and signal definitions for this connector are given in Table 2-1.

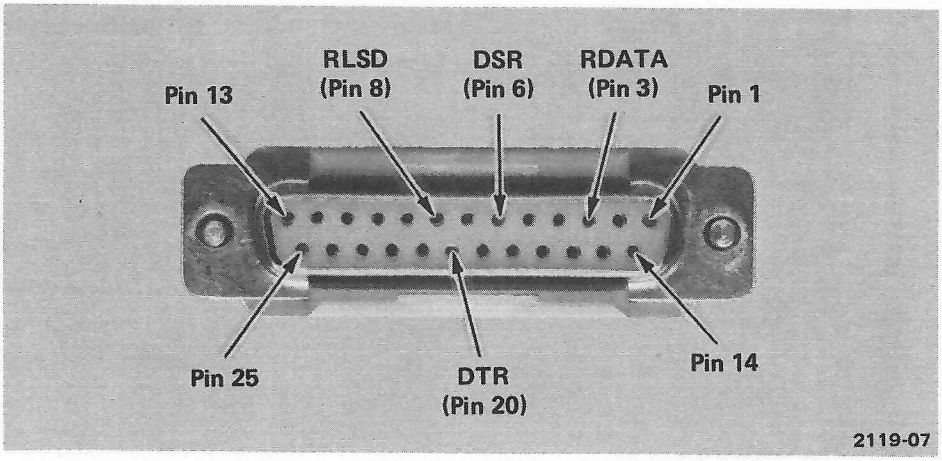
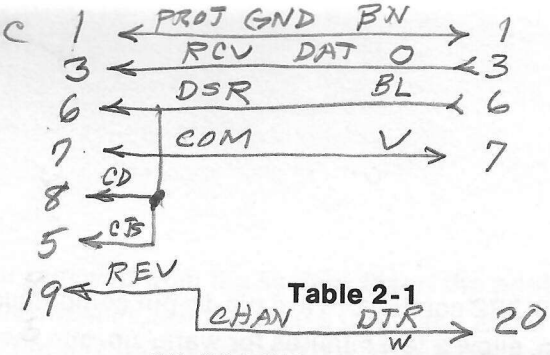


Figure 2-5. RS-232 Connector.



Rev Dick Rampack 9-6-84

EJ Marchol

Table 2-1

RS-232 SIGNAL DEFINITIONS

Pin	Mnemonic	Name	Definition
1	GND	Chassis Ground	This pin is the ground connection to the cable shield and the GS main chassis.
3	RDATA	Received Data	This pin is the bit-serial output to the printer and also serves as the calibration voltage source.
6	DSR	Data Set Ready	This signal is held active (near +9 Vdc) by the GS whenever the interface is plugged in and power is applied. This +9 Vdc signal tells the printer that the GS is able to transmit data.
7	CKT GND	Circuit Ground	This pin is the return path for all active signals.
8	RLSD	Received Line Signal Detect	This signal indicates that the GS is about to transmit data. It is activated to a +9 Vdc state automatically by the GS approximately 1 ms before all data transfers.
20	DTR	Data Terminal Ready	This signal is controlled by the printer. When active high (+9 Vdc), it indicates that the printer is ready to receive data. When in an inactive low (−9 Vdc) state, this signal prevents the interface from transmitting data. If the printer does not control this pin, the GS forces it high and enables data transmission.

NEC USES PIN 19

AT NEC PIN 20 will not be connected

NOTE

Due to the general nature of the guidelines within the RS-232-C specification, some printer RS-232 connectors may not be pin-to-pin compatible with the above pin arrangement. For example, the printer busy signal (DTR) may be found on pin 25 instead of pin 20. In such cases, it may be necessary to construct a special adapter plug or rearrange the wiring scheme inside the RS-232 connector to obtain the proper match.

BAUD RATE SELECTION

The term "baud rate" refers to the number of signal-events that happen per second in the RS-232 communication channel. Each signal event represents the transfer of a binary bit, (a binary 1 or 0). The baud rate is directly related to the number of characters transferred over the channel per second. For example, when the interface is transferring data in ASCII code format, each character is represented by one start bit, eight data bits, and two stop bits, for a total of eleven bits. If the baud rate is set to 110, then 110/11 (ten characters) are transferred per second. If the baud rate is set to 2400, then 2400/11 (218 characters) are transferred per second (assuming the program generates data that fast).

Each device connected to the communications channel must operate at the same baud rate. This means that the RATE selection on the printer interface must match the baud rate selection on the receiving device (line printer, terminal, modem, or other device). The baud rate selection switch is located on the top of the printer interface ROM Pack and is shown in Figure 2-6. The selection is made by inserting a blade-type screwdriver into the slot behind the white arrow tip and rotating the arrow tip until it points to the baud rate you want. The baud rate accuracy is ±1% of the indicated value.

NOTE

Setting the RATE switch to an unmarked position causes the interface to operate at an unpredictable rate.

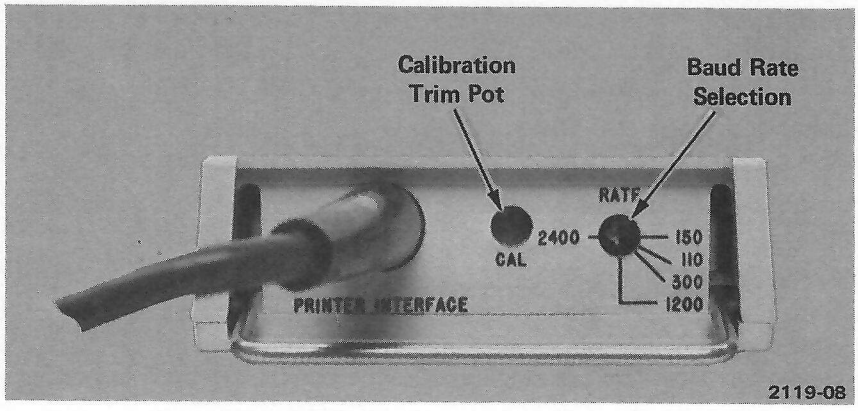


Figure 2-6. Baud Rate Selector Switch.

Section 3

INTERFACE OPERATION

INTRODUCTION

This section describes the operating features of the RS-232 Printer Interface in detail. The printer interface is operated by executing BASIC language statements either directly from the keyboard or under program control. This section begins with an operational summary of each interface command. The summary also serves as a quick reference guide. Following the summary, each interface function is covered in detail, starting with the output statements and ending with the environmental control statements. The examples and explanations of commands assume that the interface is installed in the leftmost backpack slot (I/O address @ 41). Refer to the topic "specifications" for addresses assigned to other slots.

Table 3-1

OPERATIONAL SUMMARY

Operation	Example	Explanation
LIST	LIST @ 41: or LIST @ 41,19:	Sends a list of the current BASIC program to the printer in ASCII format, starting with the lowest line number in memory and ending with the highest line number in memory.
	LIST @ 41: 500	Sends a copy of line number 500 to the printer in ASCII format.
	LIST @ 41: 500,600	Sends a copy of program lines 500 through 600 to the printer in ASCII format.
PRINT	PRINT @ 41: A;B;C$ or PRINT @ 41,12: A;B;C$	Sends the data assigned to the variables A,B, and C$ to the printer in ASCII format.
	PRINT @ 41,13: D;E;F$	Sends the data assigned to the variables D,E, and F$ to the printer in EIA format.

Table 3-1 (cont)

OPERATIONAL SUMMARY

Operation	Example	Explanation
SAVE	SAVE @ 41:	Sends a copy of the current BASIC program to the printer in ASCII format. (Control characters are not converted to a letter-backspace-underline sequence.)
	SAVE @ 41: 500	Sends a copy of program line number 500 to the printer in ASCII format.
	SAVE @ 41: 500,600	Sends a copy of program lines 500 through 600 to the printer in ASCII format.
TLIST	TLIST @ 41:	Sends a copy of the internal magnetic tape directory to the printer in ASCII format.
LINE DELIMITER	PRINT @ 37,26:0 PRINT @ 37,26:1	Sets the output line delimiter to CR. Sets the output line delimiter to CR/LF.
END OF LINE DELAY	PRINT @ 41,15:500	Sets the minimum End of Line Delay to 500 milliseconds.
RECEIVED LINE SIGNAL DETECT	PRINT @ 41,11:0	Sets the RLSD signal line to an OFF state (near −9 Vdc).
	PRINT @ 41,11:1	Sets the RLSD signal line to an ON state (near +9 Vdc).
CALIBRATE BAUD RATE	PRINT @ 41,14:	Sets the interface to calibration mode. A 50% duty cycle square wave is generated at pin 3 on the RS-232 connector. Adjust trim pot on interface until the square wave frequency is 1/2 the baud rate setting. Press BREAK key twice to exit the calibration mode.

THE LIST STATEMENT

Syntax Form:

[Line number] LIS [I/O address] [line number [, line number]]

Descriptive Form:

[Line number] LIST [I/O address] [line number [starting , line number ending]]

PURPOSE

The LIST statement sends a copy of the current BASIC program to the printer interface when the appropriate I/O address is specified after the keyword LIST.

Explanation

Listing a Complete Program

If the printer interface is plugged into the left backpack slot, a complete list of the current BASIC program can be sent to the interface by executing the following statement:

```
LIST @ 41:
```

When this statement is executed, either directly from the GS keyboard or under program control, a copy of the BASIC program currently in memory is sent to the printer interface as a series of ASCII character strings. Each character string represents a program line and is terminated by a carriage return (CR) character unless the CR/LF delimiter has been previously specified with a PRINT @ 37,26:1 statement. Normally, the LIST @ 41: statement is directed toward a printer (a TEKTRONIX 4641 Printer for example) which prints the program listing.

Before the program list is sent to the interface, the BASIC interpreter issues the I/O address @ 41,19: to the interface. Primary address 41 selects the printer interface as the output device. Secondary address 19 is issued by default and tells the interface to prepare to receive and retransmit a program listing or a tape listing over the RS-232-C bus in ASCII code format. The program list is then issued to the interface and transferred to the printing device.

The interface automatically issues a Form Feed control character to the printer before each LIST operation. The Form Feed control character normally pages the screen on a display terminal or advances the paper on a line printer.

Listing One Line in the Current Program

One line in the current program can be sent to a printing device by specifying the program line number as a parameter in the LIST statement. For example:

```
LIST @ 41:200
```

When this statement is executed, line number 200 is converted to an ASCII character string and issued to the printer interface. The interface then relays the program line over the RS-232 channel in ASCII code format.

Listing Part of the Current Program

A portion of the current BASIC program can be listed by specifying the starting and ending line numbers in the LIST statement. The line numbers are specified as follows:

```
LIST @ 41:500,750
```

This statement causes the BASIC interpreter to issue program lines 500 through 750 to the interface. If the first line number does not exist, then the next highest line number in memory is listed as the first statement. If the second line number does not exist, then the next highest line number in memory is listed as the last statement.

The Difference Between LIST and SAVE

The statements LIST @ 41: and SAVE @ 41: are similar in that both statements cause the BASIC interpreter to send a copy of the current BASIC program to the printer interface. The only difference in the two statements is how control characters are treated. The LIST statement converts control characters to a letter-backspace-underline sequence in the ASCII data stream. This causes the receiving device to print an underlined letter which is the symbolic representation for the control character. For example:

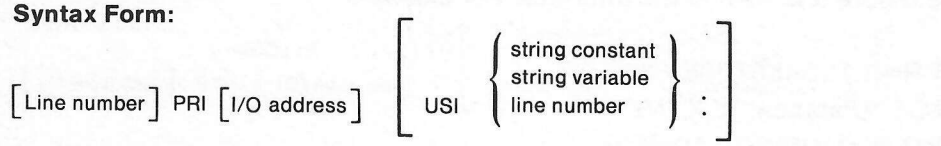
```
100 PRINT "L"
```

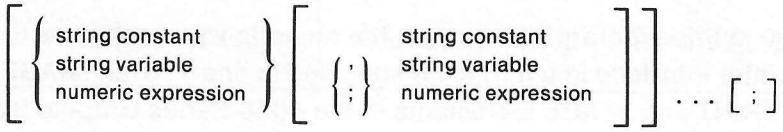
When this statement is listed, the CTRL L (Form Feed) character inside the quotation marks is issued as a three-character sequence: L, backspace, and underline (or underscore). This causes the printing device to print the symbol L in the program listing. If the actual Form Feed character were sent to the printer, a Form Feed control function might be executed. This of course would be undesirable.

When a SAVE statement is executed, the actual control characters are sent as part of the data stream. In the above example, if line 100 were saved instead of listed, a Form Feed control character would be issued instead of the L symbol. Normally, SAVE statements are directed toward mass storage devices or paper tape devices which have the ability to record control characters without executing them.

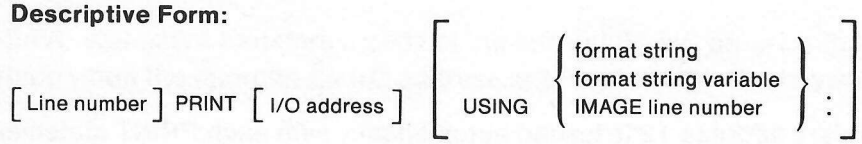
THE PRINT STATEMENT

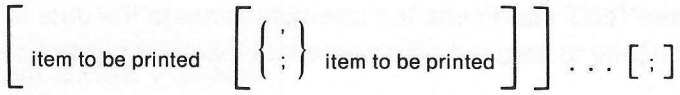
Syntax Form:





Descriptive Form:





Purpose

The PRINT statement outputs data to the printer interface in either ASCII code format or EIA code format.

Explanation

ASCII Data Output

Sending ASCII data strings to a line printer via the printer interface with a PRINT statement is the same as sending ASCII data to the GS display. The only difference is specifying an I/O address after the keyword PRINT. For example:

```
100 PRINT @41: "MY NAME IS TOM SMITH!"
```

When this statement is executed under program control, the BASIC interpreter sends the character string "MY NAME IS TOM SMITH!" to the printer interface in ASCII code format. The interface then relays the character string to the printer over the RS-232 channel in ASCII code format. The I/O address @41: is specified in this example because the printer interface is plugged into the left slot in the GS backpack.

All of the PRINT statement facilities can be used to generate data strings and send them to the printer interface. Even the PRINT USING form of the PRINT statement can be used to format data before it is sent to the interface. For example:

```
100 LET R=1.123456789E+6
110 IMAGE "Distance:",E,X,"Mi"
120 PRINT @ 41:USING 110: R
```

When line 120 in this program is executed, the numeric value assigned to R in line 100 is sent to the printer interface in a format as specified in line 110, an IMAGE statement. (Refer to the PRINT and IMAGE statements in the 4050 Series Graphic System Reference Manual for a complete explanation of formatted output.)

EIA Data Output

Normally, the secondary address 12 is issued automatically with each PRINT statement to tell the interface to format the data in ASCII code. If, however, secondary address 13 is specified as part of the PRINT statement, the interface formats the data in EIA code — a code developed specifically to be used with numerical machine control perforated tape. For example:

```
130 PRINT @ 41,13: A;B;C$
```

When this statement is executed, the numeric data assigned to the variables A, B, and C$ are sent to the printing device in EIA format. (Refer to the EIA Standard RS-244-A for details on this character code format.)

THE SAVE STATEMENT

Syntax Form:

[Line number] SAV [I/O address] [line number [, line number]]

Descriptive Form:

[Line number] SAVE [I/O address] [line number [starting , line number ending]]

Purpose

The SAVE statement transfers a copy of the current BASIC program to the printer interface when the appropriate I/O address is specified after the keyword SAVE.

Explanation

Saving the Current BASIC Program

If a SAVE @ 41: statement is executed and line numbers are not specified as parameters, the BASIC interpreter transfers a complete copy of the current BASIC program to the printer interface. The interface in turn transfers the program to the printing device.

The entire BASIC program is converted into a series of ASCII character strings starting with the lowest line number in memory and ending with the highest line number in memory. Individual statements are separated with Carriage Return (CR) characters, unless CR/LF has been previously specified as the line delimiter with a PRINT @ 37,26:1 statement. The SAVE operation does not disturb the assigned values of variables or the system environmental parameters. This means the SAVE statement can be executed as part of the program without disturbing the parameters of the program. For example:

```
200 SAVE @41:
```

The I/O address @ 41,1: in this statement is issued to the interface first. Primary address 41 selects the interface as the output device. Secondary address 1 is issued by default and tells the interface to prepare to receive and retransmit a BASIC program in ASCII code. The BASIC program is then transferred to the output device. Unlike a LIST operation, the interface does not issue a Form Feed control character (FF) before a program is saved.

Specifying a Line Number as a Parameter

If a line number is specified as a parameter in the SAVE statement, the BASIC interpreter issues the specified program line to the interface. For example:

```
SAVE @ 41:200
```

This statement sends program line 200 to the interface as an ASCII data string.

Specifying Two Line Numbers as Parameters

If two line numbers are specified as parameters, then the specified program lines and all program lines in between are sent to the interface. For example:

```
SAVE @41:200,400
```

This statement causes the BASIC interpreter to send program lines 200 through 400 to the output device via the interface.

Saving Secret Programs

Programs can be saved in secret format by first executing a SECRET statement, then a SAVE @ 41: statement. The SECRET statement causes the program to be output in a scrambled format, and only the Graphic System BASIC interpreter has the ability to unscramble the format when the program is brought back into memory.

If a BASIC program is brought into memory from a "SECRET" program file via another data channel, then the program cannot be saved or listed again. The program can only be executed. If an attempt is made to SAVE a secret program after it is brought into memory, an error occurs and the appropriate error message is printed on the GS display.

Secret programs can only be removed from memory by executing a DELETE ALL statement, an OLD statement, or by turning off the system power. Refer to the SECRET statement in the 4050 Series Graphic System Reference Manual for details on making a program secret.

THE TLIST STATEMENT

Syntax Form:

[Line number] TLI [I/O address]

Descriptive Form:

[Line number] TLIST [I/O address]

Purpose

The TLIST statement causes the internal magnetic tape unit to issue a tape file directory list for the current magnetic tape cartridge when the appropriate I/O address is specified. The list is sent to the printer interface, then transferred to the output printer in ASCII code format.

Explanation

When a TLIST @ 41: statement is executed directly from the GS keyboard or under program control, the internal magnetic tape unit rewinds the magnetic tape to the beginning. A fast search is then executed to find the tape file header for each file on the tape. As each file header is found, the header information is sent to the printer interface as an ASCII character string terminated by a Carriage Return, unless (on a 4052F10 only) CR/LF has been previously selected as the line delimiter with a PRINT @ 37,26:1 statement. The information is then transferred to the printing device and the search for the next file header begins. The tape list operation is initiated by entering the keyword TLIST @ 41: from the GS keyboard and pressing RETURN, or by executing a TLIST statement under program control, such as

```
250 TLIST @ 41:
```

The I/O address @ 41,19: is issued to the interface first. Primary address 41 selects the printer interface as the output device. Secondary address 19 is issued by default and tells the interface that the information coming next is a program or a tape directory to be listed. The tape directory is sent next to the interface as a series of ASCII character strings. Each ASCII character string represents the information in one file header and is normally terminated by a Carriage Return character. The interface receives and retransmits each character string to the printer.

For program files, the directory lists the tape file number, whether the program is secret or not secret, and the maximum number of bytes allocated to the file (physical length). For data files, the directory lists the file number, the type of file (ASCII or BINARY), and the maximum number of bytes allocated to the file. If the file is empty, it is listed as NEW; and if the file is the last (dummy) file, it is listed as the LAST file.

ENVIRONMENTAL PARAMETERS

Changing the Output Line Delimiters

The Graphic System normally uses CR (Carriage Return) as the output line delimiter for all data transfers in ASCII code. This delimiter can be changed, however, by executing the following statement, either directly from the GS keyboard or under program control:

```
PRINT @ 37,26:1
```

Primary address 37 selects the internal status bytes of the GS as the target of this statement. Secondary address 26 selects the status byte which controls the delimiter for ASCII I/O operations. The 1 following the colon tells the GS to use CR/LF as an output delimiter instead of CR.

This status byte is returned to its initial power up state by executing the following statement:

```
PRINT @ 37,26:0
```

The 0 tells the GS to use CR instead of CR/LF as output line delimiter.

It is important to know this parameter at all times because it affects all ASCII input/output operations. For example, if this parameter is set to CR/LF for a LIST @ 41: operation, then followed with an OLD operation from the internal magnetic tape, an error could result if CR is used as the line delimiter for the program stored on tape. It is good practice always to return this parameter to its default value (CR) with a PRINT @ 37,26:0 statement after the current ASCII I/O operation involving the CR/LF line delimiter is finished.

The End of Line Delay Parameter

The printer interface has an internal parameter which controls the minimum time delay between successive data line transmissions. For example, when the statement LIST @ 41: is executed, a current program list is transferred from the GS memory to the printer interface, then relayed over the RS-232-C line to the output device. The transfer rate for characters is related to the data rate selection on the ROM Pack. Between program line transmissions, a small delay is generated to give the receiving device time to handle and process the data. The time delay between transmissions is automatically set to 25 milliseconds on system power up. This delay can be lengthened or shortened by executing the following special PRINT statement:

PRINT @ 41,15: numeric expression

The BASIC interpreter reduces the numeric expression to a numeric constant and issues the numeric constant to the interface. The numeric constant must fall within the range 0 through 65535. The interface interprets the number as the delay time in milliseconds. For example, PRINT @41,15:500 sets the delay to 500 milliseconds. It is good practice to set the delay at the beginning of every program involving output to the printer interface. (The delay should be set to 25 ms when outputting to the 4641 Printer.)

After the delay parameter is set, the parameter stays set until another PRINT @ 41,15: statement is executed, or until power is removed from the ROM Pack. In the latter case, the parameter reverts back to the 25 millisecond initial value. Executing an OLD statement or a DELETE ALL statement, or pressing the AUTOLOAD key also resets this parameter to the default value. The End of Line Delay is generated each time the printer interface issues a Carriage Return (CR), a Vertical Tab (CTRL K), a Line Feed (LF), or a Form Feed (FF) character.

Received Line Signal Detect (RLSD)

Received Line Signal Detect (pin 8 on the RS-232-C connector) serves as an RS-232-C general purpose control signal. Before data is transferred, the GS automatically sets RLSD to a +9 Vdc (active) state. RLSD remains active throughout the data transfer. At the end of the transfer RLSD goes inactive (—9 Vdc). RLSD can be used to control an operating feature on the output device or it can be used as an interrupt request signal.

In some applications RLSD can be used as an interrupt request to the output device. The output device responds by activating Data Terminal Ready (pin 20 on the RS-232-C connector). This tells the GS to start sending data. Anytime during the transfer the output device can release Data Terminal Ready (DTR) to momentarily stop the data flow. When ready again, the output device activates DTR and the data transfer continues. The combined use of RLSD and DTR provides a communication path between the GS and the printer; this path gives both devices the ability to monitor and control the data flow.

For all LIST, TLIST, and SAVE operations, RLSD is automatically activated approximately 1 millisecond before the transmission begins and goes inactive after the transmission ends. For PRINT operations, RLSD is activated 1 ms before the transmission begins and goes inactive approximately two character times before the transmission ends.

In addition to the automatic activation of RLSD during data transfers, direct control is also provided with a special PRINT statement. Executing the statement PRINT @ 41,11:1 activates RLSD, and it remains active until a PRINT @ 41,11:0 statement is executed or until power is removed from the interface. Notice that in each PRINT statement, only the parameter after the colon is different; 1 means ON and 0 means OFF. The following example illustrates a use for this feature:

```
100 PRINT @41,11:1
110 PRINT @ 41: "The results are "; X,Y,Z
120 PRINT @ 41,11:0
```

This program transmits a character string "The results are " plus the data assigned to the variables X, Y, and Z to the printer interface. For illustrative purposes, assume the output device is a paper tape punch which records the data on paper tape. Assume also that the RLSD signal controls the power ON/OFF switch to the punch.

When line 100 is executed, the BASIC interpreter issues the I/O address @ 41,11:1 to the printer interface. Primary address 41 selects the interface as the target to receive data. Secondary address 11 tells the interface to prepare to receive a change in the RLSD parameter status. The 1 following the colon tells the interface to activate the RLSD signal (pin 8) and to keep RLSD active until told to do otherwise. This action turns on the power to the paper tape punch.

Line 110 is executed next. The data items "The results are ", X, Y, Z are transferred to the interface and relayed to the punch. At any time during the transfer, the punch can hold Data Terminal Ready (pin 20) in an inactive state and stop the data flow. When the punch is ready again, DTR is activated and the data flow continues.

When the transfer is complete, line 120 is executed. This special PRINT statement again addresses the RLSD parameter in the printer interface. The 0 following the I/O address tells the interface to return RLSD to an inactive state; this turns off the punch power.

This illustrates a possible use for RLSD and DTR. RLSD and DTR are actually undefined signals, and the system designer has the freedom to use these signals in any way desired.

Initializing the RLSD Parameter

The RSLD parameter is reset to the inactive state on power up, or when an INIT, AUTOLOAD, OLD, DELALL, RETURN, END, or CLOSE is executed.

Section 4

BAUD RATE CALIBRATION

CALIBRATING THE 4051 PRINTER INTERFACE

It is important that the interface baud rate be within 1% of the RATE switch selection. The printer interface is calibrated when it leaves the factory and should not have to be recalibrated under normal circumstances. However, for those cases when recalibration is necessary, the following calibration guidelines are provided. (The 4052 printer interface is crystal controlled and has no calibration control.)

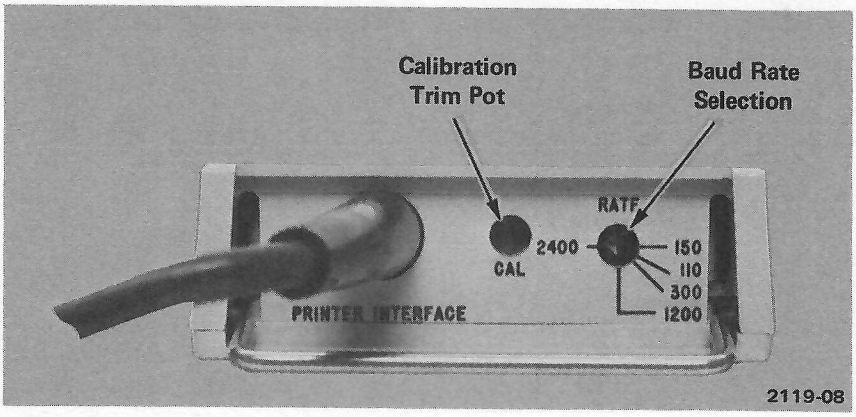


Figure 4-1. Baud Rate Selection Switch and Calibration Trim Pot.

If you are having trouble with the interface, check everything else before you check the calibration. The baud rate calibration is the least likely source of trouble. Never turn the CAL trim pot at random, just to see what happens. Never attempt to calibrate the baud rate without the proper test equipment.

Calibrating the interface at 2400 baud also calibrates the 150, 300, and 1200 baud selections. All of these baud rate frequencies track together because they are even multiples of each other. The 110 baud selection will generally be within 2% tolerance when the interface is calibrated at 2400. However, when the interface is dedicated to a 110 baud application, it is best to recalibrate the interface with the RATE switch set to 110.

The calibration procedure is performed by placing the interface in the calibration mode with a PRINT @ 41,14: statement. The CAL trim pot on the top of the interface housing is then adjusted until a square wave on pin 3 of the RS-232 connector is 1/2 the desired baud rate frequency. The square wave frequency can be measured with a frequency counter such as a TEKTRONIX DC 503 counter/timer.

CALIBRATION PROCEDURE

1. Flip the 4051 power switch to the OFF position.

2. Insert the 4051 RS-232 printer interface into the left receptacle in the 4051 backpack. See Figure 4-2. Rock the plastic housing gently from side to side while pressing down, until the interface connector firmly seats into the backpack connector.

3. Turn the 4051 power switch to the ON position and allow a few minutes for warm up.

4. If using a frequency counter, place the input probe on pin 3 of the RS-232 connector and adjust the counter to display the square wave frequency.

5. Using a blade-type screwdriver, rotate the calibration trim pot first one way, then back the other until the square wave frequency is 1/2 the baud rate selection. Refer to Table 4-1 for the proper frequency and cycle time for each baud rate.

Table 4-1

CALIBRATION DATA

Baud Rate	Cal Square Wave		Frequency Counter Gate Time
	Freq.	Cycle Time	
2400	1200	833.3μs	1 s
1200	600	1.667 ms	1 s
300	150	6.667 ms	1 s
150	75	13.33 ms	1 s
110	55	18.18 ms	1 s

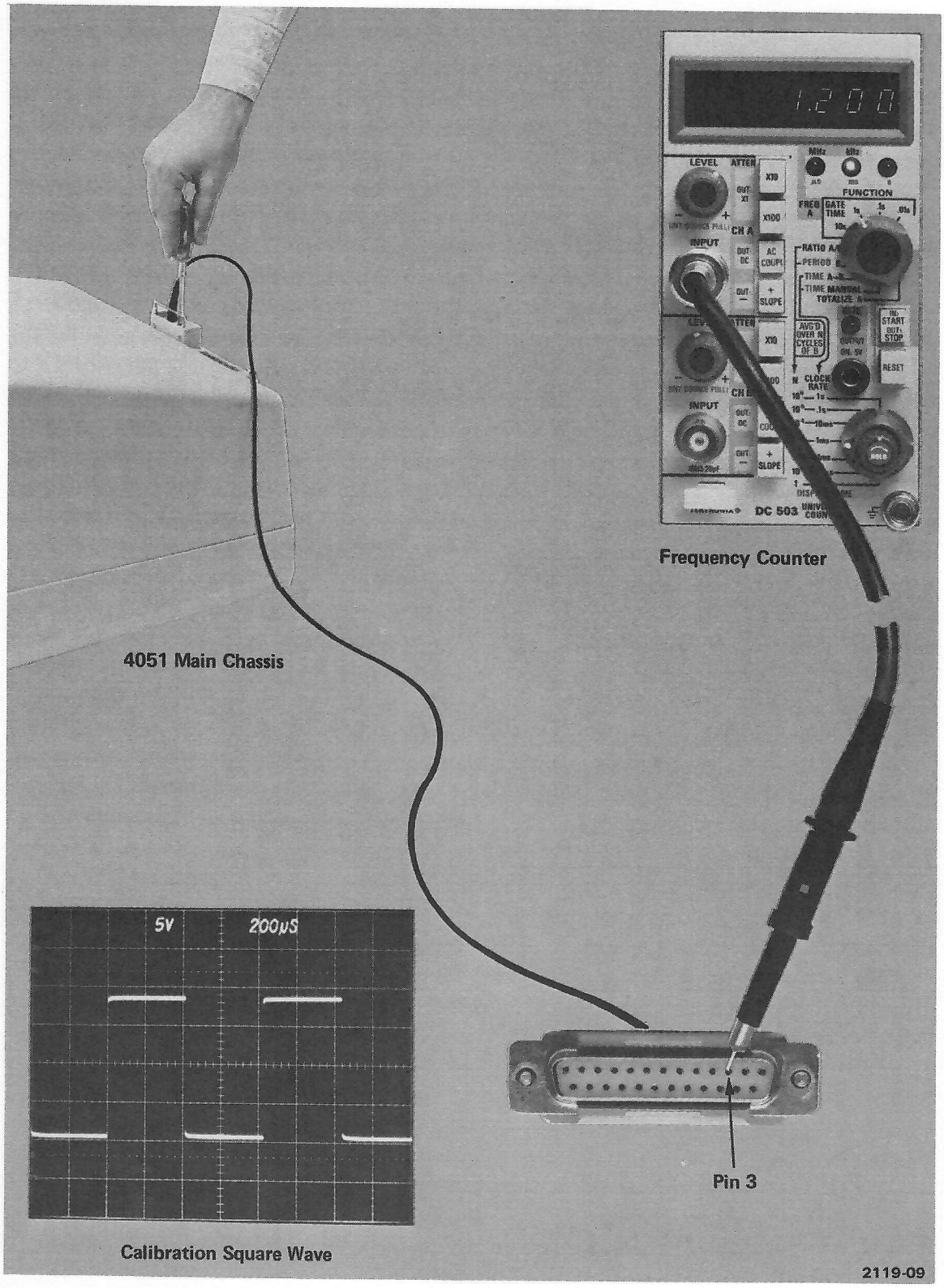


Figure 4-2. Baud Rate Calibration.

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