OPERATING INSTRUCTIONS

AND

SERVICE MANUAL

LOW THERMAL SCANNER

MODLES 160A, 164A, 320A

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WARRANTY AND SERVICE

CERTIFICATION: Data Proof certifies that this product was tested and inspected and found to meet its published specifications when it was shipped from the factory.

WARRANTY: This product is warranted against defects in materials and workmanship for a period of one year from date of shipment. During the warranty period, Data Proof will, at its option, either, either repair or replace products which prove to be defective.

SERVICE: For warranty service or repair this product must be returned to the factory. The buyer shall prepay shipping charges to Data Proof and Data Proof shall pay surface shipping to the buyer. Permission must be obtained from the factory for warranty repair returns.

LIMITATIONS: The forgoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the buyer, or unauthorized modifications or misuse.

Neither Data Proof or any of its employees shall be liable for any direct or indirect, special, incidental or consequential damages arising out of the use of this product.
No other warranty is expressed or implied.

SAFETY PRECAUTIONS

This product has been designed and tested in accordance with IEC1010-1/EN61010-1 including amendment 1(1995) for insulation category II use. Use of this equipment in a manner not specified may could result in personal injury.

AC POWER SOURCE: This product is intended to operate from an ac power source that will apply not more than 264 V ac between either of the supply conductors and ground.

POWER CORD: Use only the power cord and connector appropriate for the voltage and plug configuration in your country. The cord must contain a safety ground conductor and be connected to a plug which has a connection to earth ground. Use only a power cord that is in good condition.

FUSE: To avoid fire hazard use only the specified fuse. The fuse must be rated at 0.25 ampere/250 volts time-delay.

SIGNAL INPUT POWER: Signals applied to the input or output terminals must be limited to levels deemed safe by the IEC/EN specifications. When applied voltages are above 30 volts, the current source must limit the current to not more than 2 milliamps.

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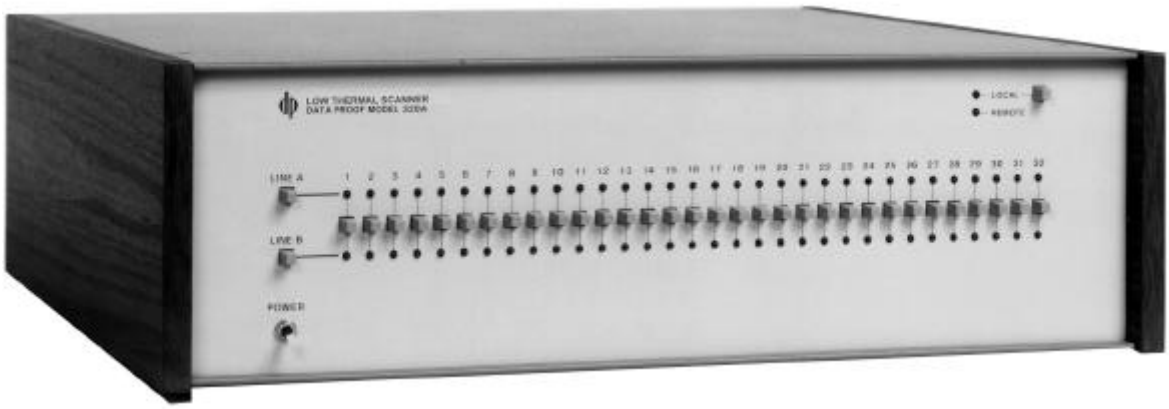
SECTION 1

GENERAL INFORMATION

1.1 DESCRIPTION

Data Proof Low Thermal Scanners with extremely low thermal offsets are ideal for automating precision measurements to sub-ppm accuracy. This versatile dual scanner has two pairs of output lines which makes it suitable for a wide variety of uses. It can be used for comparing voltage reference standards, as well as four-terminal measurements on resistance devices.

Special care has been taken to minimize thermal offsets. The switches used are latching relays requiring only a few milli-second pulse to actuate. Several systems are used to protect the devices connected to the scanner from being damaged by operator error or scanner failure. It can be operated from the front panel or by commands sent over the general purpose interface bus.



LOW THERMAL SCANNER
DATA PROOF MODEL 320A

1.2 SPECIFICATIONS

NUMBER OF INPUTS
16 for Model 160A, 164A
32 for Model 320A

THERMOELECTRIC POTENTIALS **
20 nanovolts typical, 50 nanovolts maximum

SYSTEMATIC ERROR CONTRIBUTION FOR VOLTAGE COMPARISON **
Standard deviation less than 20 nanovolts

ENVIRONMENTAL LIMITS
Operating: 10^{o} C to 40^{o} C up to 80% relative humidity
Storage: -20^{o} C to 65^{o} C up to 95% relative humidity

** Note: Specifications apply only if temperature is stable within 1^{o}C, free of drafts and the relative humidity is below 70%. Warm scanner up for 2 hours min. Measurement using the NIST 4x4 design with inputs properly shorted. (See NIST Technical Note 430.)

SCANNER CONTROL
Local, using front panel push buttons
Remote, via IEEE-488 bus (interface included)

RELAY CONTACT RATINGS
Life: greater than 10,000,000 cycles at low levels
Initial contact resistance: 0.05 ohm maximum
Current: 100 milliamp maximum at 10 volts
Voltage switched: 100 volts maximum at 1 milliamp
Voltage non-switched*: 300 volts max. for cable inputs
Voltage non-switched*: 600 volts max. for terminal inputs
*CAUTION - reduce voltage before actuating relays.
NOTE: when applied voltage is above 30 volts, the current source must limit the current to less than 2 milliamps to meet IEC 1010-1/EN61010-1 safety requirements.

SIZE
Length: 420 mm (16.5 in.)
Width: 451 mm (17.7 in.)
Height: 133 mm (5.2 in.)

WEIGHT
16 channel scanner: 10 kg (23 lb.)
32 channel scanner: 12 kg (27 lb.)

LINE POWER
100V, 115V-127V, 220V-230V, 240V all ±10%; 50-60 Hz

1.3 REAR PANEL CONNECTIONS

SCANNER INPUTS

Opt 1: Two meter (Six foot) cables. Untined solid copper wire in groups of four pairs.

Opt 2: Low thermal binding posts. Tellurium copper, gold flashed per MIL-G-45204.

OUTPUT LINES

Four low thermal binding posts

- Line A
- Line B
- Line A common
- Line B common

INTERFACE BUS

24 pin IEEE-488 connector, CINCH No. 57-20240

FUSE

0.25 ampere/250 volts time-delay

REFERENCE STANDARD PROTECTION

Screw terminals connected to open collector TTL logic circuit. Terminal goes low (0 volts) when any relay is closed, and goes high (5 volts through 10 kohm) when all relays are open. This line can be connected in parallel with other scanners cascaded in a large system to protect standards from being shorted together. Two systems are provided, one for line A and one for line B.

1.4 REFERENCE STANDARD PROTECTION SYSTEMS

Three systems are used to help protect standards from being damaged due to scanner failure or operator error. These systems are described briefly below. See Theory of Operation Section for complete description.

a. The relays are driven from a decoder so that only one output circuit can be activated for any possible input combination.

b. Contacts on each relay are connected so that all input lines must be open before power is available to close a relay.

c. Two push-buttons must be depressed at the same time to actuate any relay. Requires two hands to operate.

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SECTION 2

INSTALLATION

2.1 INITIAL INSPECTION

This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of mars and scratches and in perfect electrical order upon receipt.

Unpack the instrument and retain the shipping container until the instrument has been inspected for damage in shipment. If in-shipment damage is observed, notify the carrier and obtain authorization for repairs before returning the instrument to the factory.

2.2 POWER REQUIREMENTS

The instrument is shipped with a three wire line cord and must be connected to a grounded 50 to 60 Hz ac power source. Transformer taps are available for operation at the following line voltages: 100V, 115V-127V, 220V-230V, 240V all ±10%. Line voltage selection is accomplished either by changing the line selector on the rear panel or changing jumpers on the power transformer depending on the scanner model. The jumper connections are shown on the power supply diagram.

WARNING: BEFORE SWITCHING ON THIS INSTRUMENT, THE PROTECTIVE TERMINAL OF THIS INSTRUMENT MUST BE CONNECTED TO A PROTECTIVE EARTH CONTACT. THE POWER LINE CORD SUPPLIED WILL PROVIDE THE PROTECTIVE GROUNDING WHEN INSERTED INTO A SOCKET OUTLET PROVIDED WITH AN EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD OR ADAPTOR WITHOUT A PROTECTIVE GROUNDING CONDUCTOR.

2.3 LOCATION

To insure optimum performance, the scanner should be installed in an area having reasonably constant temperature, no strong electrostatic or magnetic fields, and a minimum amount of vibration. The unit should not be located near heating or cooling vents or in direct sunlight. Such locations can cause sudden temperature changes resulting in generation of thermal errors in the measurements. A cloth can be placed over the binding posts on the rear panel (and at the connections to your devices) to shield it from drafts to further reduce thermal errors.

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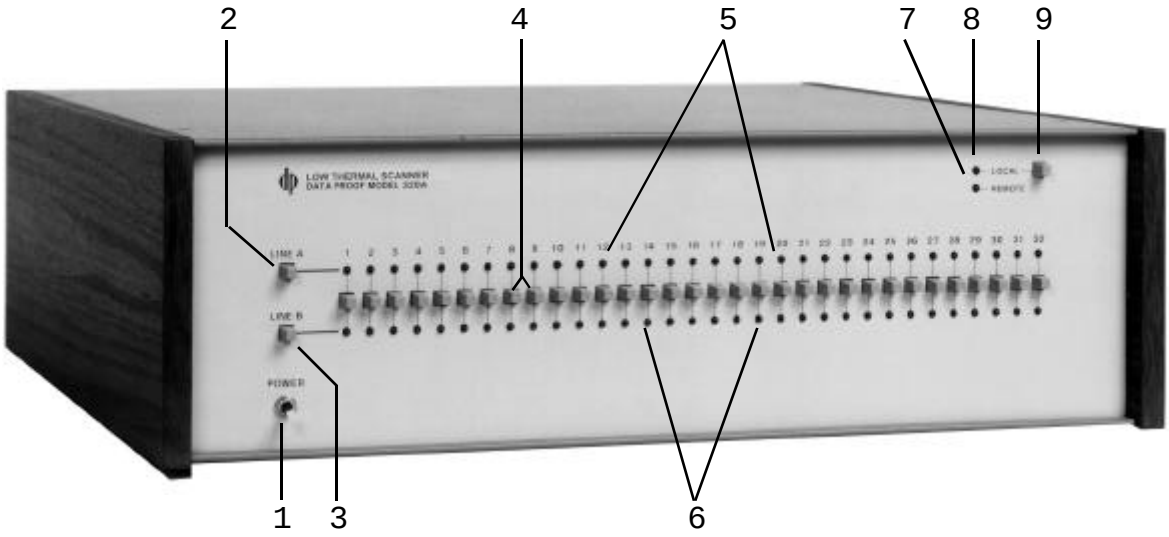
SECTION 3

OPERATION

3.1 FRONT PANEL CONTROLS AND INDICATORS (Model 320A shown)



1. Line POWER on/off switch

2. LINE A push-button - when depressed will cause any relay on the A line to be cleared.

3. LINE B push-button - when depressed will cause any relay on the B line to be cleared.

4. Numbered relay control push-buttons - when depressed at the same time that either the A LINE or the B LINE push-button is down will cause the corresponding relay to close.

5. LINE A lights - indicates which LINE A relay is closed.

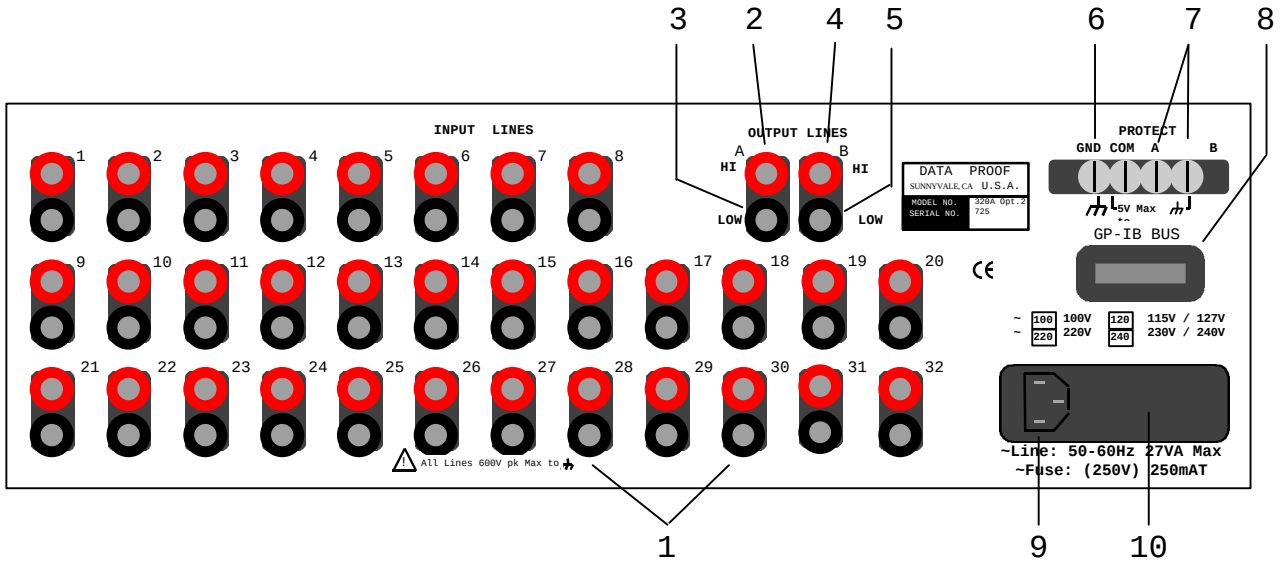
6. LINE B lights - indicates which LINE B relay is closed.

7. REMOTE light - is illuminated when the scanner is in bus control. The front panel push-buttons are inoperative.

8. LOCAL Light - is illuminated when the scanner is in front panel (local) control.

9. LOCAL push-button (if equipped) - returns scanner to local.

3.2 REAR PANEL CONNECTIONS (Model 320A option 2 is shown)



1. SCANNER INPUTS - Terminal inputs, opt 2 (shown)
Connect red terminals to positive leads of units under test and negative leads to black terminals. Numbers correspond to front panel relay numbers.

1. SCANNER INPUTS - Cable inputs, opt 1 (not shown)
Cable lines are in groups of four pairs. The relay numbers are shown on the color code chart at the end of each cable. The lines in cable with red band are to be connected to the unit positives. Connect the unit negatives to the lines with the black band.

2. LINE A OUTPUT positive - Connect to positive terminal of measuring system.

3. LINE A OUTPUT COM - Connect to Line B output com for voltage comparisons.

4. LINE B OUTPUT positive - Connect to negative terminal of measuring system.

5. LINE B OUTPUT COM - Connect to Line A output com for voltage comparisons.

6. GND - Connected to chassis at relay isothermal box.

7. PROTECT CIRCUIT - Connect to same terminals on other scanners. Provides protection for standards in a multiple scanner system. See Section 3.9 for details.

8. INTERFACE BUS - IEEE-488 bus connector used to connect scanner to controller.

9. FUSE - Use 0.25 amp, Type 3AG slow blow.

10. AC LINE INPUT - AC Power connector IEC Type with offset pin connected to chassis.

3.3 FRONT PANEL OPERATION

The scanner must be in local mode (LOCAL light on) to operate from the front panel. If the REMOTE light is on, press the LOCAL push-button or turn power off and then on to reset.

To connect one of the channel inputs to LINE A proceed as follows:

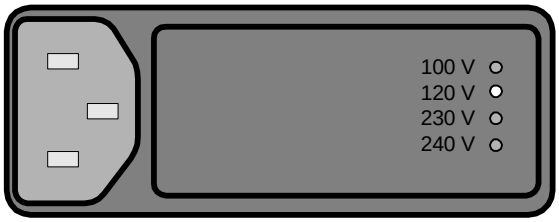
a. Press and hold down the LINE A push-button. This will cause any previously closed relay on the A LINE to be cleared.

b. Press the numbered push-button corresponding to the input to be connected. This will cause the relay to actuate connecting the input line to the A output and also turn on the appropriate light.

c. To actuate a LINE B relay repeat the above process except hold down the LINE B push-button.

NOTE: The push-buttons can be depressed in either order and the end result will be the same; that is, any previously closed relay will be opened and the desired relay will be closed. The important thing is that two push-buttons must be pressed for any relay to close.

3.4 OPERATION VOLTAGE SELECTION



The scanner can be operated at 100, 120, 230 or 240 Volt AC line voltage. The following explains how to change the voltage settings and the fuse.

Four possible voltage settings are available as shown on the Power Entry Module cover shows (IOOV, 12OV, 230V or 24OV). The white pin in one of these holes indicates the present voltage setting for the scanner. (The 120 Volt AC setting is shown above.) If this setting does not match the voltage available at your site, then it must be changed before powering on the scanner. Sites with 220 Volts line power should select 230 V.

Follow the steps below to change a fuse or convert the operating voltage of a scanner.

1. Set the scanner power switch to the OFF position (down).

2. Disconnect the power line cord from the AC wall outlet and from the power cord receptacle on the power entry module.

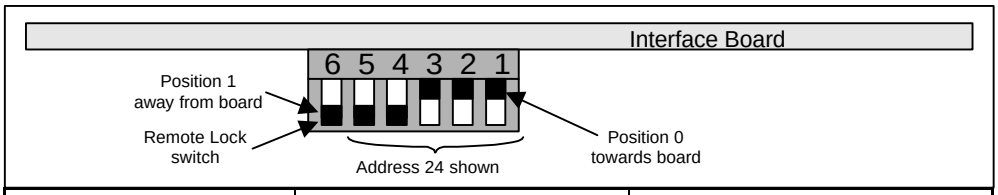
3. Inserted a small flat bladed tool into the slot at the left edge of the cover and carefully pry the cover off the fuse cavity.

4. Grasp the white plastic voltage select board use with a small pair of pliers and pull straight outward until the voltage select board unseats from the power entry module cover to change the voltage setting. Hold the board so that you can read the four voltage selection labels (100, 120, 23O and 240) imprinted on the board. Move the voltage indicator pin to the opposite side of the board from the desired voltage label. Be sure to seat the pin in the notch provided on the board's edge. Install the voltage select board so that it is fully seated in the voltage select cavity (the label side toward the fuse cavity).

5. Change the fuse if necessary. Carefully replace the power entry module cover making sure the voltage indicator pin is seated properly in the appropriate hole.

3.5 ADDRESS SELECTION

The IEEE-488 bus address of the scanner is selected by the “DIP” switches located on the interface board under the top cover. The five switches labeled 1 through 5 are used to select a unique address. The scanner normally leaves the factory with the switches set to a bus address of 24. Switch No. 6 is used to lock the scanner in remote only. The following table lists the address codes and corresponding switch settings:



ASCII Code Character		Address Switches					5 Bit Decimal code	
Listen	Talk	A5	A4	A3	A2	A1		
SP	@	0	0	0	0	0	00	
!	A	0	0	0	0	1	01	
"	B	0	0	0	1	0	02	
#	C	0	0	0	1	1	03	
$	D	0	0	1	0	0	04	
%	E	0	0	1	0	1	05	
&	F	0	0	1	1	0	06	
`	G	0	0	1	1	1	07	
(	H	0	1	0	0	0	08	
)	I	0	1	0	0	1	09	
*	J	0	1	0	1	0	10	
+	K	0	1	0	1	1	11	
`	L	0	1	1	0	0	12	
–	M	0	1	1	0	1	13	
.	N	0	1	1	1	0	14	
/	O	0	1	1	1	1	15	
0	P	1	0	0	0	0	16	
1	Q	1	0	0	0	1	17	
2	R	1	0	0	1	0	18	
3	S	1	0	0	1	1	19	
4	T	1	0	1	0	0	20	
5	U	1	0	1	0	1	21	
6	V	1	0	1	1	0	22	
7	W	1	0	1	1	1	23	
8	X	1	1	0	0	0	24	← FACTORY SETTING
9	Y	1	1	0	0	1	25	
:	Z	1	1	0	1	0	26	
;	{	1	1	0	1	1	27	
<	\	1	1	1	0	0	28	
=	}	1	1	1	0	1	29	
>	~	1	1	1	1	0	30	

TABLE 3-1 BUS ADDRESS

3.6 OPERATION FROM INTERFACE BUS

The interface circuit is designed to accept coded data sent over the bus to actuate the relays. To operate with the bus the scanner must be set to a usable address and must be connected to the controller using a 24 pin IEEE-488 cable (not supplied).

The scanner was set at the factory for bus address 24. All the examples that follow assume 24 as the address. The address can be easily changed if necessary by means of a "DIP" switch on the interface board located under the top cover. Refer to paragraph 3.6 for the procedure to change the bus address.

To actuate a relay the bus interface must first receive the correct address, then a three character ASCII code designating the relay, and then a carriage return/line feed. For example using an HPBASIC computer, the statement:

```
OUTPUT 724;"AO1"
```

would cause any relay on LINE A to be cleared, and then relay number 1 to be closed. In this example

7 is the controller IO address,
24 is the scanner address and
A01 is the code for relay 1 on line A

To clear both lines use the following HPBASIC commands:

```
OUTPUT 724;"AOO"
WAIT .2
OUTPUT 724;"BOO"
```

Note that each actuation must be a separately addressed statement. For example, the following is not valid:

```
OUTPUT 724;"AOO","BOO"  —NOT VALID—
```

Note also that a delay of at least 200 milliseconds must occur between any two actuations to allow the relays to complete their operation.

3.7 SAMPLE PROGRAMS

The following program will exercise the scanner relays 1 through 16 and leave both lines clear. This program is for HPBASIC computers with the scanner address set to 724.

```
10  ! SCANNER TEST
20  DIM Relay$[32]
30  Relay$="0102030405060708091011121314151 6"
40  FOR I = 1 TO 16
50  OUTPUT 724;"A"&Relay$[2*I-1,2*I]    ! CLOSES A RELAY
60  WAIT .5
70  OUTPUT 724;"B"&Relay$[2*I-1,2*I]    ! CLOSES B RELAY
80  WAIT .5
90  NEXT I
100 OUTPUT 724;"A00"                    ! CLEARS LINE A
110 WAIT .2
120 OUTPUT 724;"B00"                    ! CLEARS LINE B
130 END
```

Note: A Wait of at least 200 milliseconds is required between relay actuations to allow time for the relay circuits to actuate.

The second program example has exactly the same result as the first program listed above but uses string output statements. The formatted output statement is used to assure the first character that the scanner sees (after the address) is the line code and the next two characters are the relay code.

```
10  ! SCANNER TEST
30  FOR I = 1 TO 16
40  OUTPUT Code$ USING "A,ZZ";"A",I     ! SETS CODE
50  OUTPUT 724; Code$                   ! CLOSES A RELAY
60  WAIT .5
70  OUTPUT Code$ USING "A,ZZ";"B",I     ! SETS CODE
80  OUTPUT 724; Code$                   ! CLOSES B RELAY
90  WAIT .5
100 NEXT I
110 PRINT "A00"                   ! CLEARS A RELAY
120 WAIT .2
130 PRINT "B00"                   ! CLEARS B RELAY
140 END
```

3.8 REMOTE LOCK

The push-buttons can be locked out when it is desired to prevent tampering from the front panel. Position No. 6 of the "DIP" switch located on the Interface printed circuit board is used to lock the scanner in remote only. if the switch is the "O" position (towards the PC board) the REMOTE light will be on and the front panel push-buttons will not operate. The scanner can be actuated only by the bus in the usual manner. The scanner address must still be used in the output command to actuate the relays.

3.9 STANDARD PROTECTION FOR MULTIPLE SCANNERS

The protection feature can be extended to multiple scanners in a large system by means of the rear panel PROTECT terminals. The protection circuit prevents more than one relay on either the A Line or the B Line from being closed at the same time which prevents standards from being shorted together. Each relay has a contact which closes when the relay is in the open position. These contacts must all be closed (relays open)for the logic circuit to allow a close pulse to be sent out. This protection can be extended to more than one scanner in a large system by connecting the PROTECT terminals together. Both the A and B PROTECT terminals are connected to an open collector TTL gate on the control board. When all relays are open the terminal will be high (5 volts through 10 kohm), and when any relay is closed the terminal will be low (near 0 volts) . Connecting either terminal to COM will prevent any relay on that line from being activated.

To extend this protection feature when two or more scanners are used in a system, connect all PROTECT A terminals together, all PROTECT B terminals together, and all PROTECT COM terminals together.

3.10 OPTION 3 SCANNER GUARD

Option 3 scanners have both a high and low guard. The high guard surrounds the potential and current leads to the high end of the resistor. A separate low guard surrounds the leads to the low end of the resistor. The guard shields are switched along with the current and potential lines. The guard is carried through shielded cables from the resistor, through the scanner and to the output cables and requires an external source to be driven. Each guarded cable has a white and a black lead. The white and black leads are identical so either could be used as the current or potential circuit. The guard circuit is switched to chassis ground when the channel is not connected.

SECTION 4

THEORY OF OPERATION

4.0 INTRODUCTION

Data Proof Low Thermal Scanners with extremely low thermal offsets are ideal for automating precision measurements to sub-ppm accuracy. This versatile dual scanner has two pairs of output lines which makes it suitable for a wide variety of uses. It can be used for comparing voltage reference standards, as well as four-terminal measurements on resistance devices.

4.1 LATCHING RELAY

The device that makes this scanner possible is a sensitive latching relay originally manufactured for the telephone industry. The major problem with conventional relays is the thermal offset voltage caused by the heat generated by the current in the relay coil. With this latching relay a short pulse of only 10 milliseconds is all that is required to toggle the contacts from one side to the other. Thus the heat generated is negligible. The relays are attached to the boards with spring clips so that they can be easily removed for replacement if necessary

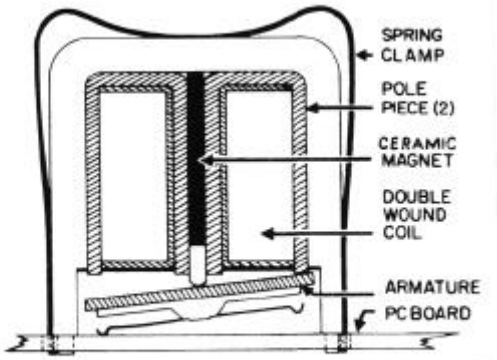


FIGURE 4.1 LATCHING RELAY ARRANGEMENT

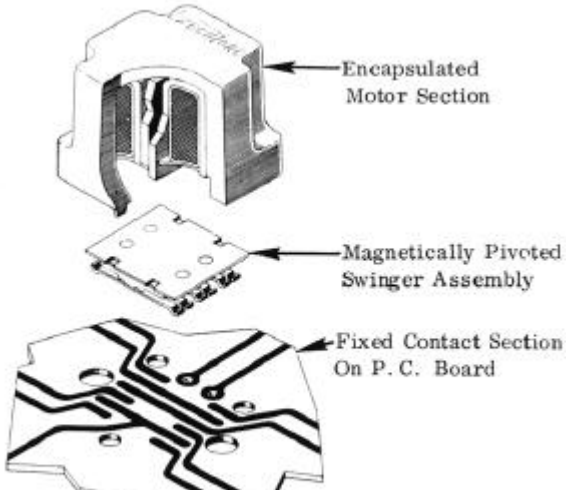


FIGURE 4.2 LATCHING RELAY CONSTRUCTION

Figure 4.1 shows how the relay is arranged. Figure 4.2 shows the construction details. The gold fingers attached to the relay armature make contact to gold pads on printed circuit boards. A permanent ceramic magnet holds the armature in place against one of the two pole pieces. If the coil on the side opposite is energized, the armature will toggle so that it is held against the other pole piece. once the armature has toggled the current in the coil can be removed. This requires less than ten milliseconds.

The relays used in the scanner have 3-pole, 2-throw bifurcated contacts. The contacts short out parallel traces on the printed circuit board connecting the channel inputs to the output lines. A third contact provides current to a light on the front panel to indicate which relay is closed.

4.2 LOW THERMAL DESIGN

Special care has been taken to minimize thermal offsets. The switches used are latching relays requiring only a short pulse to actuate, and thus no self-heating occurs. Gold plated fingers on the relay armature make direct contact to hard gold pads on special circuit boards.

Relays make connection by shorting together adjacent pads on the board with pairs of contacts. Thus any thermal emf caused by a contact is canceled out by the nearly equal thermal emf generated by the other half of the pair.

Switching assemblies with eight relays to a PC board are housed in a heavy machined aluminum box. This isothermal enclosure helps to maintain a uniform temperature at each of the relay contacts.

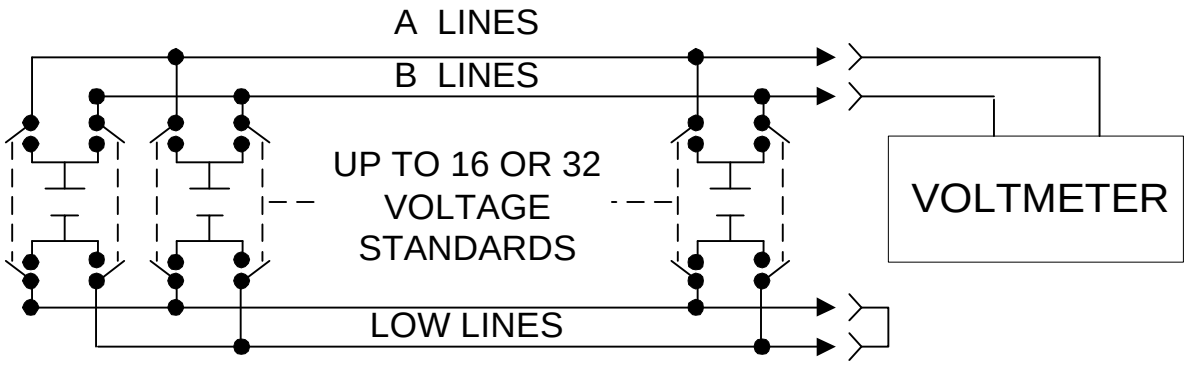


FIGURE 4.3 SCANNER CONFIGUATION

The printed circuit edge connectors carry only the relay coil and panel light circuits. All the channel input lines are soldered to the relay boards directly to prevent the thermal and noise voltages caused by connectors.

4.3 SCANNER CONFIGURATION

In order to compare voltage reference standards, two units at a time must be connected in series opposition with the unit negative terminals tied together. To accomplish this, two relays are connected to each unit with one relay switching to an output line marked A, and the other relay switching to a second output line marked B. A second contact on each relay connects the negative terminals to common lines. As shown in Figure 4.3 the A and B lines are connected to a measuring system to obtain the small difference voltage between the two units.

Both the positive and negative terminal of the unit is switched so that when both relays are open the unit is completely floating to minimize leakage current problems. The two common lines are brought out to the rear panel, but are normally shorted together when using the NBS design procedure.

4.4 LOGIC CIRCUITS

The scanner is designed to allow easy operation from both the IEEE-488 Bus and the front panel. The information from the bus is in binary form sent serially, one ASCII character at a time. This serial format is changed to a parallel format by means of a decoder ROM on the interface board as can be seen in Figure 4.4.

To allow the system to operate from the front panel, the push-button data is converted to a form identical to binary data from the bus interface circuit. A selector at this point switches between bus or push-button operation. A 6-to-64 line decoder after the selector converts the 6-bit parallel data to a single line output which actuates one of the relay coil drivers.

4.5 PROTECTION FOR DEVICES CONNECTED TO THE SCANNER

Some devices such as standard cells can be damaged if two relays on the same output line are closed at the same time. The Data Proof scanners have three methods to protected devices connected to the scanner inputs.

Two of the three protection schemes can be seen in Figure 4.4. The first one is in the logic itself. The data at the selector is in six bit binary. Thus only one of the 64 relays can be activated for any possible combination of the six input lines. If a failure should occur in the bus interface, encoder or selector circuits, or if an incorrect message is sent over the bus, no devices will be damaged because only one relay can be closed.

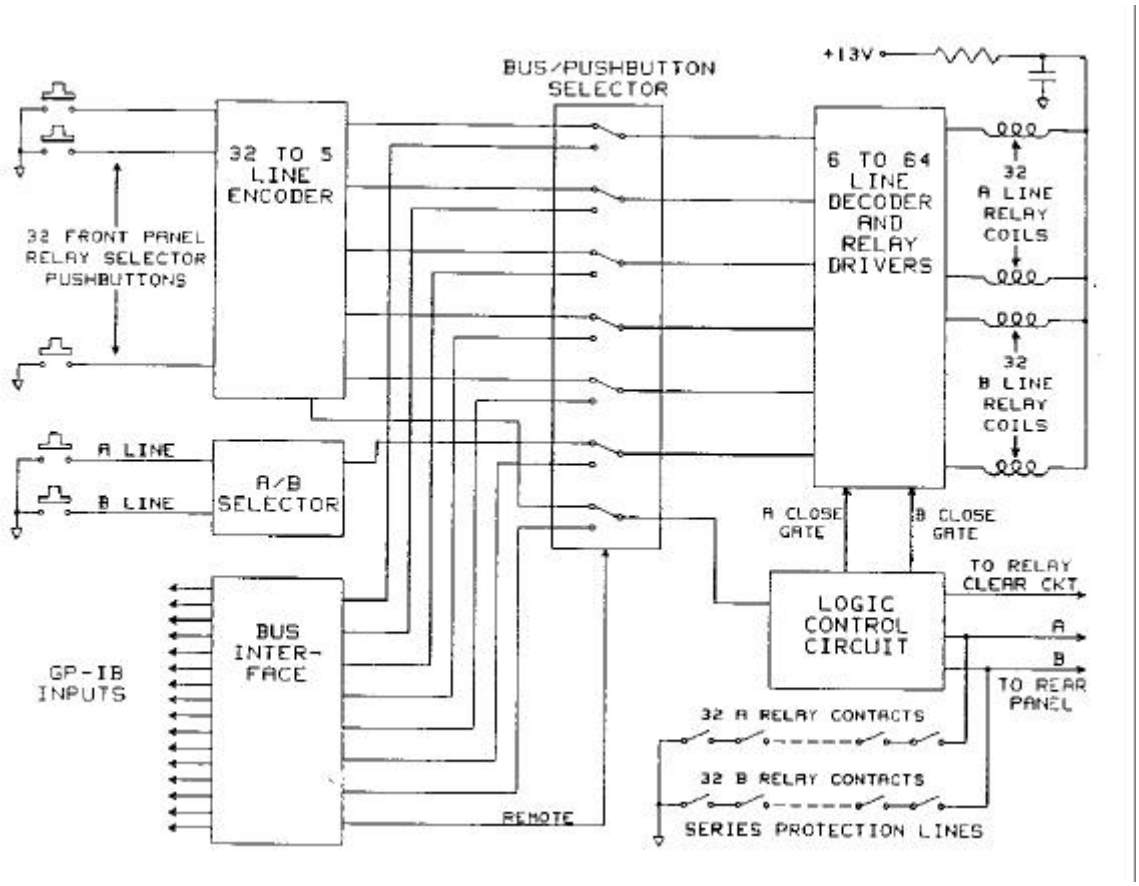


FIGURE 4.4 FUNCTIONAL DIAGRAM OF SCANNER

The second method for protection, also shown in figure 4.4, is the 'close gate' lines to the decoder circuits. The control circuit will allow these gates to open only if the series protection line is complete to ground. One of the contacts on each relay is connected in series, and will complete the series protection circuit only if all the relays on the line are in the clear position. Thus, no relay on the A line can be closed if any other relay on the A line is already closed; and similarly no B line relay can be closed if any other relay on the B line is already closed. These series protection lines are brought out to terminals on the rear panel. Thus if more than one scanner is used in a large system and these terminals are connected together, all units in the system will be protected.

The third protection mechanism to protect devices from damage is not shown on the diagram but is part of the control logic circuit. This is the requirement that two push-buttons on the front panel must be pressed at the same time for any relay to actuate. These would be either the A or B line button and any of the 32 relay selector push-buttons. This is to help prevent accidental operation. It takes two hands to operate the scanner from the front panel.

4.6 PROCEDURE FOR MEASURING VOLTAGE REFERENCES

The National Institute of Standards and Technology has recommended a method of inter-comparing voltage reference standards by measuring the difference between the units in pairs in a statistically balanced design. Usually the number of unit pair measurements is twice the number of units being compared. One possible design for comparing two groups of four units is shown in Figure 4.5.

READING	A LINE		B LINE	
El	Group	1, Unit 1	- Group	2, Unit 1
E2	Group	1, Unit 1	- Group	2, Unit 3
E3	Group	1, Unit 3	- Group	2, Unit 3
E4	Group	1, Unit 3	- Group	2, Unit 1
E5	Group	1, Unit 2	- Group	2, Unit 2
E6	Group	1, Unit 2	- Group	2, Unit 4
E7	Group	1, Unit 4	- Group	2, Unit 4
E8	Group	1, Unit 4	- Group	2, Unit 2
E9	Group	2, Unit 2	- Group	1, Unit 1
E10	Group	2, Unit 2	- Group	1, Unit 3
Ell	Group	2, Unit 4	- Group	1, Unit 3
E12	Group	2, Unit 4	- Group	1, Unit 1
E13	Group	2, Unit 1	- Group	1, Unit 2
E14	Group	2, Unit 1	- Group	1, Unit 4
E15	Group	2, Unit 3	- Group	1, Unit 4
E16	Group	2, Unit 3	- Group	1, Unit 2

FIGURE 4.5: 4x4 MEASUREMENT DESIGN

As can be seen in the figure the eight units are compared using 16 measurements. Note that each unit appears on the A side twice and on the B side twice.

When all the unit difference measurements are complete, a least squares fit of the data can be computed. The estimated, or least squares optimized, differences can be compared to the measured values to compute a standard deviation characterizing the random error of the

measurements. This is a measure of the total system performance. Standard deviations typically 30 nanovolts or less can be expected with the scanner and a good measuring system.

EMF STANDARD OBERSVATIONS Std Dev= 0.002 A-B Comp= 0.001 10 MAR 1991

OBS	A-LINE	B-LINE	READING	DEV	OBS	A-LINE	B-LINE	READING	DEV
1	A 1	E 1	-0.001	0.001	33	E 1	A 1	0.003	0.001
2	A 2	E 1	-0.014	0.001	34	E 2	A 1	-0.002	-0.001
3	A 2	E 2	-0.012	-0.000	35	E 2	A 2	0.012	0.000
4	A 3	E 2	-0.009	-0.000	36	E 3	A 2	0.023	0.000
5	A 3	E 3	-0.017	0.003	37	E 3	A 3	0.022	0.001
6	A 4	E 3	-0.016	-0.002	38	E 4	A 3	0.015	0.001
7	A 4	E 4	-0.007	0.001	39	E 4	A 4	0.007	-0.001
8	B 1	E 4	-0.013	0.000	40	F 1	A 4	0.006	-0.000
9	B 1	F 1	-0.013	-0.001	41	F 1	B 1	0.011	-0.001
10	B 2	F 1	-0.004	-0.000	42	F 2	B 1	0.013	-0.000
11	B 2	F 2	-0.006	0.000	43	F 2	B 2	0.007	0.001
12	B 3	F 2	-0.007	0.000	44	F 3	B 2	0.015	-0.000
13	B 3	F 3	-0.018	-0.001	45	F 3	B 3	0.019	0.003
14	B 4	F 3	-0.012	0.003	46	F 4	B 3	0.013	-0.004
15	B 4	F 4	-0.016	-0.000	47	F 4	B 4	0.020	0.004
16	C 1	F 4	-0.022	0.001	48	G 1	B 4	0.005	-0.001
17	C 1	G 1	-0.014	-0.001	49	G 1	C 1	0.013	-0.001
18	C 2	G 1	O.004	-0.001	50	G 2	C 1	0.017	0.001
19	C 2	G 2	0.002	-0.000	51	G 2	C 2	-0.006	-0.004
20	C 3	G 2	-0.000	-0.002	52	G 3	C 2	0.006	0.002
21	C 3	G 3	-0.006	-0.001	53	G 3	C 3	0.004	-0.001
22	C 4	G 3	0.007	0.002	54	G 4	C 3	0.006	-0.003
23	C 4	G 4	-0.002	-0.003	55	G 4	C 4	0.000	0.001
24	D 1	G 4	-0.008	0.002	56	H 1	C 4	-0.018	-0.002
25	D 1	H 1	0.006	0.001	57	H 1	D 1	-0.003	0.002
26	D 2	H 1	0.005	-0.001	58	H 2	D 1	0.004	0.000
27	D 2	H 2	-0.003	0.001	59	H 2	D 2	0.004	0.001
28	D 3	H 2	-0.003	0.000	60	H 3	D 2	0.011	-0.001
29	D 3	H 3	-0.011	0.001	61	H 3	D 3	0.012	0.001
30	D 4	H 3	-0.010	-0.000	62	H 4	D 3	0.014	-0.000
31	D 4	H 4	-0.015	-0.002	63	H 4	D 4	0.013	-0.001
32	E 1	H 4	-0.019	0.001	64	A 1	D 4	-0.011	-0.001

FIGURE 4-6: 32 CHANNEL SYSTEM TEST WITH INPUTS SHORTED

4.7 TEST RESULTS

Figure 4.6 shows the results of an actual test run on a typical Model 320A Scanner. It is a run of 64 measurements simulating eight sets of four standard units. For this test each of the 32 inputs was shorted individually with a short length of copper wire. Thus the printout shows the total errors in the measuring system.

For this run each channel was shorted together between the high and low input. The test results show residual thermal emfs and noise for the scanner and the measuring system used.

The measuring system consists of a Keithley 181 Nanovoltmeter connected to the Scanner A and B high (red) output lines with the A and B low (black) output lines shorted together. The Data Proof Voltage Reference Maintenance Program (VoltRef) was run on a computer to control the instruments to make the measurements.

VoltRef closes the two relays, waits 20 seconds and then takes 10 readings. It then reverses the relays, waits another 20 seconds and takes 10 more readings. The average of the 20 readings is the printed value. When all the readings are obtained, VoltRef computes a least squares fit of the data using the NIST procedure.

As can be seen from the print out, the standard deviation for the entire measurement was less than 10 nanovolts and the thermally generated emfs for all channels were less than 25 nanovolts.

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SECTION 5

MAINTENANCE AND TROUBLE SHOOTING

5.0 PERIODIC MAINTENANCE

There are no adjustments or controls in the scanner. No periodic maintenance is required.

5.1 UNSTABLE READINGS

The most common cause for unstable readings is poor connections between the units being measured and the scanner inputs. Loose connections or leads that are oxidized will cause unstable readings. The leads should be shinny and can be restored by lightly sanding with fine sandpaper or an emery board. Periodic cleaning of the leads and tightening connections may improve your readings.

Scanner channels that are used less than once a month may develop a film on the gold relay contacts. The relay contacts are wiped clean each time they are used; however, if a relay is not used for a while the film may not be wiped clean with only one closing of the relay. Infrequently used relays should be switched on and off a few times before use. This can be done from the front panel or by using the Check Scanner routine in any of the Data Proof software programs.

A less common reason for unstable readings is a relay that has drifted out of adjustment so that the contacts do not properly wipe clean. A bad relay contact can be verified by moving the test unit to a different channel and trying the measurement again. Another way to check for a bad relay is to short out several channels including the suspect channel. Then run a test using the Data Proof VoltRef software with the shorted channels . If one and only one channel is consistently unstable, then the relay should be replaced. See section 5.4 for replacement procedure.

5.2 RELAY FAILURES

Relay failure is just about the only cause of scanner malfunction. All relays are carefully adjusted and very thoroughly screened. Improved relay adjustment procedures and drive circuits have minimized but not yet completely eliminated these failures. A bad relay that will not open or close can be identified by the channel indicator light staying on or off.

Note: If one relay hangs up on the closed position, no other relays in the line can be closed. The protect circuit prevents more than one relay on a line from closing. See section 4.4 for protect circuit.

5.3 LOCATING THE RELAY CHANNELS

When the cover of the isothermal box is removed, the relay boards can be seen. Each board holds four A-line relays and four B-line relays. Refer to figure 5.1. The A-line relays are along the top of the board and the B-line relays are at the bottom. The first relay is at the end of the board closest to the rear panel. Channels one through four are on the board closest to the power transformer. The next board has channels five through eight and so on. There are printed tags next to each board on the rear side of the box which indicate the channel numbers for the boards.

5.4 REPLACING RELAYS

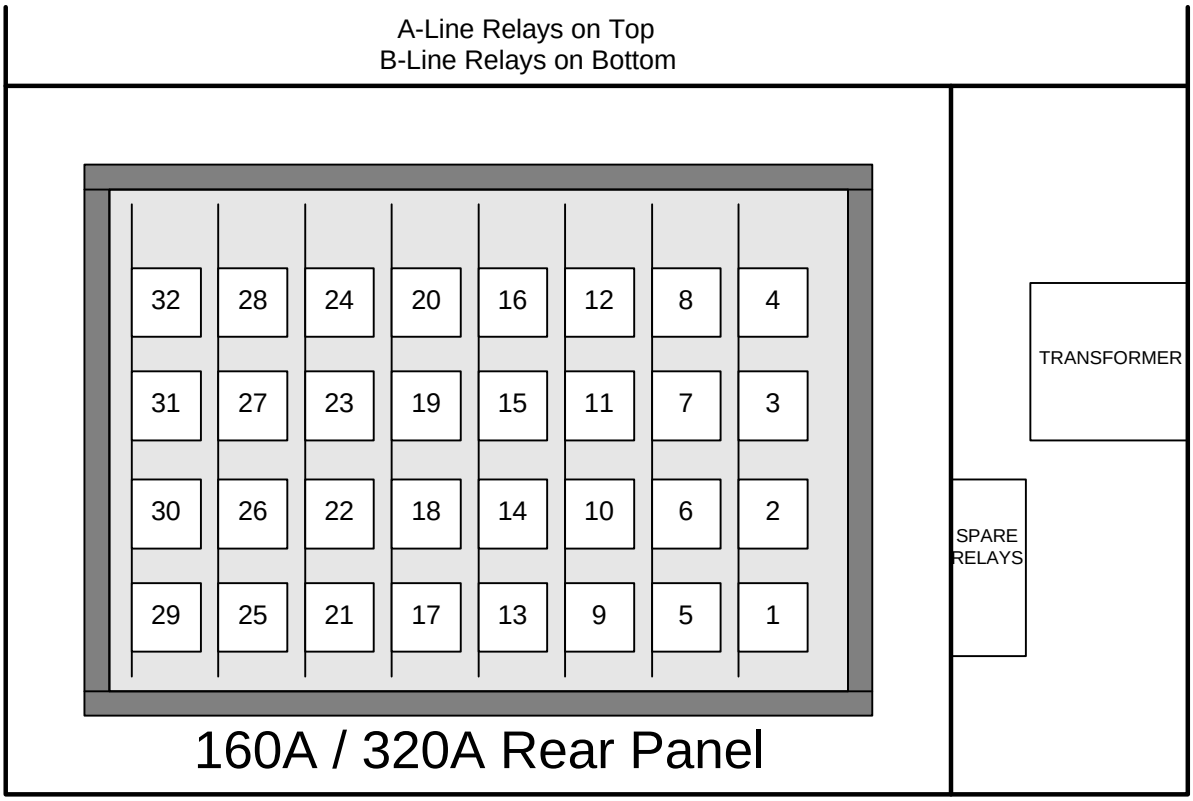
The relays are held onto the boards with spring clips. They can easily be removed by slipping a knife blade between the clip and the relay housing and prying out. Relays in the top row can be replaced without removing the boards from their sockets. For relays in the lower row the board must be pulled out. There is enough slack in the channel input lines to allow the board to be withdrawn far enough to replace the lower relays.

WARNING: STANDARD CELLS CONNECTED TO THE SCANNER COULD BE DAMAGED DURING THE PROCESS OF EXCHANGING RELAYS. IT IS RECOMMENDED THE CELLS BE DISCONNECTED FROM THE BOARD BEING WORKED ON.

To install a new relay on the board, center the alignment pins over the holes in the board and press the relay down until the housing is flush with the board. The clips will have to be pried out with a blade and then snapped into the larger holes.

Two spare relays are included with each scanner when shipped from the factory. They are located in a bracket near the power transformer. Replacement relays can be obtained from the factory by requesting part number 49-01.

Any relay that fails to operate will be replaced at no charge at any time as long as the failed relay is returned to Data Proof. This will allow the relay to be inspected to determine the cause of failure to improve quality. This free replacement offer does not apply to normal wear-and-tear and may be withdrawn without notice.



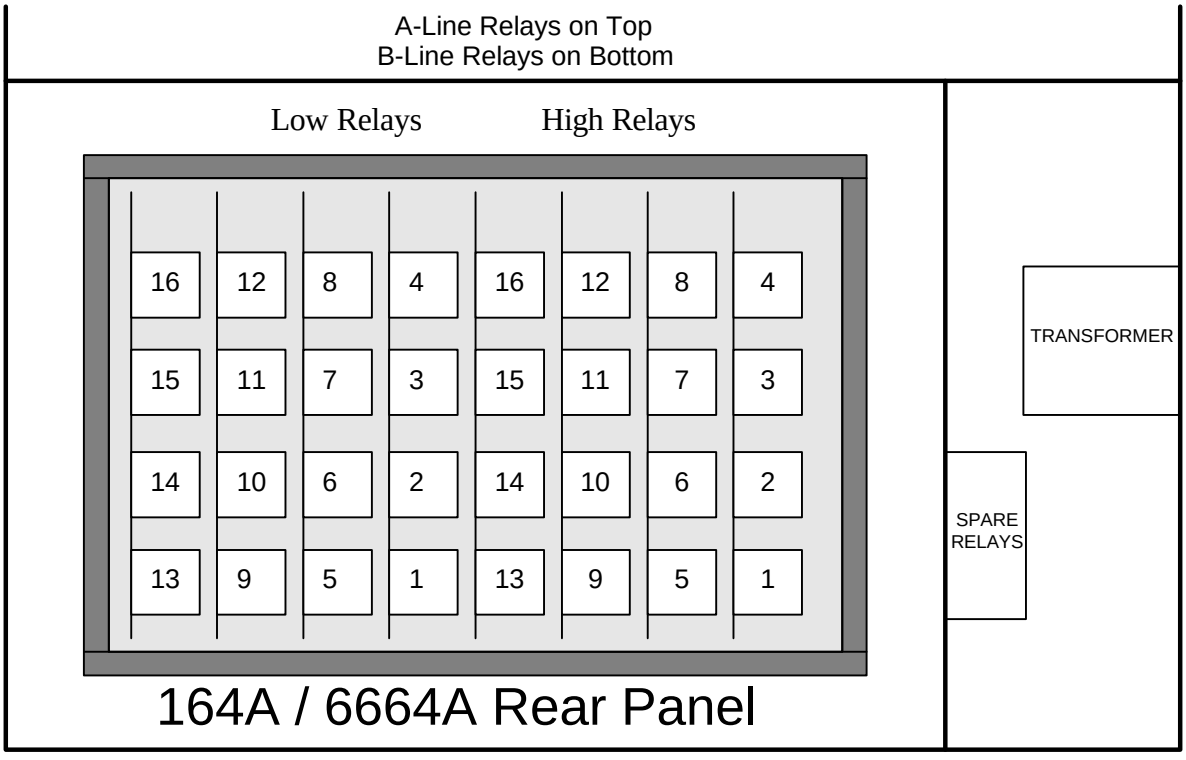


Figure 5.1 Relay Locations (Top View)

SECTION 6

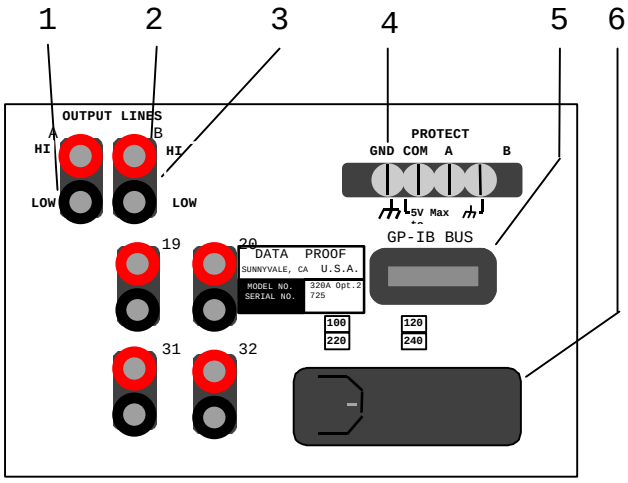
CIRCUIT DIAGRAMS AND REPLACEMENT PARTS LISTS

6.1 INTRODUCTION

This section contains circuit diagrams and information for ordering replacement parts. For each circuit board there is a circuit diagram, a component location diagram and a parts list. There is also a list of general parts that are located on the chassis and the rear panel.

6.2 ORDERING INFORMATION

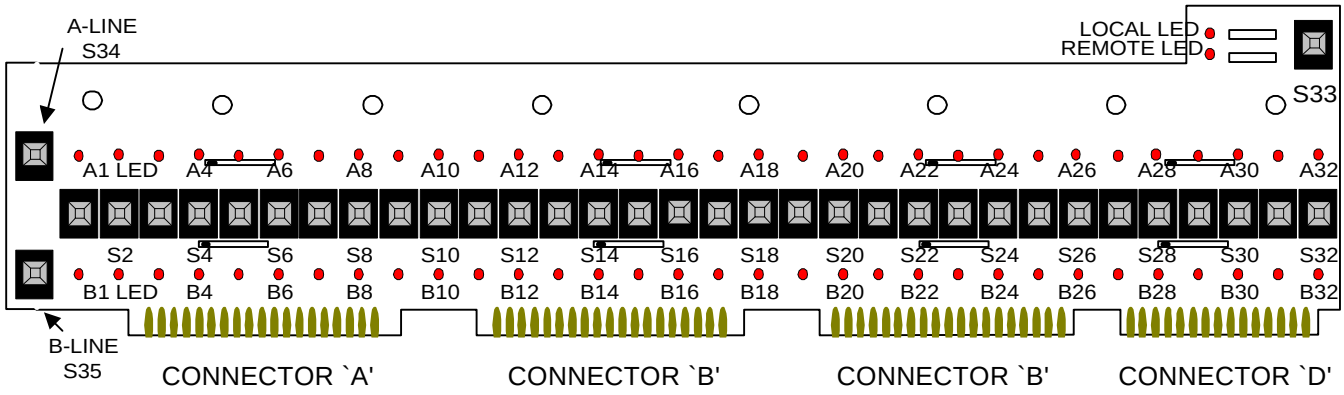
To obtain parts directly from the factory contact Data Proof at www.DataProof.com. Identify parts by their Data Proof part number. Include the instrument model and serial numbers as well as the part description.



REAR PANEL PARTS LIST, (OPTION 2 shown)		
LOCATOR NUMBER	DP PART NUMBER	PARTS DESCRIPTION
6	50-07	LINE CORD RECEPTICAL
6	50-07	LINE CORD RECEPTICAL WITH FUSE HOLDER
	11-03	FUSE, .25A SloBlo
1	51-01	LOW THERMAL BINDING POST, BLACK (Tellurium copper gold flashed)
2	51-02	LOW THERMAL BINDING POST, RED (Tellurium copper gold flashed)
3	51-03	BINDING POST MOUNTING BASE
4	51-04	TERMINAL BLOCK , 4 CONDUCTOR
Opt. 1	82-09	SOLID COPPER CABLE, 4 COND., 22 GAGE NEC CM (BELDEN 9794)
Opt. 3	81-12	SHIELDED TEFLON CABLE, 2 COND.,22GAGE (Stranded silver plated copper, Weico 5222)

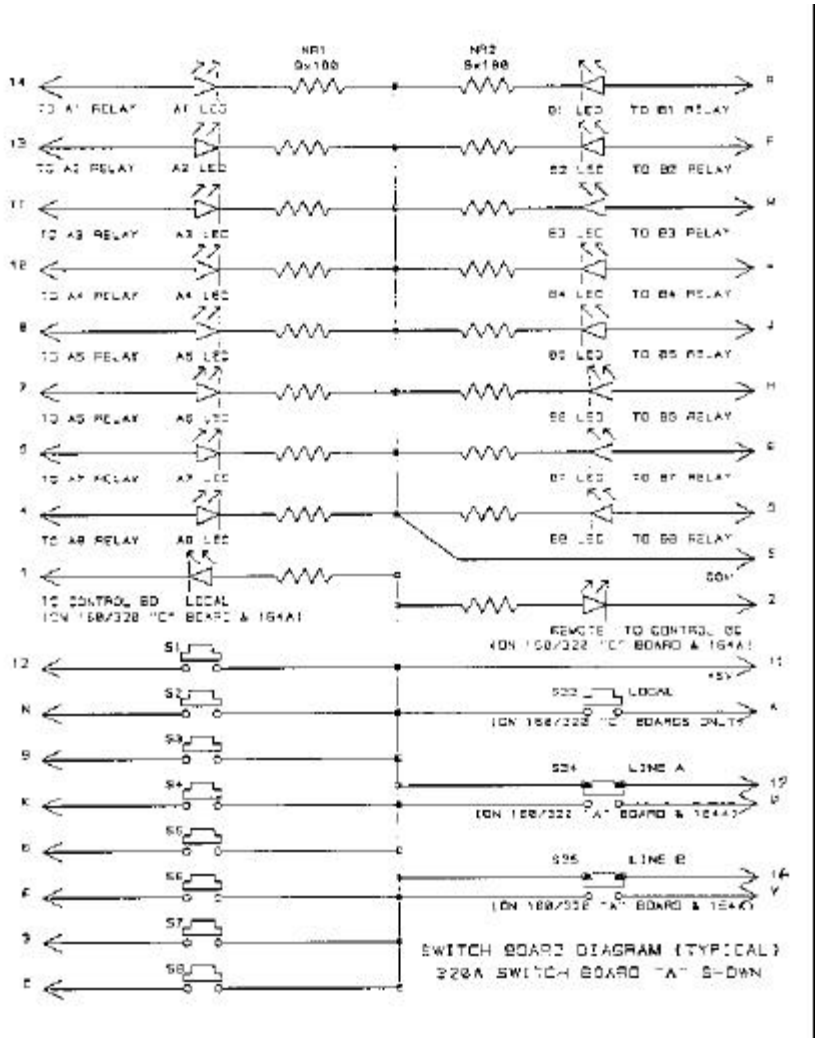
MOTHER BOARD (NOT SHOWN)

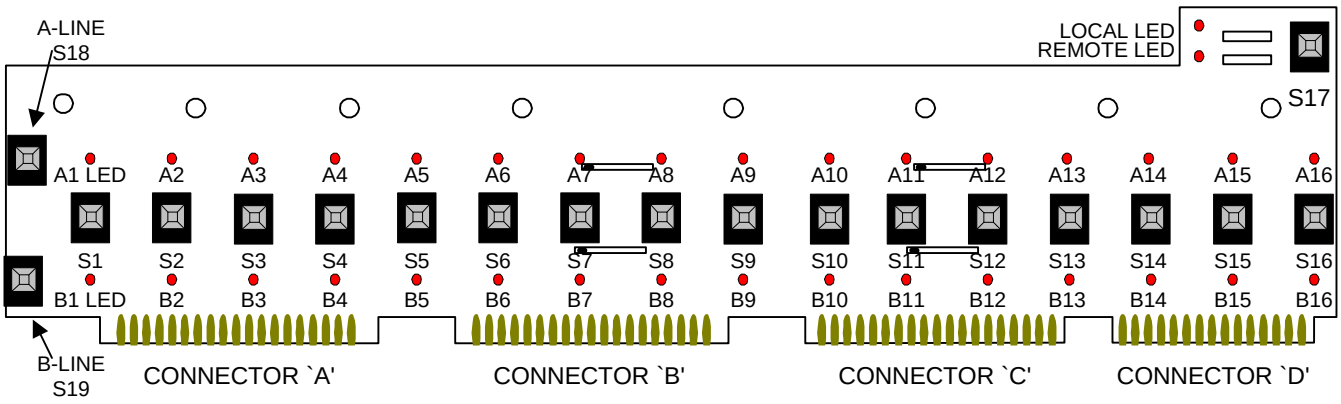
	50-04	PC CONNECTOR, 15 PIN
	50-05	PC CONNECTOR, 18 PIN
	50-06	PC CONNECTOR, 18 PIN
	51-04	FLAT CABLE CONNECTOR, 24 PIN
	81-14	FLAT CABLE, 28 AWG, 24 COND



MODEL 320A

SWITCH BOARD COMPONENT LOCATIONS





MODEL 160A

SWITCH BOARD CONNECTION TABLE

CONNECTOR `A'			
PIN	320A	164A	160A
1	---	---	---
2	---	---	---
3	S7	S7	S7
4	A8 LED	A8 HIGH	A8 LED
5	A7 LED	A7 HIGH	A7 LED
6	S5	S5	S5
7	A6 LED	A6 HIGH	A6 LED
8	A5 LED	A5 LED	A5 LED
9	S3	S3	S3
10	A4 LED	A4 HIGH	A4 LED
11	A3 LED	A3 HIGH	A3 LED
12	S1	S1	S1
13	A2 LED	A2 HIGH	A2 LED
14	A1 LED	A1 HIGH	A1 LED
15	---	---	---
16	---	---	---
17	S LINE-A	S LINE-A	S LINE-A
18	S LINE-B	S LINE-B	S LINE-B
A	---	---	---
B	---	---	---
C	S8	S8	S8
D	B8 LED	B8 HIGH	B8 LED
E	B7 LED	B7 HIGH	B7 LED
F	S6	S6	S6
H	B6 LED	B6 HIGH	B6 LED
J	B5 LED	B5 HIGH	B5 LED
K	S4	S4	S4
L	B4 LED	B4 HIGH	B4 LED
M	B3 LED	B3 HIGH	B3 LED
N	S2	S2	S2
P	B2 LED	B2 HIGH	B2 LED
R	B1 LED	B1 HIGH	B1 LED
S	COM	COM	COM
T	---	---	---
U	S LINE-A	S LINE-A	S LINE-A
V	S LINE-B	S LINE-B	S LINE-B

CONNECTOR `B'			
PIN	320A	164A	160A
1	---	---	---
2	---	---	---
3	S15	S15	S15
4	A16 LED	A16 HIGH	A16 LED
5	A15 LED	A15 HIGH	A15 LED
6	S13	S13	S13
7	A14 LED	A14 HIGH	A14 LED
8	A13 LED	A13 HIGH	A13 LED
9	S11	S11	S11
10	A12 LED	A12 HIGH	A12 LED
11	A11 LED	A11 HIGH	A11 LED
12	S9	S9	S9
13	A10 LED	A10 HIGH	A10 LED
14	A9 LED	A9 HIGH	A9 LED
15	---	---	---
A	---	---	---
B	---	---	---
C	S16	S16	S16
D	B16 LED	B16 HIGH	B16 LED
E	B15 LED	B15 HIGH	B15 LED
F	S14	S14	S14
H	B14 LED	B14 HIGH	B14 LED
J	B13 LED	B13 HIGH	B13 LED
K	S12	S12	S12
L	B12 LED	B12 HIGH	B12 LED
M	B11 LED	B11 HIGH	B11 LED
N	S10	S10	S10
P	B10 LED	B10 HIGH	B10 LED
R	B9 LED	B9 HIGH	B9 LED
S	COM	COM	COM

CONNECTOR `C'			
PIN	320A	164A	160A
1	---	---	---
2	---	---	---
3	S23	---	---
4	A24 LED	A8 LOW	---
5	A23 LED	A7 LOW	---
6	S21	---	---
7	A22 LED	A6 LOW	---
8	A21 LED	A5 LOW	---
9	S19	---	---
10	A20 LED	A4 LOW	---
11	A19 LED	A3 LOW	---
12	S17	---	---
13	A18 LED	A2 LOW	---
14	A17 LED	A1 LOW	---
15	---	---	---
A	---	---	---
B	---	---	---
C	S24	---	---
D	B24 LED	B8 LOW	---
E	B23 LED	B7 LOW	---
F	S22	---	---
H	B22 LED	B6 LOW	---
J	B21 LED	B5 LOW	---
K	S20	---	---
L	B20 LED	B4 LOW	---
M	B19 LED	B3 LOW	---
N	S18	---	---
P	B18 LED	B2 LOW	---
R	B17 LED	B1 LOW	---
S	COM	COM	COM

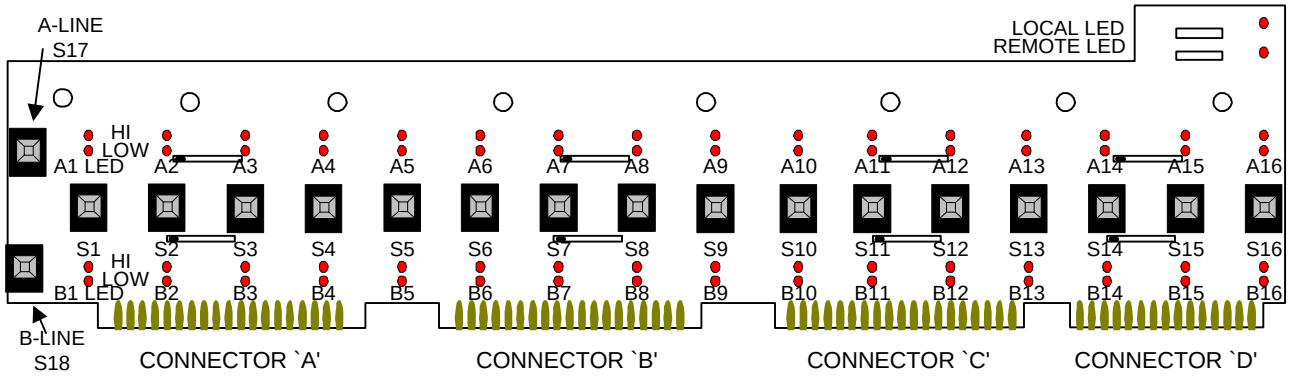
CONNECTOR `D'			
PIN	320A	164A	160A
1	LED - LOCAL - - - - - - ->		
2	LED - REMOTE - - - - - ->		
3	S31	---	---
4	A32 LED	A16 LOW	---
5	A31 LED	A15 LOW	---
6	S29	---	---
7	A30 LED	A14 LOW	---
8	A29 LED	A13 LOW	---
9	S27	---	---
10	A28 LED	A12 LOW	---
11	A27 LED	A11 LOW	---
12	S25	---	---
13	A26 LED	A10 LOW	---
14	A25 LED	A9 LOW	---
15	---	---	---
A	S LOCAL	---	---
B	---	---	---
C	S32	---	---
D	B32 LED	B16 LOW	---
E	B31 LED	B15 LOW	---
F	S30	---	---
H	B30 LED	B14 LOW	---
J	B29 LED	B13 LOW	---
K	S28	---	---
L	B28 LED	B12 LOW	---
M	B27 LED	B11 LOW	---
N	S26	---	---
P	B26 LED	B10 LOW	---
R	B25 LED	B9 LOW	---
S	COM	COM	COM

LEGEND

S = SWITCH

A = LINE A LEDs

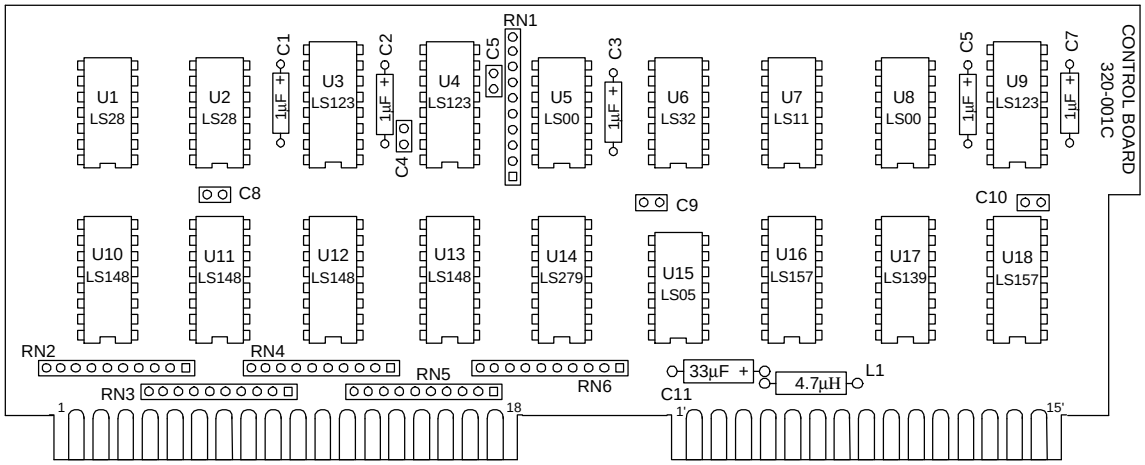
B = LINE B LEDs



MODEL 164A, 6664A

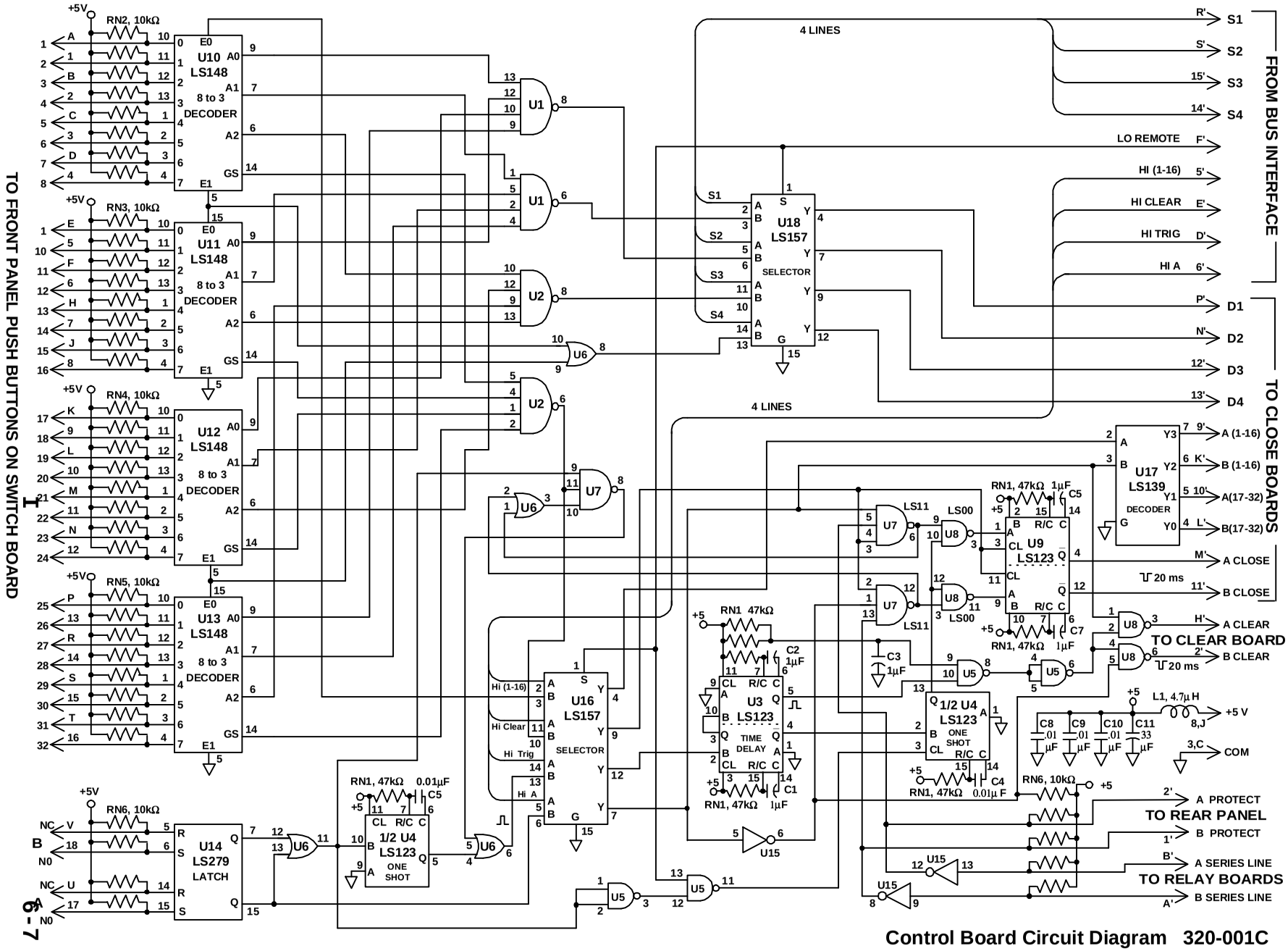
SWITCH BOARDS (ALL) PARTS LIST

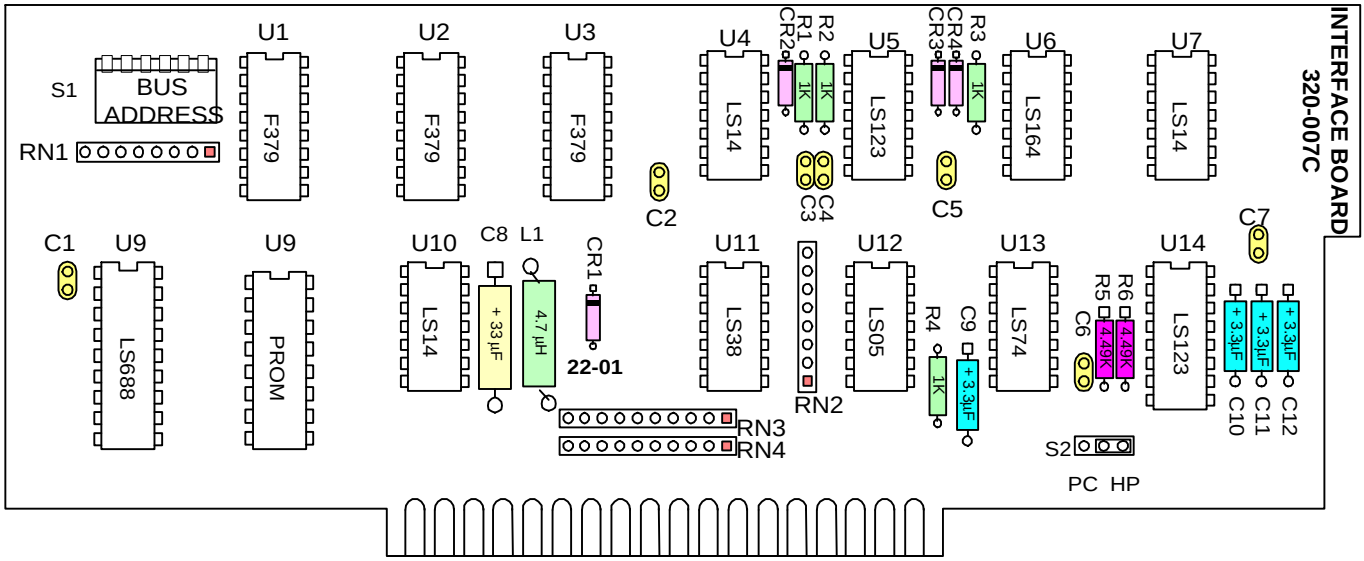
SWITCH BOARDS (ALL) PARTS LIST		
CIRCUIT DESIG.	DP PART NUMBER	PARTS DESCRIPTION
all LED's	23-01	LIGHT EMITTING DIODE, Red
SWITCHES	31-02	SWITCH, Pushbutton, SPDT
R1,R2	68-05	RESISTOR NETWORK, 9x180 ohm, Cermet SIP
R3,R4	69-03	RESISTOR, FXD, 1Kohm, .0125W, 1% Met film



CONTROL BOARD COMPONENT LOCATIONS

CONTROL BOARD CIRCUIT PARTS LIST		
CIRCUIT DESIGN.	DP PART NUMBER	PARTS DESCRIPTION
C4,5,8,9,10	16-02	CAPACITOR, FXD, .01 uFd 50VDC, 10%, Monolithic
C1,2,3,6,7	18-01	CAPACITOR, FXD, 1 uFd 15VDC, 10%, Electrolytic
C11	18-04	CAPACITOR, FXD, 33 uFd 10VDC, 10%, Electrolytic
L1	46-01	INDUCTOR,FXD,4.7uH
RN1	68-06	RESISTOR, FXD, 9x47Kohm, 2% Cermet, SIP
RN2,3,4,5,6	68-03	RESISTOR, NETWORK,9x10Kohm, 2% Cermet, SIP
U1,2	20-06	IC,DUAL 4-Input NAND Gate, 74LS20
U3,4,9	20-10	IC,DUAL Monostable MULTIVIBRATOR, 74LS123
U5,8	20-02	IC,QUAD 2-Input NAND Gate, 74LS00
U6	20-07	IC,QUAD 2-Input OR Gate, 74LS32
U7	20-04	IC,TRIPLE 3-Input AND Gate, 74LS11
U10-13	20-13	IC,8-TO-3 Line ENCODER, 74LS148
U14	20-17	IC, QUAD Set-Reset LATCH, 74LS279
U15	20-03	IC,HEX INVENTOR, 74LS05
U16,18	20-15	IC,QUAD 2-Input DATA SELECTOR, 74LS157
U17	20-12	IC,2-TO-4 Line DECODER, 74LS139


FROM BUS INTERFACE
TO CLOSE BOARDS
TO FRONT PANEL PUSH BUTTONS ON SWITCH BOARD
TO CLEAR BOARD
TO REAR PANEL
TO RELAY BOARDS
4 LINES
4 LINES
LO REMOTE
HI (1-16)
HI CLEAR
HI TRIG
HI A
S1
S2
S3
S4
D1
D2
D3
D4
A (1-16)
B (1-16)
A(17-32)
B(17-32)
A CLOSE
B CLOSE
A CLEAR
B CLEAR
A PROTECT
B PROTECT
A SERIES LINE
B SERIES LINE
+5 V
COM
U10 LS148 8 to 3 DECODER
U11 LS148 8 to 3 DECODER
U12 LS148 8 to 3 DECODER
U13 LS148 8 to 3 DECODER
U14 LS279 LATCH
U16 LS157 SELECTOR
U18 LS157 SELECTOR
U17 LS139 DECODER
U3 LS123 TIME DELAY
U9 LS123
1/2 U4 LS123 ONE SHOT
RN1, 47kΩ
RN2, 10kΩ
RN3, 10kΩ
RN4, 10kΩ
RN5, 10kΩ
RN6, 10kΩ
20 ms
L1, 4.7µH
Control Board Circuit Diagram 320-001C
4 - 6
7

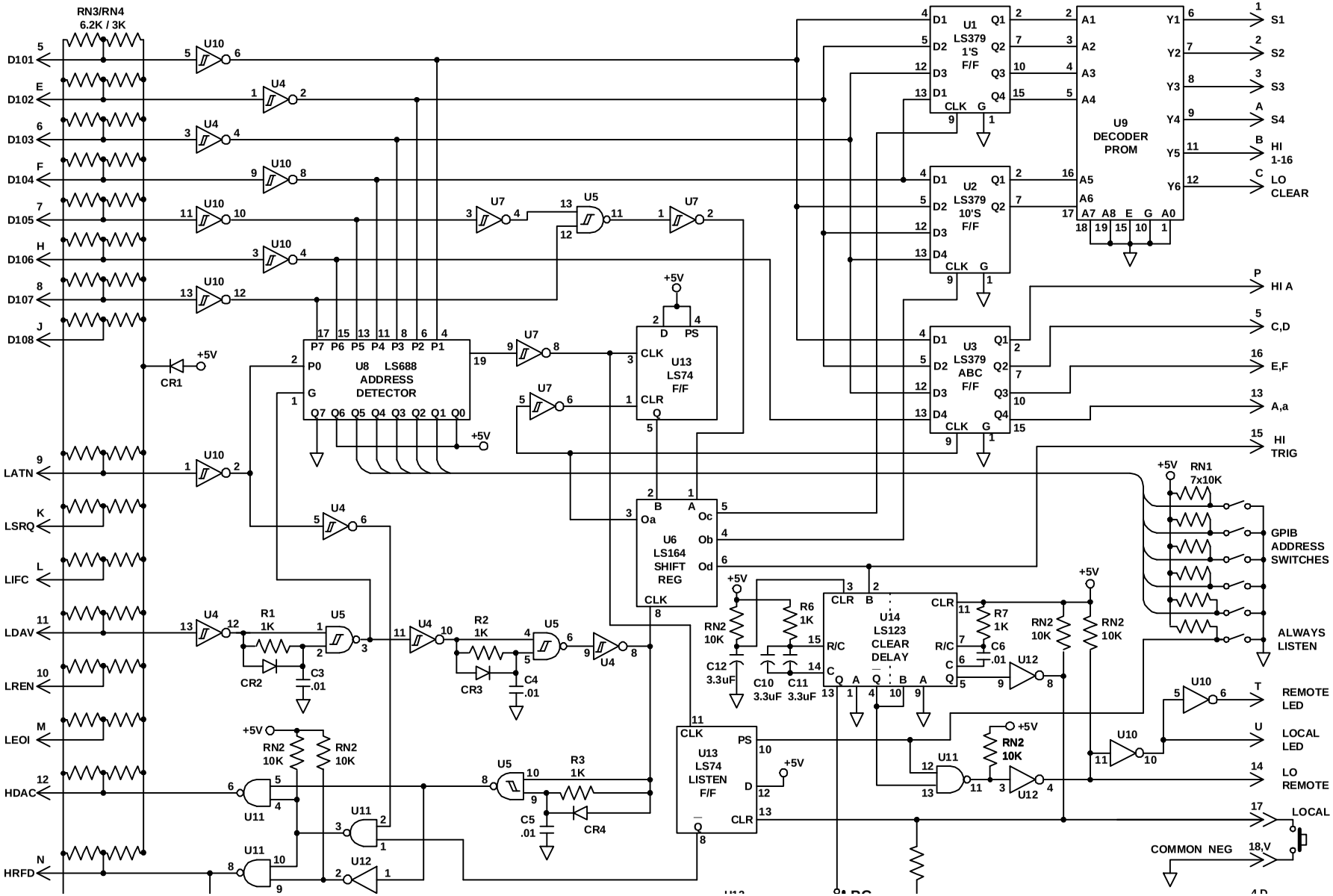


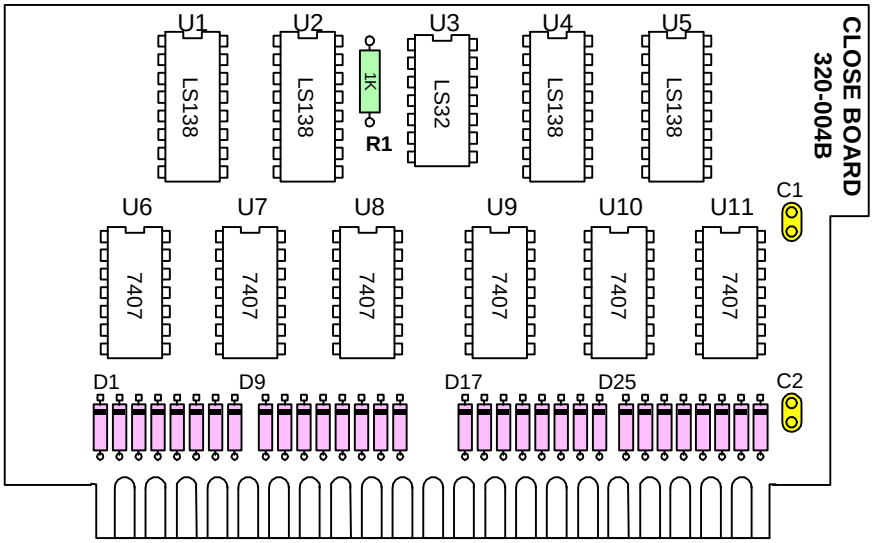
NTERFACE B0ARD COMPONENT LOCATIONS

INTERFACE BOARD CIRCUIT PARTS LIST

CIRCUIT DESIGN.	DP PART NUMBER	PARTS DESCRIPTION
C1-7	16-02	CAPACITOR, FXD, .01 uFd 50VDC, 10%, Monolithic
C8	18-04	CAPACITOR, FXD, .33 uFd 10VDC, 10%, Tantalum
C9-12	18-02	CAPACITOR, FXD, 3.3 uFd 15 VDC, 10%, Tantalum
CR1-4	22-01	DIODE, 50VPIV, 200mA, 1N4150
L1	46-01	INDUCTOR,FXD,4.7uH
R1-4	69-03	RESISTOR, FXD, 1Kohm, .0125W, 1% Met film
R5-6	69-05	RESISTOR, FXD, 49.9Kohm, .0125W, 1% Met film
RN1,2	68-02	RESISTOR, NETWORK,7x10Kohm, 2% Cermet,SIP
RN3,4	68-04	RESISTOR, NETWORK,8x6.2Kohm, 2% Cermet,SIP
S1	31-05	SWITCH,SIP,6 Position
S2	50-11	CONNECTOR HEADER, 3 Posts
U1-3	20-18	IC,QUAD D-Type FLIP-FLOP, LS379
U4,7,10	20-05	IC,HEX Schmitt Trigger INVENTOR,, LS14
U5	20-11	IC,QUAD 2-Input Schmitt Trig NAND, 74LS132
U11	20-08	IC,QUAD 2-Input NAND, 74LS38
U13	20-09	IC,DUAL D-Type FLIP-FLOP, LS74
U14	20-10	IC,DUAL Monostable MULTIVIBRATOR, LS123
U8	20-19	IC,8-BIT MAGNITUDE COMPARATOR, LS688
U9	20-20	MEMORY CIRCUIT, 512x8,Programed
U12	20-03	IC,HEX INVENTOR, Open Col. Output, LS05
U6	20-16	IC,8-BIT SHIFT REGISTER, LS164

Note: The IDC Connector jumper (switch) that can be switched to accommodate either HP Basic computers or PC computers. The switch should connect the center and right pin for HPBASIC computers. The center and left pin are connected for most PC's. (National Instruments AT-GPIB/TNT board has been found to work better with the switch in the HP position.


RN3/RN4
6.2K / 3K
D101
D102
D103
D104
D105
D106
D107
D108
LATN
LSRQ
LIFC
LDAV
LREN
LEOI
HDAC
HRFD
U1 LS379 1'S F/F
U2 LS379 10'S F/F
U3 LS379 ABC F/F
U9 DECODER PROM
S1
S2
S3
S4
HI 1-16
LO CLEAR
HI A
C,D
E,F
A,a
HI TRIG
U8 LS688 ADDRESS DETECTOR
U13 LS74 F/F
U6 LS164 SHIFT REG
U14 LS123 CLEAR DELAY
U13 LS74 LISTEN F/F
RN1 7x10K
GPIB ADDRESS SWITCHES
ALWAYS LISTEN
REMOTE LED
LOCAL LED
LO REMOTE
LOCAL
COMMON NEG
CR1
CR2
CR3
CR4
R1 1K
R2 1K
R3 1K
R6 1K
R7 1K
RN2 10K
C3 .01
C4 .01
C5 .01
C6 .01
C10 3.3uF
C11 3.3uF
C12 3.3uF
+5V

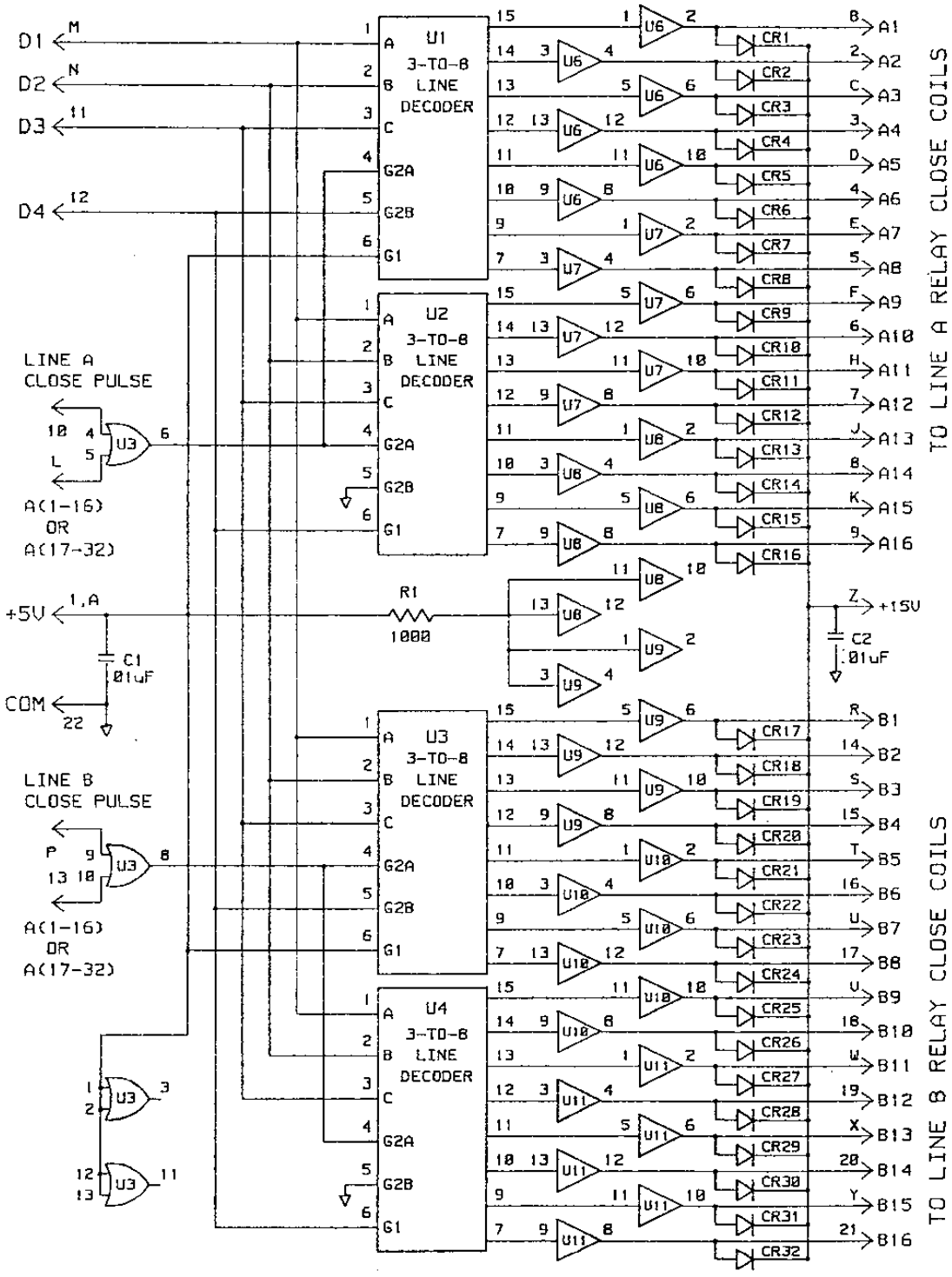


CLOSE BOARD COMPONENT LOCATIONS

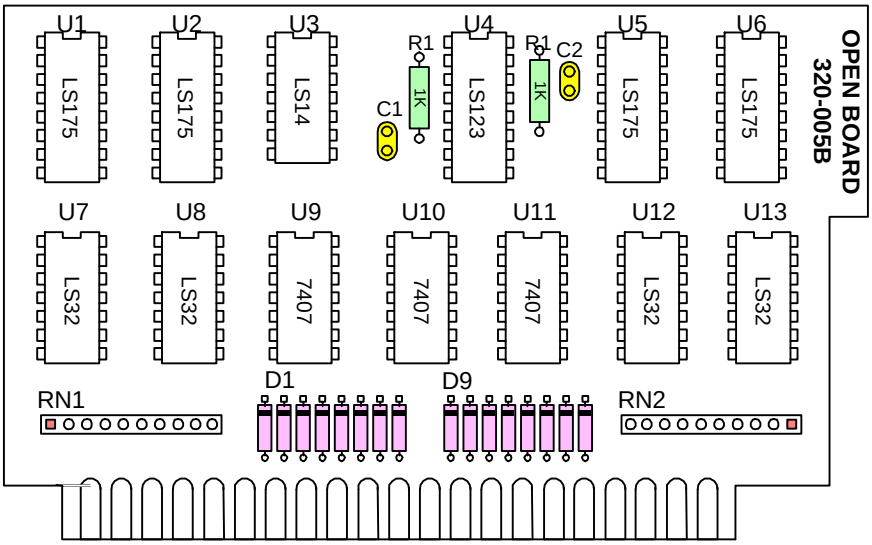
Notes: One Close Boards are used in Model 160A
Two Close Boards are used in Model 320A

CLOSE CIRCUIT PARTS LIST

CIRCUIT DESIG.	DP PART NUMBER	PARTS DESCRIPTION
C1,C2	16-02	CAPACITOR, FXD, .01 uFd 50VDC, 10%, Monolithic
R1	69-03	RESISTOR, FXD, 1Kohm, .0125W, 1% Met film
CR1-CR32	22-01	DIODE, 50VPIV, 200mA, 1N4150
U1,2,4,5	20-22	3-TO-8 LINE DECODER, 74LS138N
U3	20-07	QUAD 2-Input OR gate, 74LS32N
U6-U11	20-01	Hex BUFFER, Open Collector, 7407



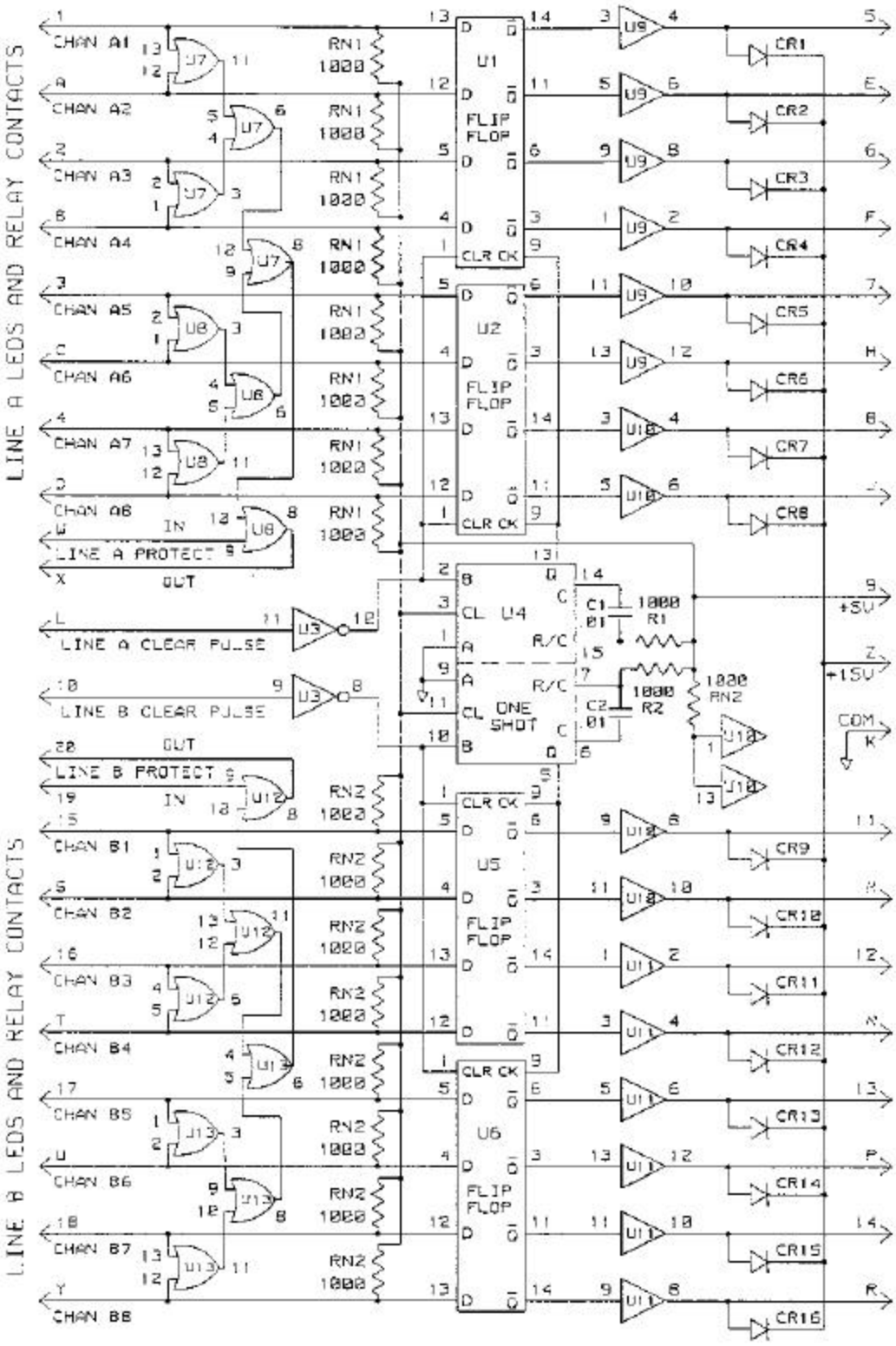
320-004B CLOSE BOARD CIRCUIT DIAGRAM



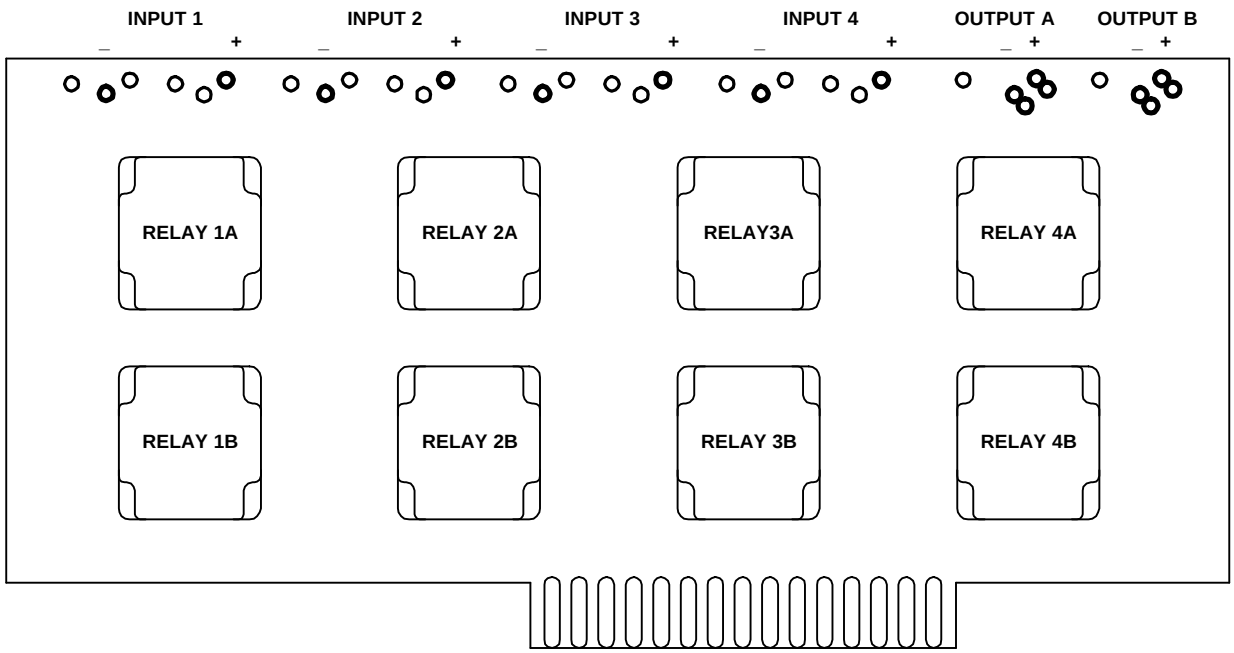
OPEN BOARD COMPONENT LOCATIONS

Notes: Two Open Boards are used in Model 160A
Four Open Boards are used in Model 320A

OPEN CIRCUIT PARTS LIST		
CIRCUIT DESIG.	DP PART NUMBER	PARTS DESCRIPTION
C1,C2	16-02	CAPACITOR, FXD, .01 uFd 50VDC, 10%, Monolithic
RN1,RN2	68-01	RESISTOR NETWORK, 9x1 Kohm, Cermet SIP
R1,R2	69-03	RESISTOR, FXD, 1Kohm, .0125W, 1% Met film
D1-D16	22-01	DIODE, 50VPIV, 200mA, 1N4150
U1,2,5,6	20-21	Quad D-TYPE FLIP-FLOP, 74LS175N
U3	20-05	Hex INVERTOR, 74LS14N
U4	20-10	MONOSTABLE MULTIVIBRATOR, 74LS123N
U7,8,12,13	20-07	QUAD 2-Input OR gate, 74LS32N
U9,10,11	20-01	Hex BUFFER, Open Collector, 7407



320-005B OPEN BOARD CIRCUIT DIAGRAM

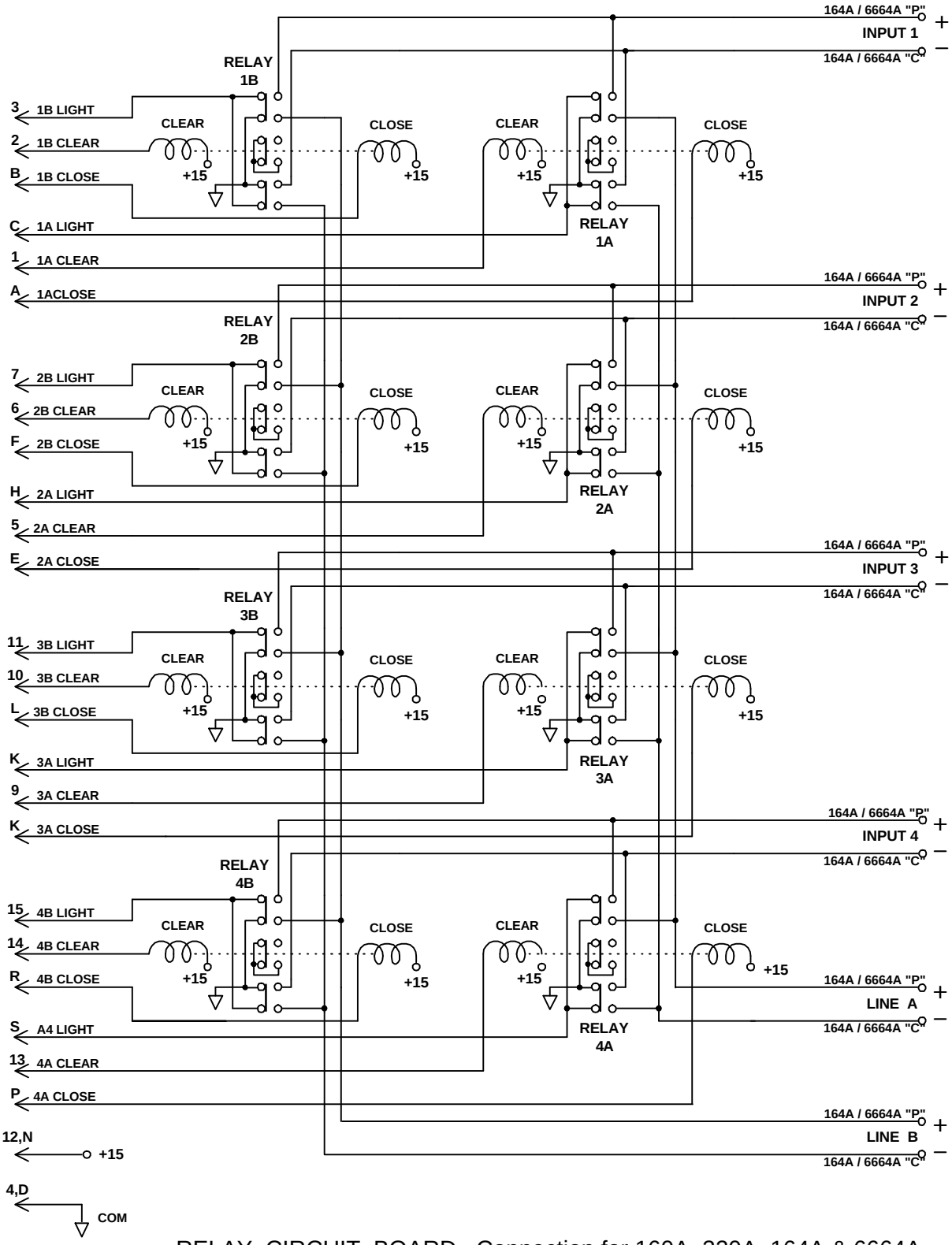


RELAY BOARD COMPONENT LOCATIONS

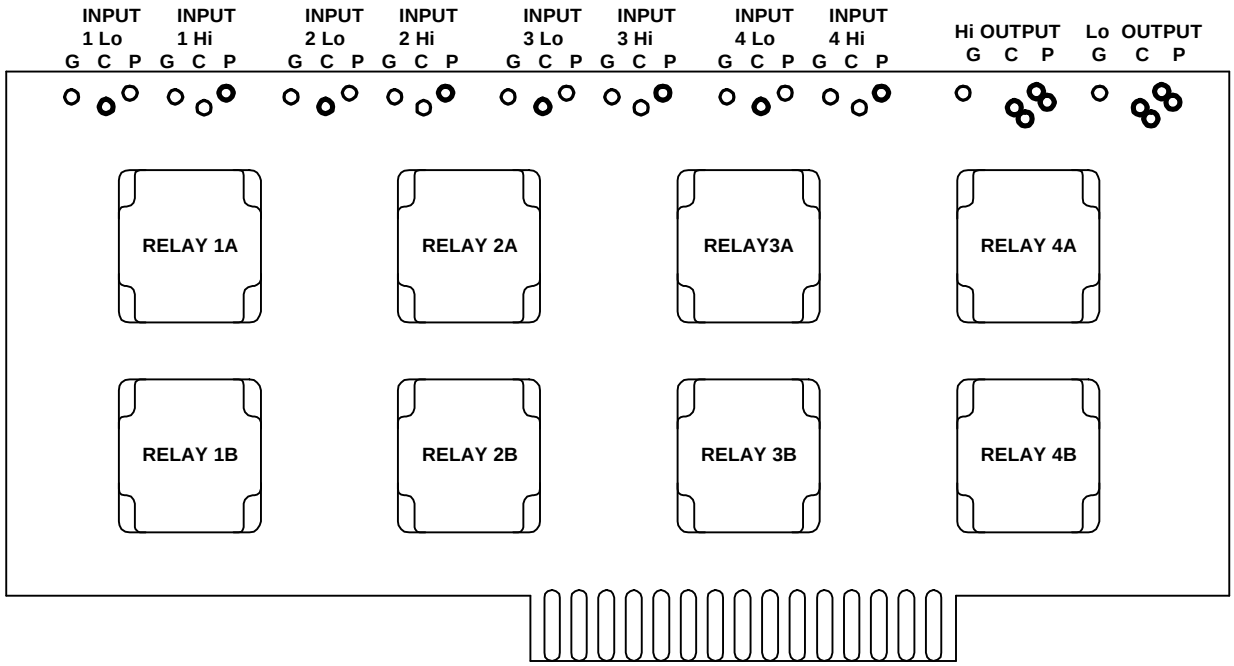
Notes:

1. Each Board holds latching relays for four channels of low thermal inputs.
2. Four or eight boards are used depending on the model
3. These boards are located under the top of the isothermal box.

RELAY BOARD PARTS LIST		
CIRCUIT DIAGRAM	DP PART NUMBER	PARTS DESCRIPTION
All PARTS	49-01	RELAY, LATCHING, 3-Pole, 2-Throw, 12V coil



RELAY CIRCUIT BOARD, Connection for 160A, 320A, 164A & 6664A



RELAY BOARD COMPONENT LOCATIONS

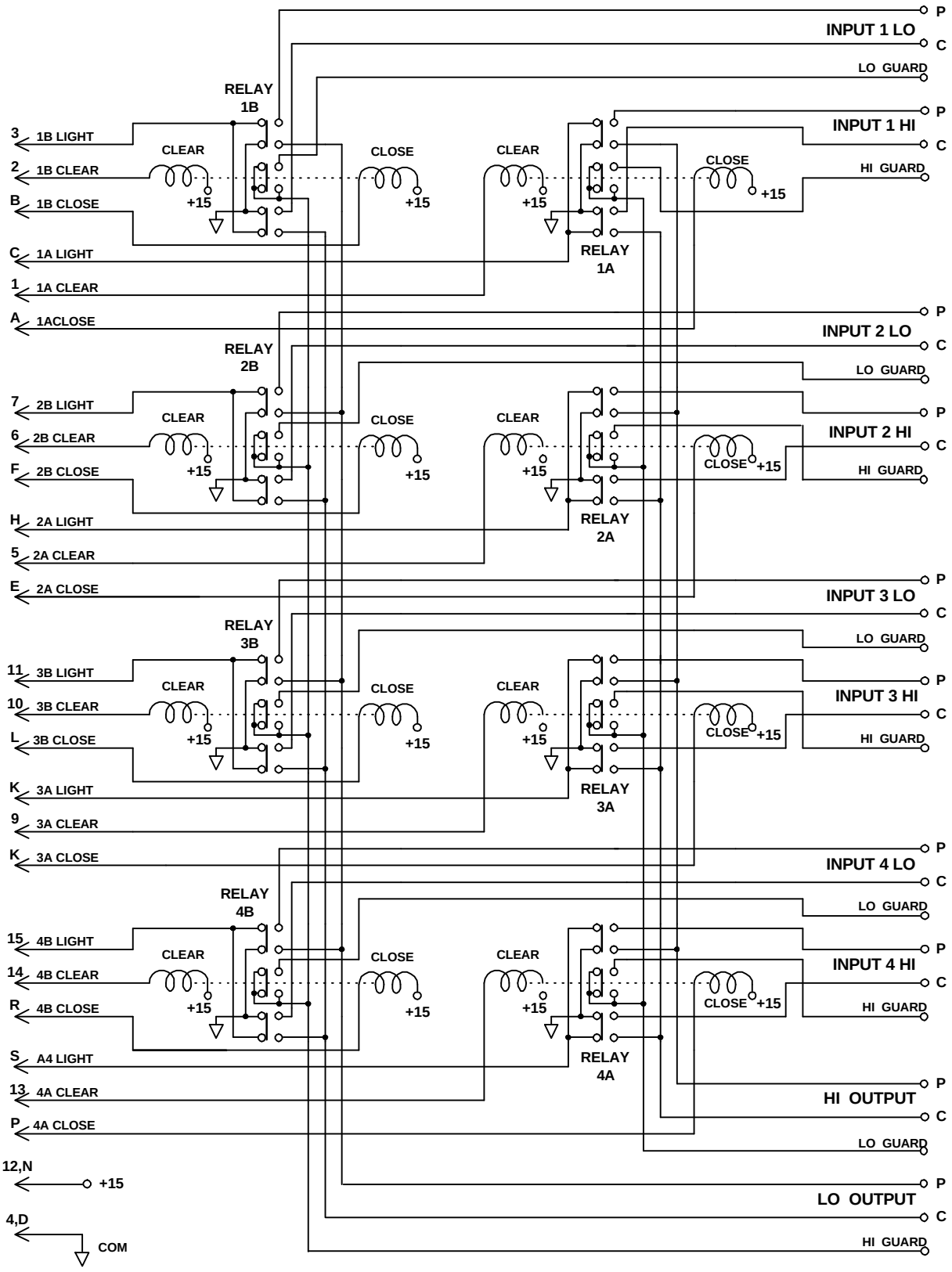
Notes:

1. Each Board holds latching relays for four channels of low thermal inputs.

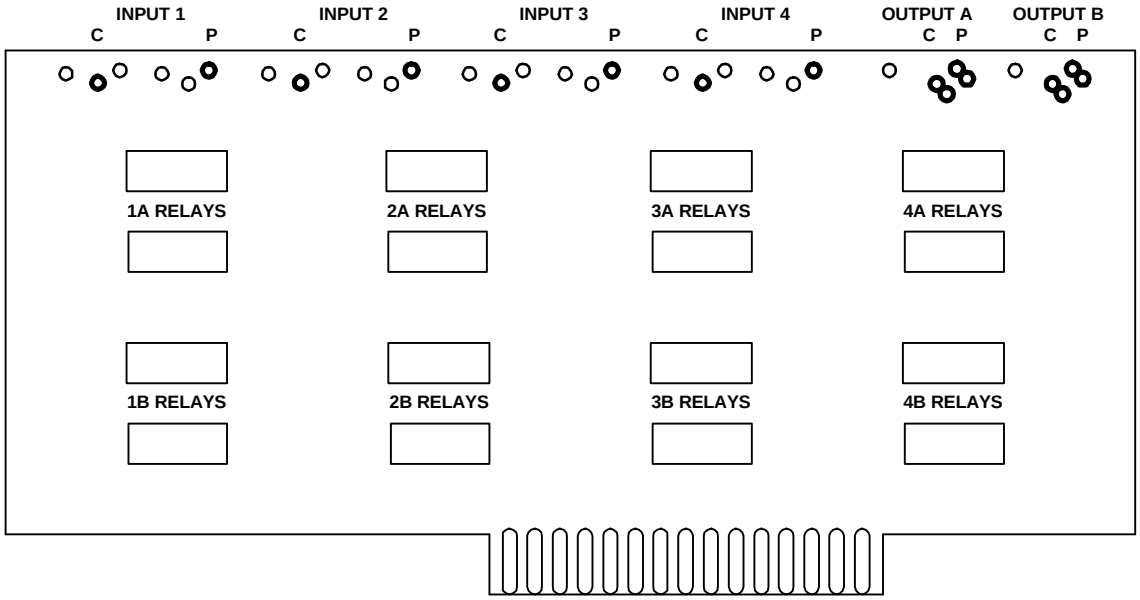
2. Four or eight boards are used depending on the model

3. These boards are located under the top of the isothermal box.

RELAY BOARD PARTS LIST		
CIRCUIT DIAGRAM	DP PART NUMBER	PARTS DESCRIPTION
All PARTS	49-03	RELAY, LATCHING, Guarded, 2-Throw, 12V coil



RELAY CIRCUIT BOARD, Option 3 Connection



2 AMP RELAY BOARD COMPONENT LOCATIONS

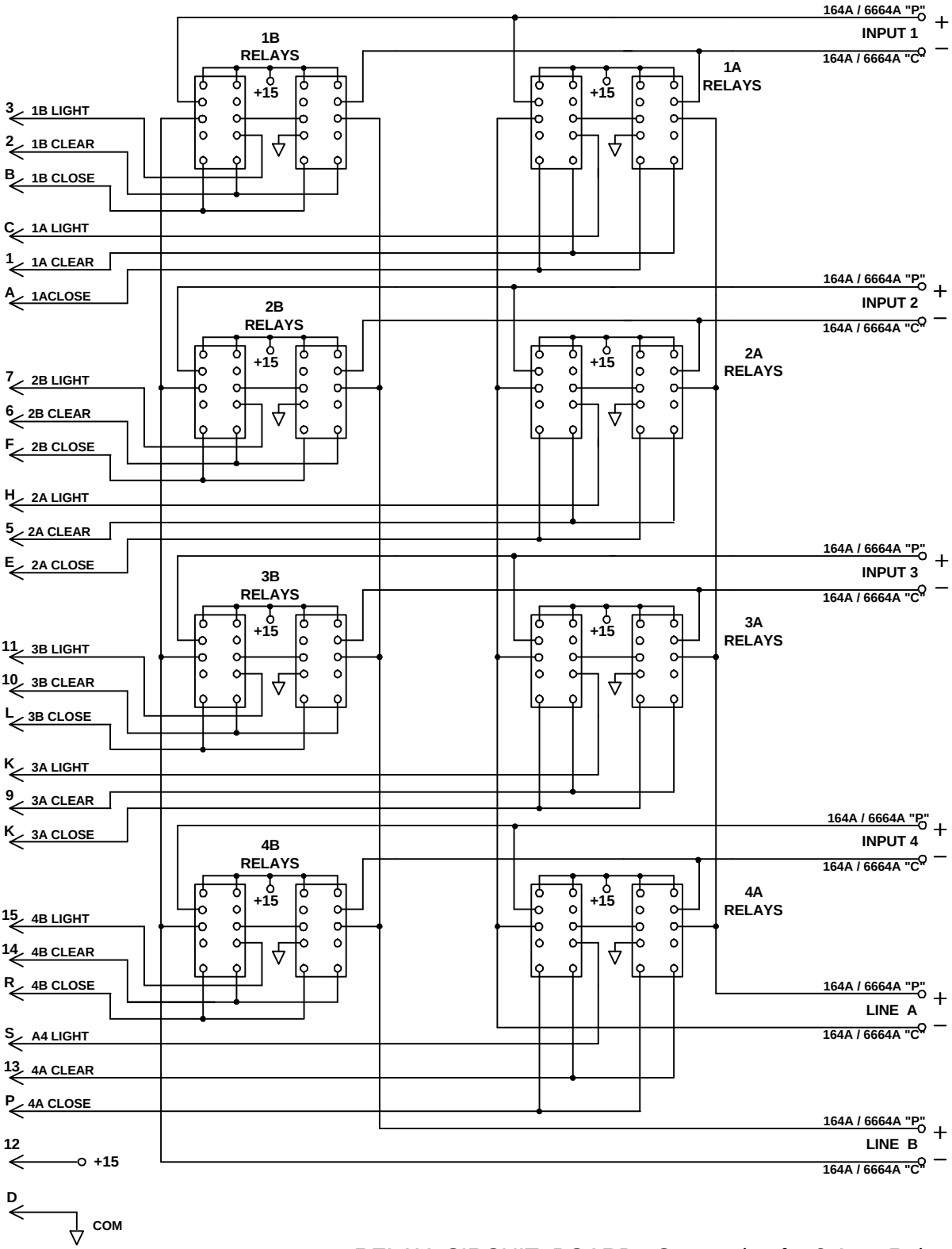
Notes:

1. Each Board holds latching relays for four channels of low thermal inputs.

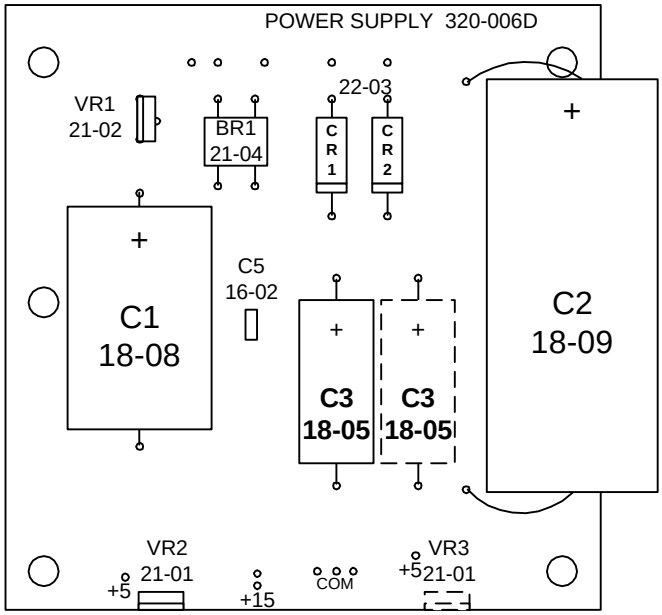
2. Four or eight boards are used depending on the model

3. These boards are located under the top of the isothermal box.

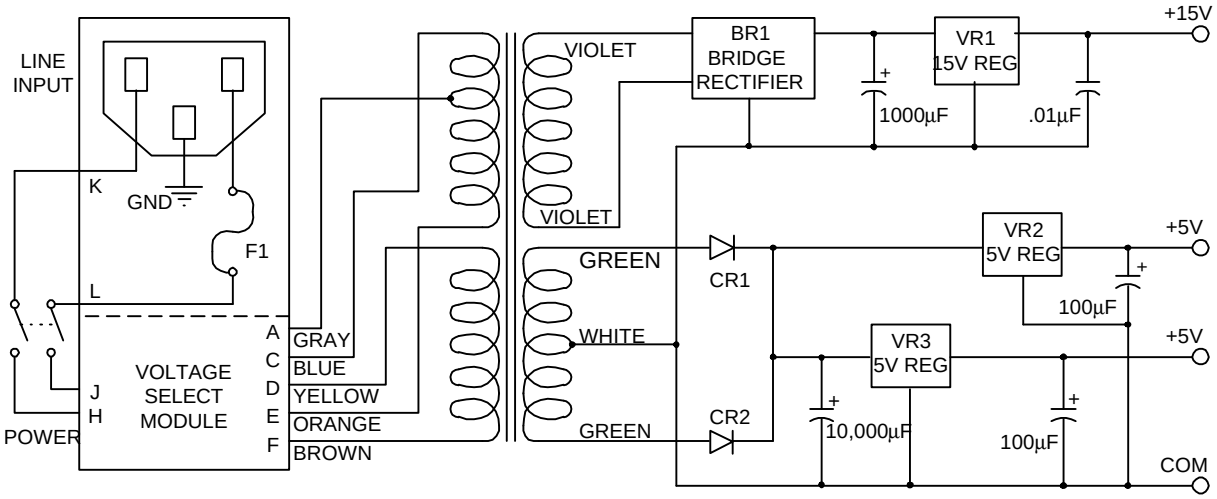
2 AMP RELAY BOARD PARTS LIST		
CIRCUIT DIAGRAM	DP PART NUMBER	PARTS DESCRIPTION
All PARTS	49-02	RELAY, LATCHING 2 AMP



RELAY CIRCUIT BOARD, Connection for 2 Amp Relays



POWER SUPPLY PARTS LIST		
CIRCUIT DIAGRAM	DP PART NUMBER	PARTS DESCRIPTION
		*** PARTS LOCATED ON PC BOARD ***
C1	18-08	CAPACITOR, FXD, 1000uF, 50VDC
C2	18-09	CAPACITOR, FXD, 10,000uF, 16VDC
C3,(C4)	18-05	CAPACITOR, FXD, 100uF, 16VDC
C5	16-02	CAPACITOR, FXD, 0.01uF
CR1,CR2	22-03	DIODE, 1N5401, 100VPIV, 3A
VR1	21-02	VOLTAGE REGULATOR, 15VDC
VR2, (VR3)	21-01	VOLTAGE REGULATOR, 5VDC
BR1	21-04	BRIDGE RECTIFIER
		*** PARTS LOCATED ON CHASSIS ***
F1	11-03	FUSE, 0.25A, 3AG SloBlo
J1	50-07	LINE CORD RECIPROCAL/VOLTAGE SELECT MOD
S1	31-03	SWITCH, TOGGLE, DPDT
T1	47-02	POWER TRANSFORMER



Power Supply Circuit Diagram 320-006D

DECLARATION OF CONFORMITY

according to ISO / IEC Guide and EN 54014

Manufacturer's Name:	Data Proof
Manufacturer's Address:	1177 S. De Anza Blvd. San Jose, CA 95129
Declares, the product	
Product Names:	Low Thermal Scanner Low Thermal Quad Scanner Low Thermal Guarded Scanner
Model Numbers:	160A, 164A, 320A
Product Options:	All Options

Conforms to the following Product Specifications

EMC:	EN50081-1 (1992)/EN55022 Class B EN50082-2 (1992) / IEC 801-2 (1984)
SAFETY:	EN 61010-1:1993/1995
Supplementary Information:	The Product herewith complies with the

Sunnyvale, California

James A. Marshall, President
January 10, 1996 & May 15, 1997

Note: The declaration of conformity applies only to scanners with the CE Mark on the rear panel.