HEWLETT PACKARD

Current Loop Converter 13266A

user manual

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Introduction 1

What Is Current Loop?

The Hewlett-Packard Current Loop Converter is used to interface a terminal to a remote computer. The Current Loop Converter allows data communications over longer distances than are possible with standard RS-232C interfaces. Another advantage of current loop operation is that it can be used in environments that are electrically "noisy". This includes areas where industrial electrical equipment is used.

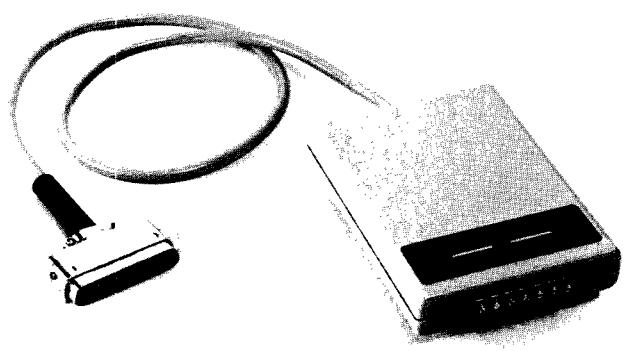
The standard HP 13266A comes with a cable for use with HP 262X series terminals. You must build a second cable to connect the converter to your particular computer system. Instructions for making this cable are given later in the manual.

When unpacking the converter, retain the shipping container. It can be reused if it is necessary to return the unit to Hewlett-Packard for service.

The Current Loop Converter is used in the same manner as other telecommunication interfaces. There are no special operating procedures. To use the Current Loop Converter, perform the following steps:

- If you are unfamiliar with current loop interfacing, read the remainder of this section. It will provide a brief explanation.
- Configure the Converter. To do this you should know some of the communication requirements of your computer system. The configuration process is described in Section II.
- Build a current loop cable. A description of cable requirements is given in Section III.

You can configure the Current Loop Converter to operate with a wide variety of devices. Although it is designed to be used with Hewlett-Packard 262X series terminals, it can be used with RS-232C devices capable of providing operating power to the converter.



Specifications:

Size:	120mm (width) 160mm (length) 30mm (depth)	Weight:	0.54 kg
		Cable Length:	1 meter

Figure 1-1. HP 13266A Current Loop Converter

Table 1-1 lists the power requirements of the converter. All voltages must be accurate to +/- 5%. (RS-232C and RS-449 are standards that specify signals and cable connectors to be used in communications equipment.)

Table 1-1. Converter Power Requirements

Voltage	Max Current Required	Pin Number	
		50-Pin Connector	Internal Connector
+12V	90 mA	10	1
-12 V	80 mA	11	2
+5 V	200 mA	35,36	3,15

The Current Loop Converter has built-in provisions for ground isolation and lightning protection. If the remote system is compatible, the converter cannot be permanently damaged by a possible wrong connection or configuration.

How Does It Work?

The Current Loop Converter interfaces devices that use changes in voltage levels to transfer information (RS-232C) to devices that use changes in current to communicate.

Standard RS-232C interfacing uses voltage levels to represent marks and spaces on the communications line. Current loop interfacing uses the presence or absence of current to represent the two logic states (1 or 0). The logic states are normally referred to as marks and spaces. The space represents a logic 0 value and the mark represents a logic 1 value. When current flowing represents a space, there is always an absence of current on the line except when a space is being transmitted. When a character is to be transmited, the current is turned on, and the first space becomes the start bit of the character.

Transmitters and Receivers

Figure 1-2a shows the elements that make up a current loop. The circuit consists of a transmitter, receiver, and current supply. The transmitter sends data by switching the flow of current on and off in the loop. The receiver detects these changes in current flow. While there is a transmittter and receiver at each end of the loop, there normally is only a single current supply in the circuit.

The Current Loop Converter can be configured with the current source in the transmitter or reciever circuit. These two configurations are shown in figures 1-2b and 1-2c.

Some equipment is designed to detect a logic "1" condition when current flows in the circuit and a logic "0" when no current flows. Other equipment equates current flowing to a logic "0". The Current Loop Converter can be configured to work either way. Detailed instructions for selecting the proper mode of operation for your equipment is given under "Configuration".

As illustrated in Figure 1-3, the device on each end of a current loop has both a transmitter and a receiver.

The transmitter manipulates the current (opens and closes the current loop) to generate marks and spaces.

The receiver monitors the state of the current loop to determine if data is being received.

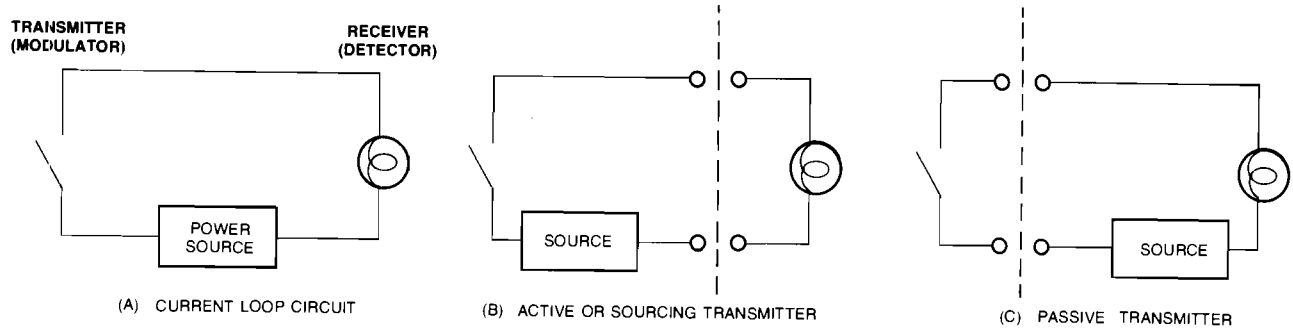


Figure 1-2. Basic Current Loop Circuit

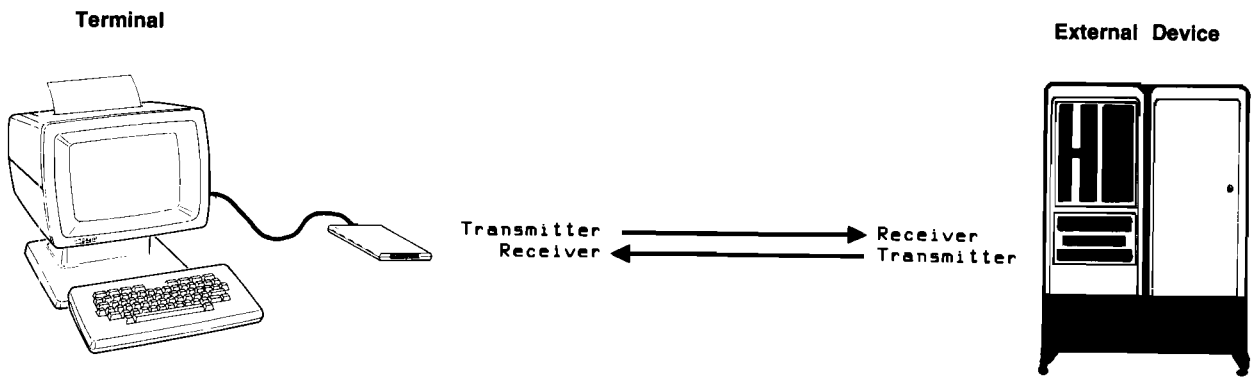


Figure 1-3. Typical Current Loop Interface

When data is not being sent, current normally flows through the loop. This provides a check to ensure that the circuit is connected and is functioning properly. When data is transmitted, the current is turned off and on according to the pattern of logic 1's and 0's to be sent. The receiving device detects the current flow and converts the information back to a series of voltage changes.

In a normal configuration the transmitter of one converter is connected to the receiver of the remote system. This forms two independent current loops allowing full duplex operation. Data can be transmitted in both directions simultaneously.

Types of Transmitters and Receivers

There are two types of transmitters and two types of receivers:

- sourcing (active)
- sinking (passive)

A sourcing (active) transmitter supplies the current for the loop; a sinking (passive) transmitter does not.

A sourcing (active) receiver supplies the current for the loop; a sinking (passive) receiver does not.

Schematic representations of these four types of transmitters and receivers are shown in figure 1-4. The specifications for each is given in table 1-2.

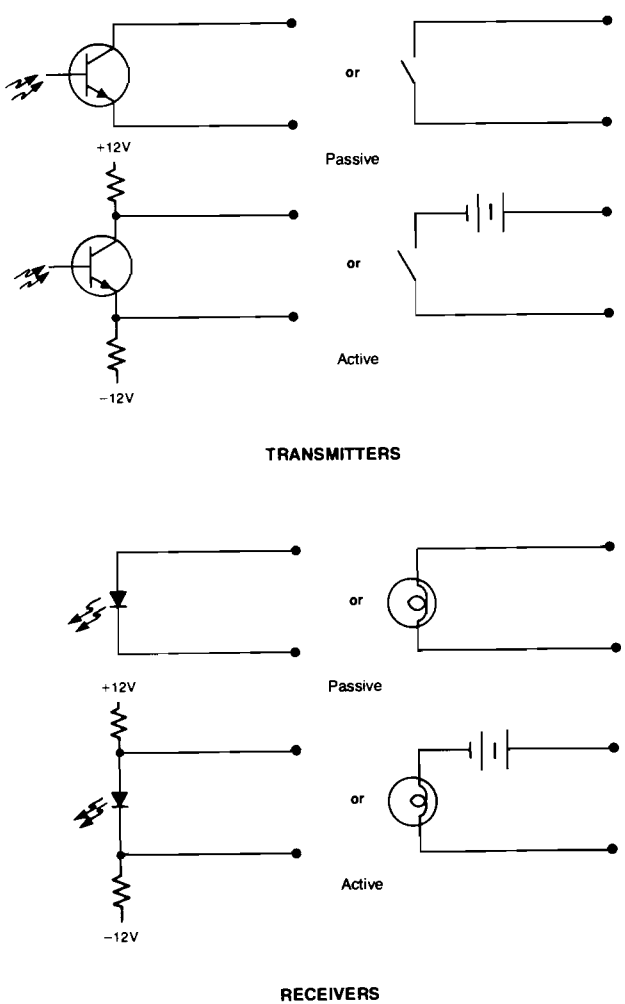


Figure 1-4. Transmitter and Receiver Types

Table 1-2. Receiver and Transmitter Specifications

Receiver and Transmitter Types	Min	Max
Receiver, Passive		
On State: Low current threshold	6 mA	60 mA
High current threshold	13 mA	60 mA
Off State: Low current threshold	0 mA	4 mA
High current threshold	0 mA	8 mA
On State voltage drop (20 mA):		
Low voltage threshold	4.7 V	
High voltage threshold	8.5 V	
Receiver, Active		
On State: Low current threshold	8 mA	22 mA
High current threshold	12 mA	22 mA
Off State: Low current threshold		2 mA
High current threshold		9 mA
Driver, Passive		
On State current		60 mA
Off State current		2 mA
On State voltage drop		2V
Off State voltage drop		40 V
Driver, Active (output voltage > 2V)		
On State current		25 mA
Off State current		0 mA

Note: "On State" means current is flowing in the loop. On state voltage drop can be increased by 1 or 10 volts.

If one device has a sourcing type of transmitter, the other must have a passive or sinking type reciever. Conversely, if one device has a sinking transmitter, the other must have an active or sourcing receiver. (See figure 1-5.)

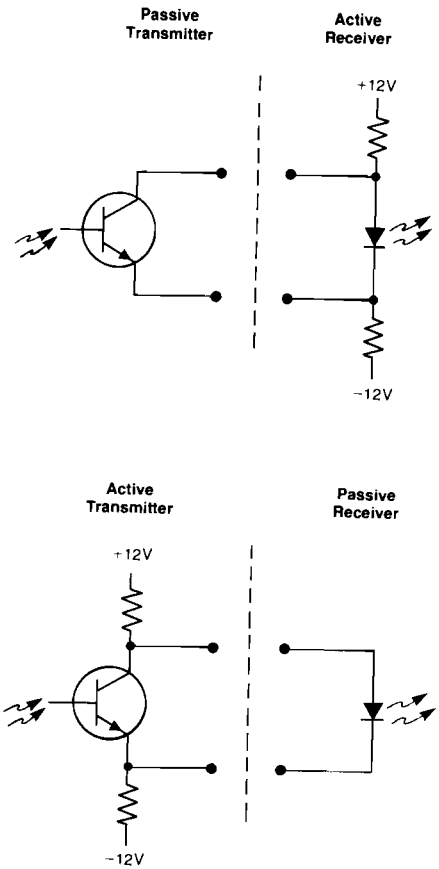


Figure 1-5. Current Loop Configurations

Most terminals using current loop communications are passive devices. They depend on the communications equipment or computer system to provide the current source(s). The Current Loop Converter can be used with this type of system. On systems that do not provide a current source the Current Loop Converter can provide a current source of up to 25 mA.

When the Current Loop Converter is used with non-HP systems, the type of receiver used on the remote system can be determined either from the manufacturer's documentation, or by testing.

A remote system can be tested using a 10 ohm resistor and a voltmeter with a sensitivity of 1000 ohms/volt or greater. Without connecting the converter, measure the voltage across the host system's output lines. (See figure 1-6.) Be sure that the host system is turned on. Test both the transmit and receive circuits.

It may not be possible to tell the sense of the idle state of the remote system. In the following test, the logic sense is not important when testing the remote system's receiver circuit. If the voltage is less than 2 volts, the system is probably passive and you can skip directly to the configuration procedure. If the voltage is more than 40 volts, the system is not compatible with the converter.

CAUTION

Do not attempt to connect the converter to a system having a loop circuit voltage greater than 40 volts. Connection may result in damage to the converter.

If the voltage is between 2 volts and 40 volts, connect the 10 ohm resistor across the line and measure the voltage across the resistor. The voltage should drop to less than about 0.6 volts. If the voltage does drop to below about 0.6 volts, the host system circuit is probably active. If it does not, the system is not compatible with the converter.

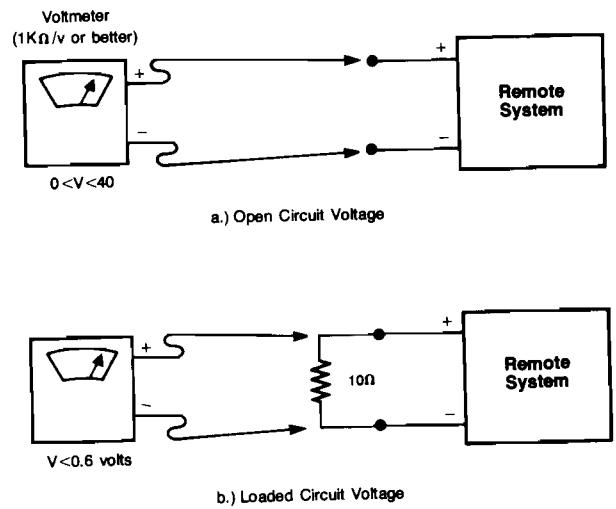


Figure 1-6. Remote System Test

Configuration 2

The Current Loop Converter can be configured to work in a wide range of current loop applications and with a variety of equipment. The converter is configured by setting switches mounted inside the converter. The switches are accessed by removing the converter's cover. The cover is held in place by three screws. (See figure 2-1.) When replacing the cover, make sure that the LED (Light Emitting Diode) indicators are matched up with the two small holes in the converter cover. Tighten the screws only until snug. Do not over tighten them or you may damage the converter cover.

Note

The internal parts of the converter are not clamped in place. Be careful not to dislodge any of the parts while configuring the converter. Make sure that the parts are installed correctly before replacing the top cover or it may not fit properly.

Configuration consists of the following:

- Assigning the current sources
- Set current flowing to be a "1" or "0"
- Setting the signal thresholds

There are ten configuration switches, S1 through S10. Table 2-1 lists brief descriptions of the switch functions. If you are using Hewlett-Packard equipment you can use the standard switch settings given in table 2-2. You can then connect the current loop cable and begin operation.

Note

The Converter Loop-Back switch is normally shipped in the TEST position. Make sure that this switch is set to NORMAL before attempting to operate the converter with a remote system.

CAUTION

Since other manufacturer's equipment design is subject to change, Hewlett-Packard can not guarantee that the Current Loop Converter will be compatible with all equipment. Before connecting the Current Loop Converter to another manufacturer's equipment, refer to the manufacturer's documentation to ensure compatibility and proper operation.

Table 2-1. Configuration Switch Descriptions

Switch	Description	
	OPEN	CLOSE
Driver		
S1, S2	Driver passive	Driver active
S3	Higher on state voltage (increase by 10 volts)	Lower voltage on state
S4	Higher on state voltage (increase by 1 volt)	Lower current threshold
S5	Mark = current	Mark = no current
Receiver		
S6, S7	Receiver active	Receiver passive
S8	High voltage threshold	Lower voltage threshold
S9	Lower current threshold	Higher current threshold
S10	Mark = no current	Mark = current

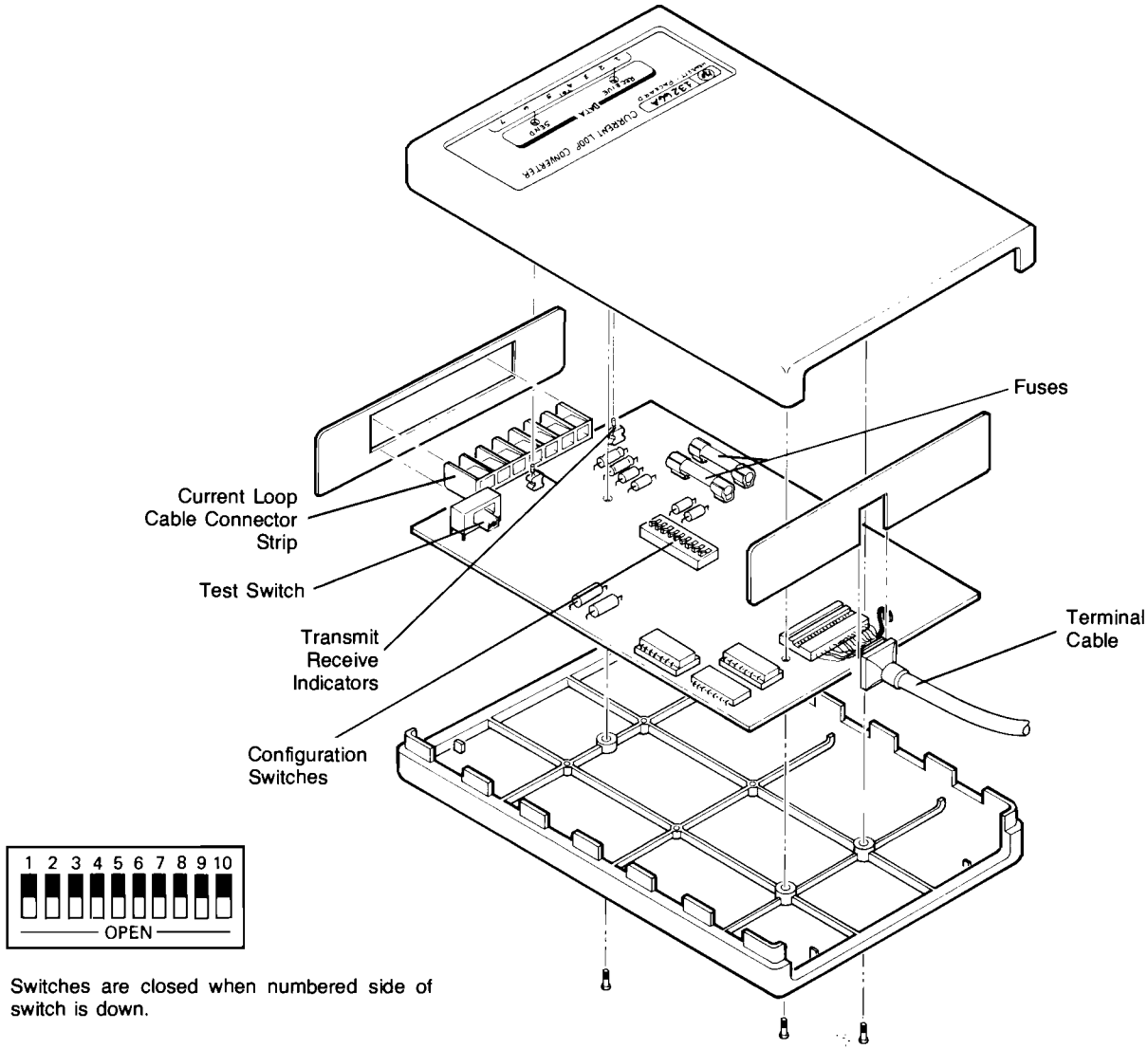


Figure 2-1. Accessing the Configuration Switches

Table 2-2 Local Converter Settings for Standard HP Configurations

Remote Device	Driver					Receiver				
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
HP 13266A				O		O	O			
HP 12531 ③	C	O				O	O			O
HP 12680 ③	C	O				O	O			O
HP 12966 ③④	C	O				O	O			O
HP 264X Current Loop						O	O			
Teletype ASR33 ③	C	O			O	O	O			
Half Duplex	O	O				O	O		O①	O②

All switches are closed unless otherwise indicated.

Notes: 1. Open if I<=16 mA.
2. Open if mark = no current.
3. Use CLOS and CLO- instead of CLO+ and CLO- to drive the remote device. (See Section III.)
4. Requires HP 93546 Special Order from Hewlett-Packard Data Systems Division.

If you do not find your equipment listed in table 2-2, you must determine the proper switch settings. The following paragraphs describe the switch functions in more detail. Read the descriptions and then use the flowchart in figure 2-2 to configure the converter. Once the converter has been configured, you can connect the current loop cable and begin operation.

Current Source

The S1,S2 and S6,S7 switches are used to select whether or not the converter is to supply current from its driver and receiver circuits. Normally the driver will supply current. In a full duplex connection there are four typical configurations:

- Drivers at both ends provide current (S1,S2 = C, S6,S7 = O)
- Receivers at both ends provide current (S1,S2 = O, S6,S7 = C)
- Local device provides current (S1,S2,S6,S7 = C on local unit)
- Remote device provides current (S1,S2,S6,S7 = O on local unit)

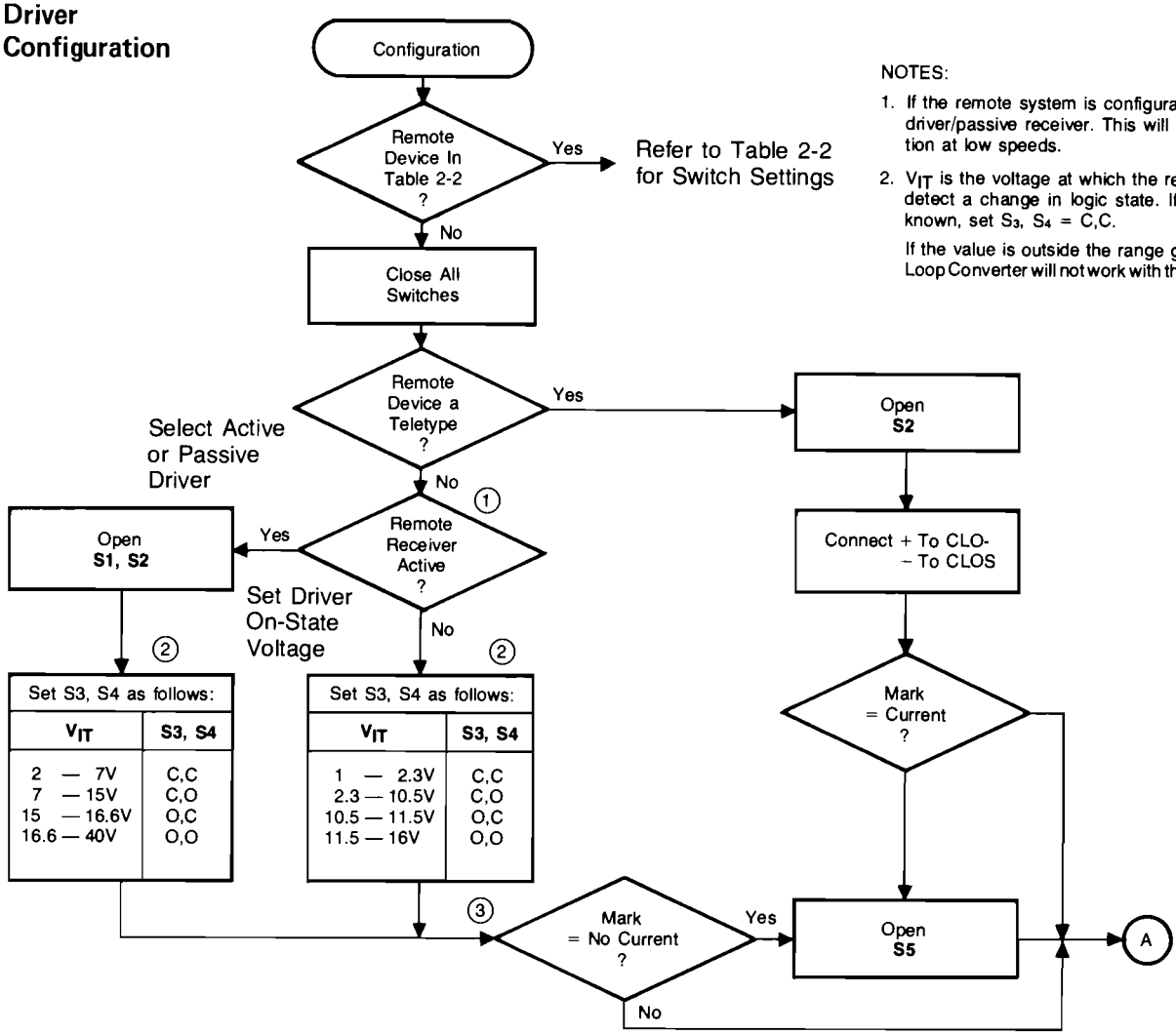
Note that if the drivers are to provide the current, you should decrease the voltage threshold on the receiver to allow for a voltage drop in the loop. (Refer to receiver threshold.)

Selecting the Logic Sense

Switch S5 selects whether current flowing in the loop driver is a logic "1" or "0". Closing S5 sets current flow = "0". This is the normal setting.

Switch S10 selects whether current flowing in the receiver circuit is a logic "1" or "0". Closing S10 sets current flow = "1". A mark is a "1" (< -3 volts). This is the normal setting. Note that the current flow is that in the receiver or driver circuit of the converter and not necessarily the current in the line.

Driver Configuration



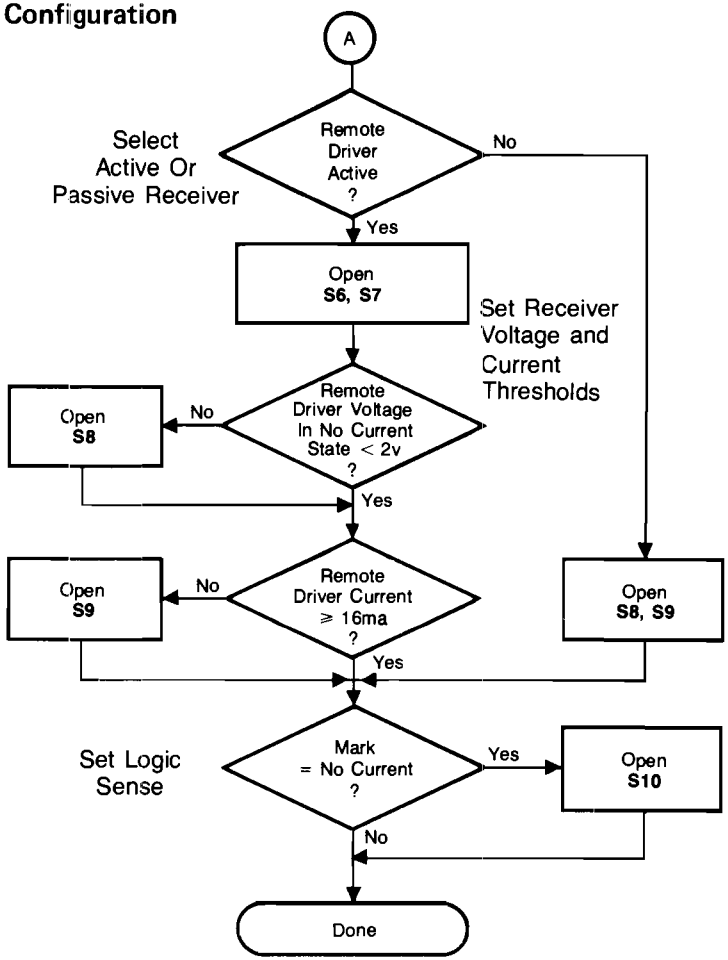
NOTES:

1. If the remote system is configurable, select active driver/passive receiver. This will guarantee operation at low speeds.
2. V_{IT} is the voltage at which the remote system will detect a change in logic state. If the value is unknown, set S_3, S_4 = C,C.

   If the value is outside the range given, the Current Loop Converter will not work with the remote system.

Figure 2-2. Configuration Procedure

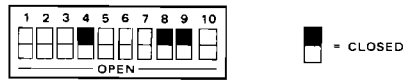
Receiver Configuration



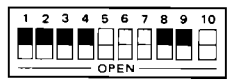
Sample Configurations

(Current Sense: Mark = no current)

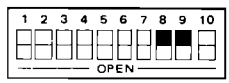
1. Remote receiver and driver active (open S1, S2, S6, S7).
   Remote driver current >16 ma (close S9).
   Driver low state voltage is 0v (close S8).
   Voltage threshold is 16.2v (open S3, close S4).



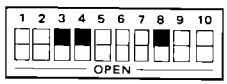
2. Remote receiver passive, driver active (close S1, S2, open S6, S7).
   Remote driver current >16 ma (close S9).
   Driver low state voltage is 0.8v (close S8).
   Voltage threshold is 1.7v (close S3, S4).



3. Remote receiver and driver active (open S1, S2, S6, S7).
   Remote driver current >16 ma (close S9).
   Driver low state voltage is 0v (close S8).
   Voltage threshold is 18v (open S3, S4).



4. Remote receiver and driver active (open S1, S2, S6, S7).
   Remote driver current <16 ma (close S9).
   Driver low state voltage is 0v (close S8).
   Voltage threshold is 5.6v (close S3, S4).



5. Remote receiver passive, driver active (close S1, S2, S6, S7).
   Remote driver current >16 ma (close S9).
   Driver low state voltage is 0v (close S8).
   Voltage threshold is 1.5v (close S3, S4).

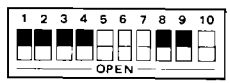


Figure 2-2. Configuration Procedure (Continued)

When setting S5 and S10 it doesn't matter which sense is selected as long as the remote and local devices use the same convention. If the wrong sense is selected for the receiver, garbled characters will appear on the screen. If in doubt, configure the receiver first and verify proper operation by sending data from the computer to the terminal before setting the transmit sense.

Note

The send and receive current loops can be set to use different current senses.

Setting Signal Levels

Receiver Current Threshold

The converter is designed to operate best with equipment using current levels of 20 mA for the currrent on condition. The receiving threshold for current is set at 10 mA. This means that current levels below 10 mA are seen as the no current condition and current levels above 10 mA are seen as the current condition.

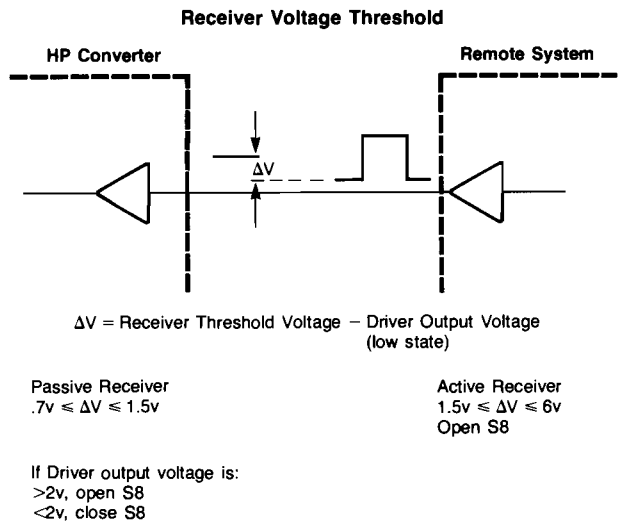
Some equipment uses lower current levels. Switch S9 can be used to adjust the current threshold or switching level for the converter. Opening S9 will lower the switching point to 5 mA. In this case current levels below 5 mA will be seen as the no current condition and current levels above 5 mA will be seen as the current condition.

Receiver Voltage Threshold

Whenever the remote driver is active, the local receiver high state voltage should be only .7 to 1.5 volts higher than the remote driver low state voltage. This minimizes the signal reflections and allows for a maximum DC voltage drop in the loop.

Note

The voltage threshold (2.8 v or 6.1 v) is the switching point of the receiver. This is lower than the "current on" state at 20 ma (4.7 v or 8.5 v).



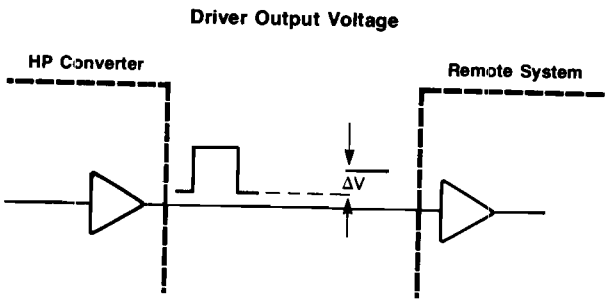
If the remote driver is passive, the DC voltage drop through the loop is in the other direction and the voltage threshold has to be raised. The receiver voltage threshold should be set to 1.5 v to 6 v higher than the remote driver output voltage. This is done by opening switches 8 and 9.

Passive receiver configurations give more signal reflection and is not recommended for distances greater than 2000 feet. If distances greater than 2000 feet are desired and you can choose between an active or passive receiver (the remote system is configurable), choose active receivers for minimum signal reflections.

Driver On State Voltage

You must adjust the driver output voltage of converter to match the termination at the remote receiver. This will help reduce signal reflections across the current loop line. The reflections are proportional to the length of the loop and can cause data errors at high baud rates. Adjustment is made using switches S3 and S4 to select the lowest switching voltages possible (see figure 2-2).

At speeds above 4800 baud reflections will cause a problem for cable lengths of more than 1000 feet. In a line having an impedence of 75 ohms, the voltage difference between the local driver output voltage (low state) and the remote receiver switching threshold should be 1.5 V. A difference of 6 V can be used for distances up to 2000 feet but the baud rate must be reduced to 2400 baud.



ΔV = Receiver Threshold – Driver Output Voltage (low state)

Voltage Difference	Maximum Distance	Maximum Baud Rate
1.5 V to 6.0 V	2000 Ft	4800 Baud
> 6.0 V	1000 Ft	2400 Baud

When the local driver is passive, switches S3 and S4 are used to set the driver on state voltage at 1.5 to 6 volts less than the remote receiver threshold voltage. Leaving switches S3 and S4 closed will guarantee low speed operation. The settings for higher data speeds are as follows:

Remote Receiver Threshold	S3	S4
2v - 7v	C	C
7v - 15v	C	O
15v - 16.6v	O	C
16.6v - 40v	O	O

When the local driver is active, the driver on state voltage should be .7 to 1.5 volts less than the remote passive receiver voltage threshold. Switches S3 and S4 should be set as follows:

Remote Receiver Threshold	S3	S4
1v - 2.3v	C	C
2.3v - 10.5v	C	O
10.5v - 11.5v	O	C
11.5v - 16v	O	O

Ground Isolation

You should provide ground isolation between all devices in a network. The driver and receiver in the Current Loop Converter are isolated from the local ground whenever they are used in the passive configuration. This is with S1,S2 and S6,S7 open (see figure A-1).

If either the driver or receiver circuits are active, the drivers and receivers on the remote device should be isolated. If you cannot guarantee isolation, it is recommended that the Current Loop Converter not be used in applications over 1000 feet, in "noisy" environments, or where there is a difference in ground potential between the remote and local devices.

Lightning Protection

The converter is protected against lightning when both the driver and receiver circuits are configured as active (S1,S2,S6, and S7 closed). In this mode the converter can absorb up to 1500 watts for 1 ms. When the converter circuits are passive, the receiver circuit is protected against voltage spikes up to 3 kV and having more than 1 us of rise or fall time. There is no protection against a direct strike by lightning. Note that the degree of protection will depend on both the local and remote devices.

Sites that are particularly susceptable to lightning include those having any of the following:

- Tall structures
- Power lines between buildings
- Low humidity
- High altitude

If your site contains any of the previous conditions, you should have lightning protection for the current loop.

Fault Protection

The Current Loop Converter can withstand voltages between +20 Volts and -20 Volts connected to any of the converter's current loop pins. The converter uses fuses for protection against currents greater than 60 mA.

Installing the Converter 3

Making a Cable

A standard 1 meter cable (HP part number 5061-2448) to connect the converter to an HP 262X series terminal is provided with the converter. The cable has a 50-pin connector at the terminal end and a 24-pin connector at the converter end. A wiring diagram and parts list is given in figure 3-1.

The current loop cable should be made using a shielded cable with two sets of twisted pair wires. The cable wires should be AWG 22 (American Wire Gauge size 22). Smaller wire can be used for relatively short distances. Wire can be ordered by the foot from Hewlett-Packard as part number 8120-1187 or from Belden Company as part number 8723. The ends of the twister pairs and the shield braid can be connected directly to the barrier strip connector on the Current Loop Converter or you can use either spade or eye type lugs to connect to the barrier strip. Figure 3-2 shows how the cable should be prepared.

Item Number	HP Part Number	Description
1	8120-2890	Cable and strain relief
2	1251-0086*	Connector, 50-pin
3	1251-0171*	Rubber bushing
4	0890-0790	Shrink sleeve
5	1251-4332	Housing, 24-pin
6	1251-4182	Contact socket
7	1251-3808	Polarizing plug
8	0362-0595	Faston .25" female

* These parts can be ordered as 5061-2412.

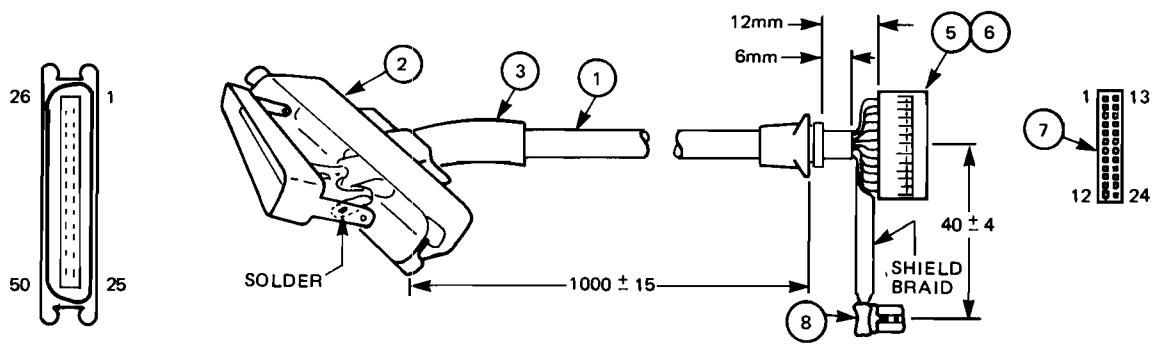


Figure 3-1. Terminal to Converter Cable

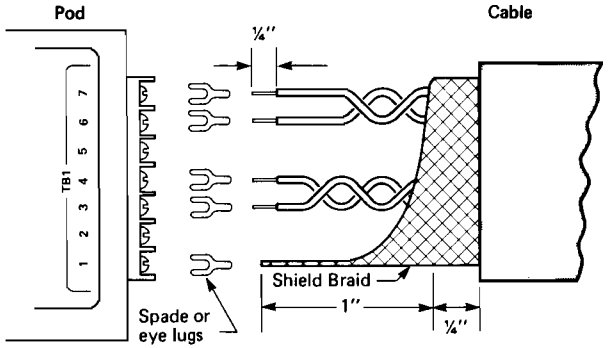


Figure 3-2. Current Loop Cable Wiring

The cable should then be connected as shown in figure 3-3. Note that the input signal for one device is taken from the output signal of the other. Positive terminals should connect to positive terminals.

One end of the shield must go directly to earth ground. The other end must be connected to ground through a .01 microfarad, 3kV capacitor. This is to allow high frequency signals (lightning, electrical noise, etc.) to be filtered to ground. It also prevents low frequency current from flowing in the shield. This may happen if there are slight differences in the supply voltages of the two devices. Pin 7 of the Current Loop Converter provides this capacitor to ground connection.

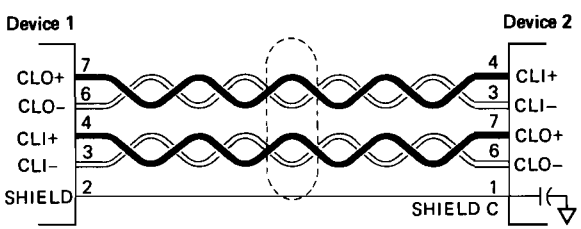


Figure 3-3. Current Loop Cable Connection

Table 3-1. Converter to Terminal Signals

HP 262X (50-Pin)	Converter Internal	Signal	Description
10	1	+12 V	+/- 5% @ 90 mA
11	2	-12 V	+/- 5% @ 80 mA
35	3	+5 V	+/- 5% @ 200 mA
12	4	SD (BA)	Send Data
27	5	N.C.	
42	6	RD+ (BB)	Read Data +
17	7	GND (AB)	
13	8	RS (CA)	Request To Send
44	9	CS (CB)	Clear To Send
45	10	N.C.	
48	11	GND (AB)	
-	12	N.C. (key)	
14	13	N.C.	
23	14	SC (ground) (AB)	
36	15	+5 V	
41	16	N.C.	
43	17	N.C.	
7	18	N.C.	
40	19	N.C.	
15	20	N.C.	
26	21	N.C.	
9	22	N.C.	
47	23	N.C.	
46	24	RR (CF)	Receiver Ready

Notes: 1. N.C. indicates no connection.
2. Signal names are RS449 Communications Standard names.
3. Signal names in parentheses are RS-232 names.
4. RS, CS, and RR are tied together in the converter to allow the terminal communications Self-Test feature to work.

Table 3-2. Converter to Current Loop Signals

Pin Number	Signal	Description
1	ShieldC	Ground (capacitor)
2	Shield	Ground
3	CLI-	Data In -
4	CLI+	Data In +
5	CLOS	Relay Output
6	CLO-	Data Out -
7	CLO+	Data Out +

Testing the Converter

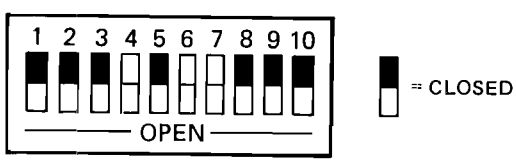
The Current Loop Converter can be quickly tested using an internal loop-back test. The loop-back test causes the output of the converter to be echoed back as input. If the data sent appears correctly on the terminal screen during the test, then the converter and terminal are probably functioning properly.

Note

Since a standard configuration for the converter is used for the test, not all of the converter features are tested.

Procedure

1. Set the converter configuration switches as follows:



2. Disconnect the current loop cable to the remote system.

3. Set the converter Loop-Back switch to TEST. The Loop-Back switch is normally shipped in the TEST position.

4. Type TEST on the terminal keyboard. The results should appear on the terminal display as follows:

```
TEST        (terminal set for full duplex)
```

or

```
TTEESSTT    (terminal set for half duplex)
```

If the converter is functioning properly, configure it as required for your host system and resume operation. If the test does not work, carefully check the cable

1. Check to make sure that the cable between the converter and the terminal are properly connected.

2. Make sure that the converter is properly configured for for the test.

3. Make sure that the terminal is set for remote operation and is properly configured.

4. If you have fabricated your own cable, make sure that all signal lines have been properly connected. Use an Ohm meter to check the continuity of each of the signal lines.

If the test still fails, contact your nearest HP Sales and Service office. (A list is given at the back of this manual.) DO NOT attempt to repair the converter.

Service or Repair

If the converter fails the self-test or does not work properly, contact the nesarest Hewlett-Packard Sales and Service office. A list is given at the back of this manual. DO NOT attempt to repair the converter. If it is necessary to return the unit to Hewlett-Packard for repair, use the original shipping container or equivalent.

Current Loop Converter Diagrams A

A simplified schematic diagram of the HP 13266A Current Loop Converter is shown in figure A-1. This diagram can be used as an aid in determining compatibility with a remote system and in selecting the proper converter configuration.

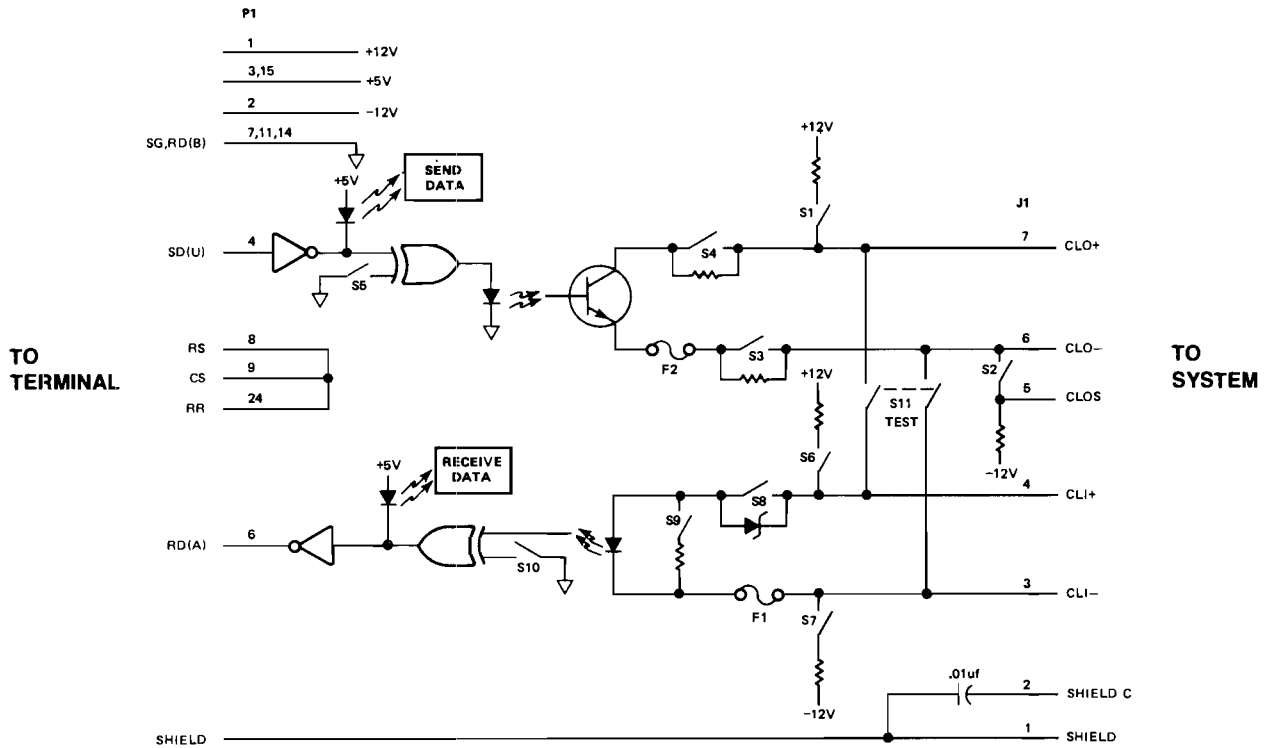


Figure A-1. Current Loop Converter Simplified Schematic Diagram

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