



User's Manual

Model DRC-82C

Temperature Controller

This manual applies to instruments with Serial Number 13110 and higher.

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information concerning the Lake Shore Cryotronics, Inc. Model DRC-82C Temperature Controller. Included is an instrument description, specifications, and information concerning the instrument and accessories.

1-3. DESCRIPTION.

1-4. The DRC-82C Temperature Controller is a microprocessor controlled instrument that accepts inputs from up to two sensors, displays the temperature with up to 5 digits of resolution, and provides analog control of a heater output against a selected set-point.

1-5. Dual-sensor input allows simultaneous display of both input sensors in either Kelvin or voltage. Either sensor can be user-designated to be the system control sensor. Thus, the user can monitor both the control-point temperature and sample temperature without the need to switch between the two. If standard DRC-curve sensors are used, the two inputs can be displayed directly in Kelvin. In the case of the control sensor, the reading is rounded to the nearest 0.1 Kelvin over the entire temperature range. For the sample input, the temperature is rounded to 0.01 Kelvin over the entire range.

1-6. The DRC-82C accommodates a wide variety of temperature sensors. Most applications are conveniently served with Lake Shore standard-response curve DRC-series Silicon Diode Sensors. These Sensors are selected to match a standard temperature response which is programmed into the 82C. DRC-curve sensors are routinely interchangeable and provide an overall accuracy of 0.5K at helium and nitrogen temperatures and 1K at room temperature.

1-7. When greater precision is required, an individually calibrated sensor can be utilized along with the DRC-Precision Option whereby the temperature response of the specific sensor is stored in the instrument's memory. Accuracy of 0.1K or better is possible in this mode.

1-8. Any calibrated diode sensor can actually be used with the DRC-82C since either or both input channels can be set to display sensor voltage directly rather than Kelvin. The users calibration table then provides the temperature conversion.

1-9. The ample memory space provided in the DRC-82C allows several response curves to be stored in one instrument. Depending on the complexity of the curves, up to ten can be factory-programmed into the unit (user programming of individual response curves is possible via the IEEE-488 Interface with an appropriate computer). A rear-panel DIP switch is used to select which particular sensor response curve is desired for each input. Thus, the user is able to make sensor changes at will even when different response curves are required.

1-10. Multiple sensors are easily accommodated with the addition of the Model 8084 Sensor Selector. This versatile scanner permits either front-panel or IEEE-488 selection of up to 10 sensors as inputs. The 8084 provides sensor identification direct to the DRC-82C which will (when more than one response curve is programmed) automatically select the proper curve for each sensor selected.

1-11. The set point is also displayed on the front panel and can be set from the front panel. In the voltage mode, the set point can be set within 100 microvolts, while in the Kelvin mode, the set point can be set within 0.1 Kelvin. The set point automatically takes on the mode which is selected for the control sensor.

1-12. The control modes - proportional (gain), integral (reset), and derivative (rate) - are set from the front panel in per cent of full scale ranging from 00 to 99%. There is a continuous 2-digit display of each mode. The gain mode is in a nominal log per cent with the reset and rate being linear.

1-13. Heater power is displayed as a per cent of full scale with five orders of magnitude in heater power range selectable from the front panel. Resolution of the power meter is 1 per cent. Output power can be set to any value by means of the manual heater power selection. Automatic power control will then operate about this selected manual set point of output power. This power meter can be converted to a current meter by changing a switch setting located on the main board if the customer so desires (see Section 3-123).

1-14. The 1978 IEEE-488 Interface Bus is standard in this instrument. All front panel control and set point functions are programmable. The input and output data formats are ASCII formats.

1-15. RS-232C, HP-IL, BCD and Linear Analog Output options are available in addition to the standard IEEE-488.

Table 1-1. Instrument Specifications

Specifications, Model DRC-82C Temperature Controller

Input:

Temperature Range: 1.4 to 330K with standard DRC Sensor (to 380K with other DT-500 Sensors).

Sensor (order separately): Silicon Diode. DT-500-DRC, DT-500CU-DRC-36 or any calibrated DT-500 Series Diode. See response curve details below.

Sensor Input: Dual-sensor input. 4-terminal input for each sensor. Rear panel switch designates Control Sensor. Display Sensor is selected from front panel or Interfaces.

Sensor Excitation: Current source. 10 microamperes for each sensor.

Sensor Response Curve: Domestic US units require Sensor Curve "D". Export units require Sensor Curve "E". Sensor curves subject to change, refer to manual for proper curve when reordering Sensors. Curves to match existing Sensors available on special request. See also DRC-Precision Option.

Sensor Response Selection: Rear-panel DIP switch permits selection of appropriate sensor response curve when more than one curve is stored (see DRC-Precision Option).

Input Resistance: Greater than 1000 megohms.

Maximum Sensor Power Dissipation: 25 microwatts at 4.2K.

Temperature Readout:

Display: LED display simultaneously shows sample sensor temperature, control sensor temperature, and control set-point directly in Kelvin or in voltage.

Resolution: Sample sensor temperature: 0.01K for temperatures below 30K, better than 0.05K above (or 0.1mV in voltage). Control sensor temperature: 0.1K (or 0.1mV in voltage).

Accuracy (20-25°C ambient): $\pm 0.5K$ at 4K and 77K, $\pm 1.0K$ at 273K with standard Sensor. See DRC-Precision Option for accuracy with Lake Shore calibrated Sensor.

Temperature Coefficient (10-20°C and 25-35°C ambient): $\pm 0.01K/^{\circ}C$.

Response Time: Less than 1 second to rated accuracy.

Temperature Control:

Set Point: Keypad selection as a numeric value, as a step change from prior value, or incrementally via up/down counter. All keypad operations can be duplicated with optional interfaces.

Set Point Resolution: 0.1K (0.1mV when display is in voltage mode).

Typical Controllability: Better than 0.001K for temperatures below 30K and 0.005K above 30K in a properly designed system.

Control Modes: Proportional (gain), integral (reset) and derivative (rate). Set numerically (00 to 99% of internally established range) or incremented via front-panel keypad. Continuous 2-digit display of each mode. Manual Mode allows 0 to 100% of available heater output to be selected via keypad. Auto and Manual modes can be used concurrently. All keypad operations can be duplicated thru interfaces.

Control Sensor: Either Sensor Input (designated from rear-panel).

Heater Output: Up to 50 watts (1A, 50V) available. 5 output ranges can be selected either from front-panel or interfaces and provide approximate decade attenuation of maximum power output. Output can be manually set to any value (see Manual Control Mode above)

Heater Output Monitor: LED bar graph continuously displays heater output level (resolution: 1% of output range).

General:

Sensor Voltage Monitor: Buffered output of each sensor voltage:

Remote Interface: Provides remote programming via IEEE-488 Interface. All front-panel keypad/pushbutton functions (except power on/off) can be controlled through the interface and all front-panel displayed information (along with sensor identification) is output through the interface.

Dimensions, Weight: 432mm wide x 102mm high x 330mm deep (17 in. x 4 in. x 13 in.). Style L, full-rack package. Net weight 9 kg (20 lb.).

Power: 90-110, 105-125, or 210-250 VAC (selected via internal jumpers), 50 or 60Hz, 100 watts.

Accessories Supplied: Mating connectors for sensor inputs and monitors, instruction manual.

Options Available:

Model 8219 Platinum Sensor Option: Converts either Input A or Input B (or both with two options) to accommodate platinum RTD sensors. Sensor excitation is 1 milliampere ($\pm 0.005\%$). Response curve is based on 0.1% interchangeability at 0°C and temperature coefficient (0-100°C) of 0.00385/ $^{\circ}C$. Accuracy conforms to DIN 43760 tolerances $\pm 0.1K$. Special calibrations can be accommodated with DRC-Precision Option. Lake Shore PT-100 Sensors recommended.

Note: The DRC-82C has three ports available, each of which can accommodate one 8220-Series Option. Installation of an optional Interface does not interfere with the standard (IEEE-488) Interface.

Model 8221 Loop Interface: Provides remote operation via HPIL. Inputs and outputs same as with Remote Interface. See Note above.

Model 8222 BCD Interface: Provides remote operation via bit-parallel, byte-serial, TTL compatible BCD lines. Inputs and outputs same as with Remote Interface. See Note above.

Model 8223 RS232 Interface: Provides remote operation via RS232 Standard Interface. Inputs and outputs same as with Remote Interface. See Note above.

Model 8225 Analog Output: Provides analog output proportional to Kelvin temperature of Sample Sensor. 10mV/K at < 10 ohm output resistance. See Note above.

DRC-Precision Option: Custom-programmed read-only-memory for DRC instruments which improves specified accuracy to 0.1K or better over a given calibration range. Any DT-500 Series Silicon Diode Sensor can be utilized. Requires that an appropriate calibration be purchased for the Sensor. Several calibrations can be stored in one PROM, depending on instrument model.

1-16. SPECIFICATIONS.

1-17. Instrument specifications are listed in Table 1.1. These specifications are the performance standards or limits against which the instrument is tested. Any change in the specifications due to manufacturing or design changes will be covered by revision pages, a change sheet, or both, to this manual.

1-18. OPTIONS.

1-19. The options for the Model DRC-82C Controller are listed in Table 1.1.

1-20. Option Ports are designed into the DRC-82C to ease the addition of interfaces and outputs. Each standard 82C has three unused ports, each of which can accommodate any one 8220-series option. As a result, up to three options can be used simultaneously. Most of the options are easily field installable by the user; thus, units can be changed or upgraded to satisfy changing requirements.

1-21. An IEEE-488 Interface is a standard part of each DRC-82C and does not occupy one of the option ports. All the keyboard functions of the instrument can be duplicated via the IEEE interface to provide virtually total remote operation. Additionally, the user can use the IEEE interface to program custom sensor-response curves into the instrument. All the front panel displays are active in the remote mode so that system operation can be monitored. Local (front panel) control can be easily assumed from the front panel, as might be desired during system set-up or in the case of a computer malfunction.

1-22. Additional interfaces are optionally available for the instrument and include the Model 8221 Loop Interface for remote operation via HPIL; the Model 8222 BCD Interface for remote operation via bit parallel, byte serial, TTL compatible BCD lines; and the Model 8223, RS-232C compatible interface. Each of these interfaces functions virtually the same as the IEEE-488 interface in the unit.

1-23. In addition to the interfaces, the Model 8225 Analog Output provides an analog output signal proportional to the sample sensor temperature. Future 8220 options will be announced as available.

1-24. The Model 8219 Platinum Sensor Option converts either input to platinum RTD sensors. When installed, the instrument's standard response curve is based on DIN 43760 for that input. The 8219 also converts the standard DRC-82C sensor excitation current (10 microamperes) to 1 milliampere to accommodate 100-ohm platinum sensors.

1-25. Instrument Identification.

1-26. A five-digit serial number is used to identify the Model DRC-82C. This serial number should be used in all correspondence which the user may have with Lake Shore Cryotronics, Inc.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This Section contains information and instructions pertaining to initial instrument set-up. Included are initial inspection procedures, power and grounding requirements, environmental information, bench and rack mounting instructions, a description of interface connectors, and repackaging instructions.

2-3. INITIAL INSPECTION.

2-4. This instrument was electrically and mechanically inspected prior to shipment. It should be free from mechanical damages, and in perfect working order upon receipt. To confirm this, the instrument should be inspected visually for obvious damage upon receipt and tested electrically by use to detect any concealed damage. Be sure to inventory all components supplied before discarding any shipping materials. If there is damage to the instrument in transit, be sure to file appropriate claims with the carrier, and/or insurance company. Please advise Lake Shore Cryotronics, Inc. of such filings. In case of parts shortages, please advise us also. The standard Lake Shore Cryotronics Warranty is given on the first page of this manual.

2-5. POWER REQUIREMENTS.

2-6. This instrument can be operated from ac line voltages of 90-125 volts or 210-250 volts at line frequencies of 50 or 60 Hz.

CAUTION

Verify that the 110V/220V Line Voltage Selection Card (Figure 3-2, Key no. 1, located on the rear panel of the Model DRC-82C) is set to the ac source voltage to be used (Table 2-1 and Figure 5-1) before inserting the power cord and turning the instrument on. Also ensure that the proper fuse is installed.

Table 2-1. Line Voltage Selection

Line Voltage (Volts)	Operating Range (Volts)	Fuse (A)
100	90-105	2 - SB
120	108-126	2 - SB
220	198-231	1 - SB
240	216-252	1 - SB

2-7. Power Cord.

2-8. The appropriate power cord should be included with your instrument. If that is not the case, notify the company or the appropriate Lake Shore Cryotronics, Inc. representative.

2-9. Grounding Requirements.

2-10. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends, and some local codes require, instrument panels and cabinets to be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

2-11. To preserve the protection feature of this equipment grounding wire when operating from a two-contact outlet, use a three-prong adapter and connect the green pigtail on the adapter to power line ground.

2-12. ENVIRONMENTAL REQUIREMENTS.

2-13. The DRC-82C is designed to be operated in a laboratory environment where the temperature is confined to a rather narrow temperature range about room temperature (10-35°C).

2-14. Humidity.

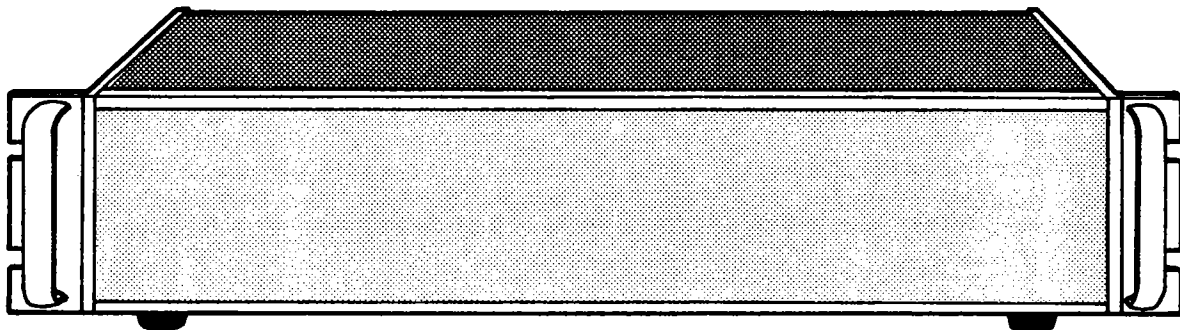
2-15. The DRC-82C is for laboratory use and no humidity specification has been determined for this instrument.

2-16. INSTRUMENT MOUNTING.

2-17. The Model DRC-82C is shipped with feet and a tilt bail installed and is ready to use as a bench instrument. The front of the instrument may be elevated for convenience of operating and viewing by extending the tilt stand. As with any precision instrument, the DRC-82C should not be subjected to excessive shock and vibrations, such as the kind that usually accompany high vacuum pumping systems.

2-18. Rack Mounting.

Figure 2-1. Typical Rack Configuration



2-19. The Model DRC-82C is housed in a Style L, full-rack package and can be installed in a standard 19" instrument rack by using the optional rack mounting kit RM-3F. The basic hardware and front handles are contained in this kit. A typical RM-3F kit installation is shown in Figure 2-1.

2-20. Sensor Input Connections.

2-21. The Model DRC-82C is supplied with two rear panel mounted 5-pin connectors for the connection of two DT-500 series silicon diodes. The recommended cable diagram for the sensor diode(s) is given in Figure 2-2. The use of a four wire diode connection is highly recommended to avoid introducing lead IR drops in the voltage sensing pair which is translated into a temperature measurement error. The indicated shielding connections are the recommended standard practice to avoid ground loops. The alternate two-wire wiring scheme shown may be used for the diode in less critical applications where control is important but small readout errors can be tolerated.

2-22. Sensor Output Monitors.

2-23. Buffered voltage outputs of both Sensor A and Sensor B are available from the MONITORS plug on the back of the instrument. This plug is a 7-pin connector which also carries the output from the Model 8225 Analog Output. This option provides for an analog output proportional to Kelvin temperature of the Sample Sensor. The signal is set at 10 mV/K at less than 10 ohms output resistance. The connections to that connector are given in Table 2-2.

Table 2-2. Monitor Plug Connections

Terminal Letter	Description
E	Voltage Output (Input A)
F	Ground (Input A)
A	Voltage Output (Input B)
B	Ground (Input B)
C	10 mV/K Temperature Option
D	Associated Ground
H	(Optional Shield)

2-24. Heater Power.

2-25. The heating element should be isolated from the sensor(s) ground(s) to preclude the possibility of any of the heater current being conducted into the diode sensor leads. In addition, the heater leads should not run coincident with the diode leads and if they are in close proximity, they should be wound so as to cross the sensor leads at ninety degree angles if at all possible. Electrical feedback from the heater in addition to the desired thermal feedback, may cause oscillations and certainly will cause erroneous temperature readings.

2-26. Since the heater output is a current drive rather than a voltage drive, the output stage does not have to be fused. However, it is imperative to match the heater resistance switch range to correspond to the resistance of the heater element which is used so that excess power is not dissipated in the instrument. Also note that the nominal maximum voltage available for any of the three settings corresponds to the maximum resistance for that particular range.

CAUTION

Do not change this switch setting with the instrument on as this will blow the input fuse and may cause damage to the output stage.

2-27. Interface Connectors.

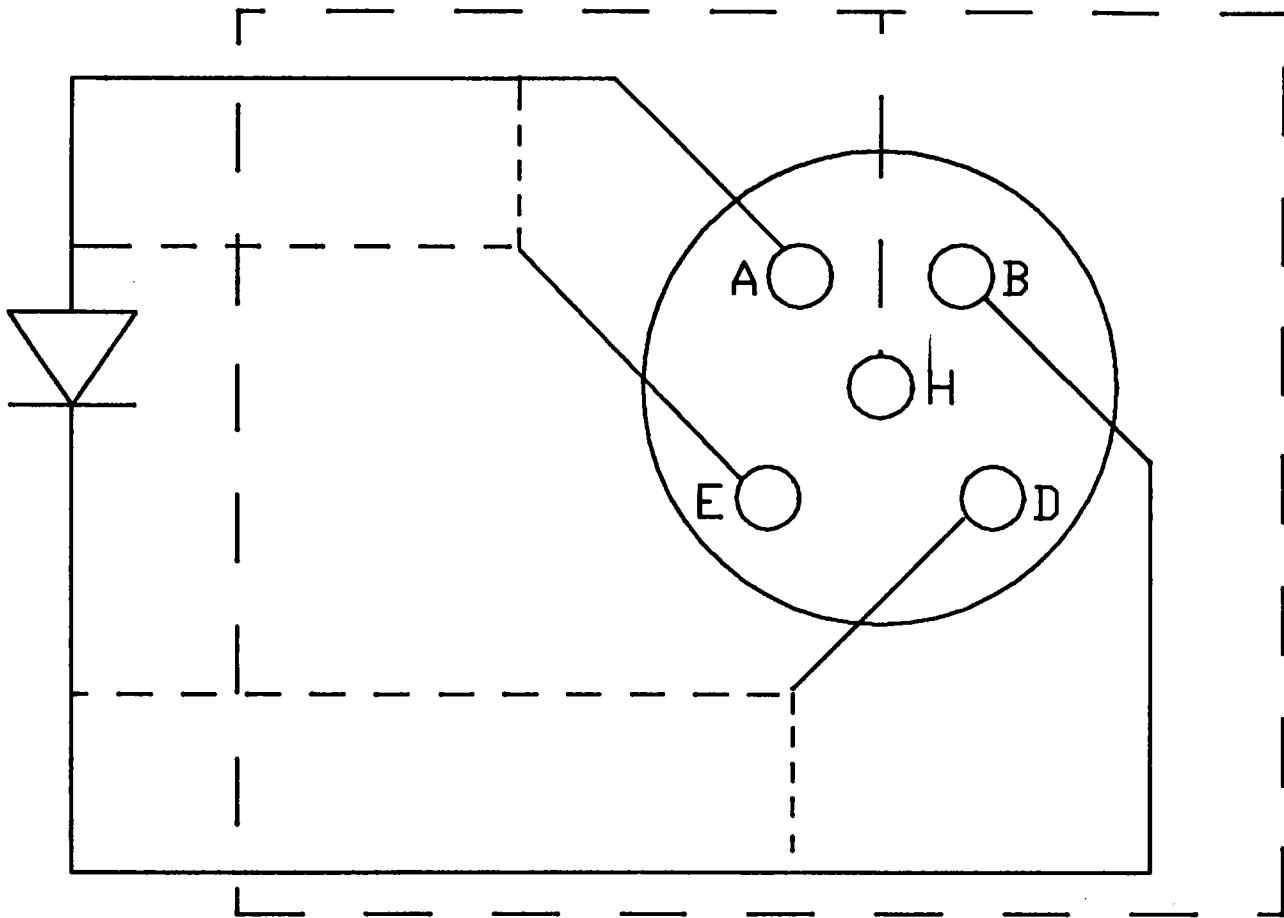
2-28. IEEE-488 Standard Interface. The IEEE-488 Connector on the back of the DRC-82C is in full compliance, both electrically and mechanically, with the IEEE Standard 488-1978. The connector contains metric threaded mounting studs, visually indicated by the color black. Metric threaded cable lockscrews must be used to secure an IEEE-488 interface cable to the instrument. Model 8072 IEEE-488 Interconnect Cables (one meter long) are available from LSCI. Refer to Figure 2.3 for the IEEE-488 connector pin assignments.

2-29. RS-232C Option. The RS-232C option uses a 25 pin D subminiature female connector located on the rear panel of the unit in the interface cutout. The pin assignments are shown in Table 2-3.

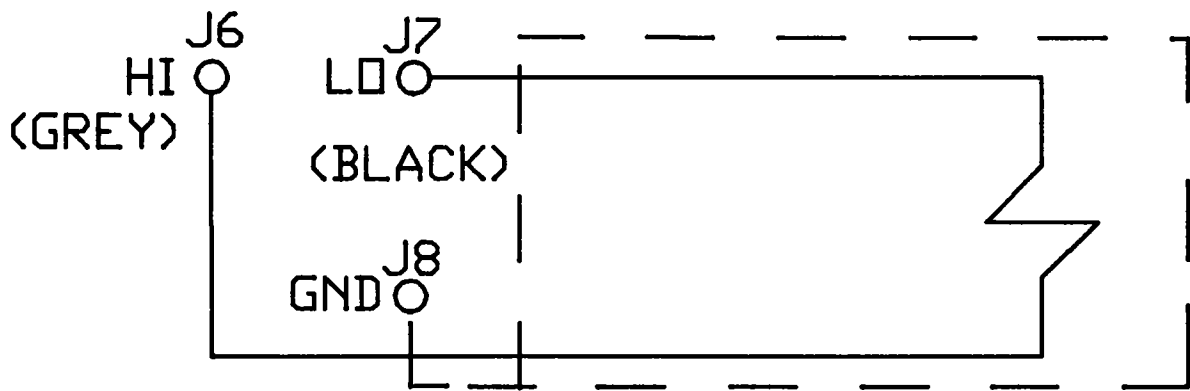
Table 2-3. RS-232C Connector Pin Assignments

Pin No.	Description	RS-232C Signal
1	Protective Ground	AA
2	Transmitted Data	BA
3	Received Data	BB
4	Request to Send	CA
5	Clear to Send	CB
6	Data Set Ready	CC
7	Signal Ground	AB
8	Received Line Signal Detector	CF
20	Data Terminal Ready	CD

DO NOT GROUND SHIELD



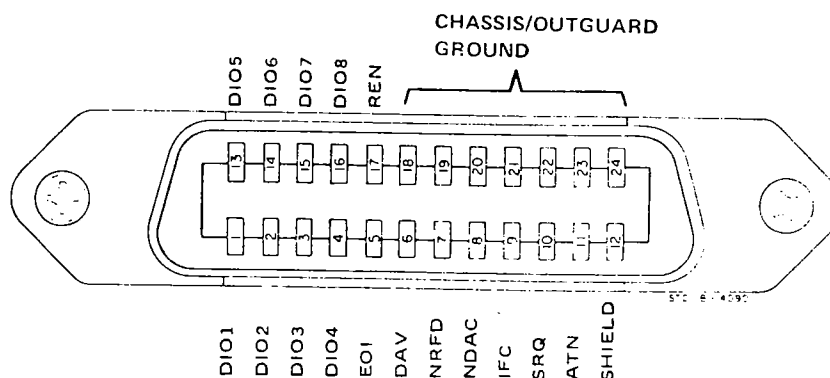
----- 4 WIRE (RECOMMENDED)
----- 2 WIRE



RECOMMENDED HEATER CABLE CONNECTIONS

Figure 2-2. Sensor & Heater Cable Connections

IEEE-488 CONNECTOR J4



DIO 1-8 (Data Input/Output)

Mnemonic referring to the eight "Data Input/Output" lines. The DIO lines transfer messages in a byte-serial, bit parallel manner.

EOI (End or Identify)

Mnemonic referring to the "End or Identify" control line. EOI is used by a device to indicate the end of a multiple-byte transfer.

DAV (Data Valid)

Mnemonic referring to the "Data Valid" control line. DAV is used to coordinate the "handshake" sequence. The DAV line is controlled by the source (talker). When DAV is true, data on the DIO lines is considered valid.

NRFD (Not Ready For Data)

Mnemonic referring to the "Ready For Data" control line. NRFD is used to coordinate the "handshake" sequence. The NRFD line is controlled by the acceptor (listener). When NRFD is true, the acceptor indicates to the source that he is ready to accept data.

NDAC (Data Not Accepted)

Mnemonic referring to the "Data Accepted" control line. NDAC is used to coordinate the "handshake" sequence. The NDAC line is controlled by the acceptor (listener). When NDAC is true, the acceptor indicates to the source that the data on the DIO lines has been accepted.

IFC (Interface Clear)

Mnemonic referring to the "Interface Clear" control line. IFC is used to place the HP-IB system in a known quiescent state. The IFC line is controlled by the system controller.

SRQ (Service Request)

Mnemonic referring to the "Service Request" control line. SRQ is used (by any device having service request capability) to indicate to the system controller that the device requires service. The controller responds by polling the devices to determine which device requested service.

ATN (Attention)

Mnemonic referring to the "Attention" control line. The state of the ATN line determines whether the HP-IB is in the "Command mode" (ATN true) or the "Data mode" (ATN false). When ATN is true, all devices must listen to the data lines, and when ATN is false, only devices that have been addressed will actively transfer data.

REN (Remote Enable)

Mnemonic referring to the "Remote Enable" control line. REN is used in conjunction with listen addresses (DIO 1-8) to select either local or remote control of each device.

For further information concerning the IEEE Std. 488-1978, refer to IEEE Standard Digital Interface for Programmable Instrumentation.

Figure 2-3. IEEE-488 Standard Interface Bus Connector

2-30. The RS-232C I/O meets EIA RS-232C specifications for AA, AB, BB, CA, CB, CC, CD and CF signals. RS-232 control signals are used in the following manner:

- CC and CF - detect RS-232 data path status and to send data
- CB - monitored to enable data output
- CA - set high to request data output enable
- CD - set high at power on and dropped if input buffer is full

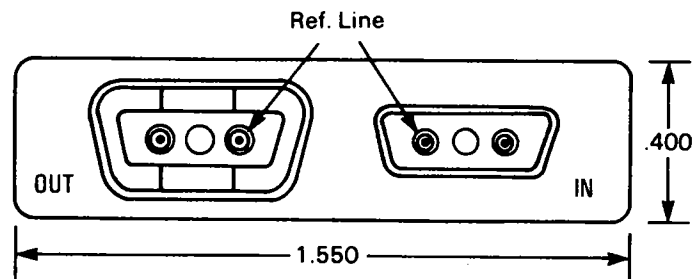
2-31. Baud Rate is internally switch settable at 300 or 1200 (crystal based 0.1% accuracy).

2-32. Data Format is internally switch selectable with even, odd or no parity, 1 or 2 stop bits; and 7 data bits. Factory set to 7 data bits, 1 stop bit, parity enabled (odd) and 300 Baud.

2-33. HP-IL (Hewlett-Packard Interface Loop) is a bit-serial interface which allows the HP-41 handheld computer to be used as a system controller, capable of transmitting and receiving data and performing a wide variety of instrument control function. Devices are connected in a circular loop structure using two wire cables going from the output of one device to the input of the next device until all devices form a closed loop.

2-34. Figure 2-4 shows the cable connector, which was designed to be non-invertible and non-reversible with a positive detent to be as "fool-proof" as possible.

Figure 2-4. HP-IL Interface Connector



2-35. The Model 8221 Loop Interface complies with the HP-IL Interface Specification, November 1982 (copyright 1982 by Hewlett-Packard Company).

2-36. REPACKAGING FOR SHIPMENT.

2-37. If the Model DRC-82C appears to be operating incorrectly, please discuss the problem with a factory representative before returning the instrument. He may be able to suggest several field tests which could avoid the unnecessary return of an instrument to the factory when the malfunction is elsewhere. If these tests determine that the fault is in the instrument, the representative will provide shipping and labeling instructions for returning it. In order to expedite the repair of the instrument, contact the factory for a Returned Goods Authorization (RGA) number. Include the instrument's model and serial numbers in all written correspondence.

2-38. When returning an instrument, please attach a tag securely to the instrument itself (not on the shipping carton), clearly stating:

- A. Owner, address and phone number
- B. Instrument Model and Serial Numbers
- C. Malfunction Symptoms
- D. Description of External Connections and Cryostats
- E. Returned Goods Authorization Number

2-39. If the original carton is available, repack the instrument in a plastic bag, place it in the carton using original spacers to protect protruding controls. Seal the carton with strong paper or nylon tape. Affix shipping labels and "FRAGILE" warnings.

2-40. If the original carton is not available, pack the instrument similar to the above procedure, being careful to use spacers or suitable packing material on all sides of the instrument.

SECTION III

OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains complete operating instructions (both bench and system) for the Model DRC-82C Temperature Controller. Included is a description of the front and rear panel controls and indicators, programming instructions, and application examples.

3-3. CONTROLS AND INDICATORS.

3-4. Figures 3-1 and 3-2 identifies the DRC-82C displays, annunciators, controls, and connectors. The identification of each item is keyed to the drawing within the figure.

3-5. FRONT PANEL DESCRIPTION.

3-6. Display Block.

3-7. Sample Sensor.

3-8. The choice of input for the SAMPLE SENSOR is made by a switch selector labeled SAMPLE on the rear panel. This switch chooses either INPUT A or INPUT B and lights the appropriate display light on the front panel.

3-9. The choice of Kelvin or Voltage display is determined by the left hand SENSOR ID switch 1. See Section 3-45. for more detail.

3-10. The multiple input light comes on if the SAMPLE Sensor (A or B) SENSOR ID switch selects a remote sensor by means of a Model SW-10A 10-Sensor Selector Switch or a Model 8084 IEEE Sensor Selector.

3-11. The display corresponds to the Voltage or Kelvin choice selected by the left hand SENSOR ID switch located on the back panel. If in voltage, the display is to the nearest 100 microvolts and if in Kelvin, the temperature is rounded to 0.01 Kelvin.

3-12. Under IEEE-488 control any of the above parameters can be changed including the Sensor A or Sensor B selection of the SAMPLE SENSOR.

Figure 3-1. DRC-82C Temperature Controller
Front Panel

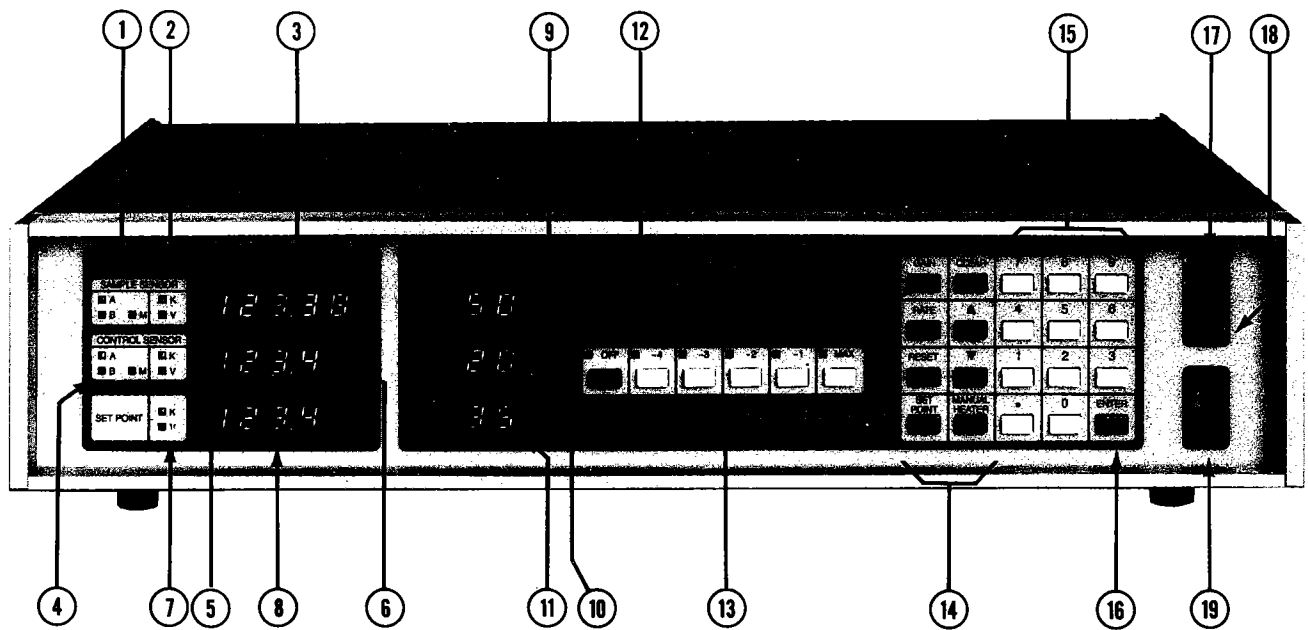


Figure 3-1. DRC-82C Temperature Controller Front Panel Description

Sample Sensor

1. Annunciated Sample Sensor input and presence of multiple curve input.
2. Annunciated Kelvin or Voltage selection.
3. Display of Sample Sensor in Kelvins or Volts.

Control Sensor

4. Annunciated Control Sensor input and presence of multiple curve input.
5. Annunciated Kelvin or Voltage selection.
6. Display of Control Sensor in Kelvins or Volts.

Set Point

7. Annunciated Kelvin or Voltage selection (corresponds to Control Sensor).
8. Display of Set Point in Kelvins or Volts.

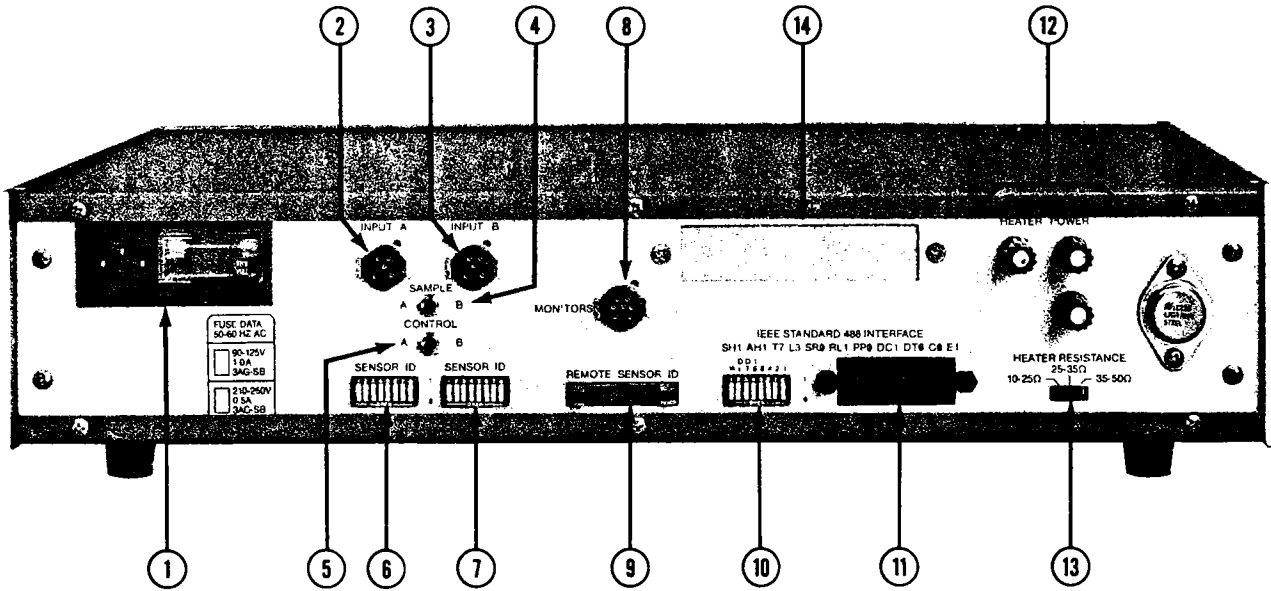
Control

9. GAIN (proportional) display in nominal log percent.
10. RATE (derivative) display in nominal percent.
11. RESET (integral) display in nominal percent.
12. HEATER POWER bar graph in per cent of full scale.
13. Full scale selection of heater power for five orders of magnitude. Includes output power OFF Position.

Keyboard

14. Function select keys.
15. Numeric entry keys.
16. Numeric entry termination key.
17. Return-to-LOCAL key with annunciator
18. REMote key with annunciator
19. Power ON-OFF switch.

**Figure 3-2. DRC-82 Temperature Controller
Rear Panel**



**Figure 3-2. DRC-82 Temperature Controller
Rear Panel Description**

1. Line Cord receptacle with fuse
2. Sensor INPUT A connector
3. Sensor INPUT B connector
4. SAMPLE display selector switch
5. CONTROL display and control input selector switch
6. SENSOR A ID (Bit 1 is a sample display bit)
7. SENSOR B ID (Bit 1 is a control display bit)
8. Monitors output of Sensor INPUT A and Sensor INPUT B buffered voltages and 8225 linear analog output option
9. REMOTE SENSOR ID - Position data from SW10A or 8084
10. IEEE-488 address switch
11. IEEE-488 connector
12. Heater Power output terminals
13. Heater resistance range selector switch
14. Optional interface access place

3-13. Control Sensor.

3-14. The choice of input for the control sensor is made by a switch selection labeled CONTROL on the rear panel. This switch chooses either INPUT A or INPUT B and lights the appropriate display light on the front panel.

3-15. The choice of Kelvin or voltage display is determined by the right hand SENSOR ID switch 1. See Section 3-45. for more detail.

3-16. The multiple input light comes on if the CONTROL Sensor (A or B) SENSOR ID switch selects a remote sensor by means of a Model SW-10A 10-Sensor Selector Switch or a Model 8084 IEEE Sensor Selector.

3-17. The display corresponds to the voltage or Kelvin choice selected by the right hand SENSOR ID switch located on the back panel. In voltage, the display resolution is 100 microvolts and in Kelvin, the display is rounded to 0.1 Kelvin which corresponds to the Set Point resolution.

3-18. Under IEEE-488 control any of the above parameters can be changed with the exception of the Sensor A or Sensor B selection of the Control Sensor since this choice is hard-wired by the CONTROL switch.

3-19. Set Point.

3-20. The Set Point is in the same units as the Control Sensor display units. If the Control Sensor is in volts, then the Set Point is in volts and may be set to a resolution of 100 microvolts. With the Control Sensor display in Kelvin, the Set Point display is also in Kelvin settable to a resolution of 0.1 Kelvin.

3-21. Control Block.

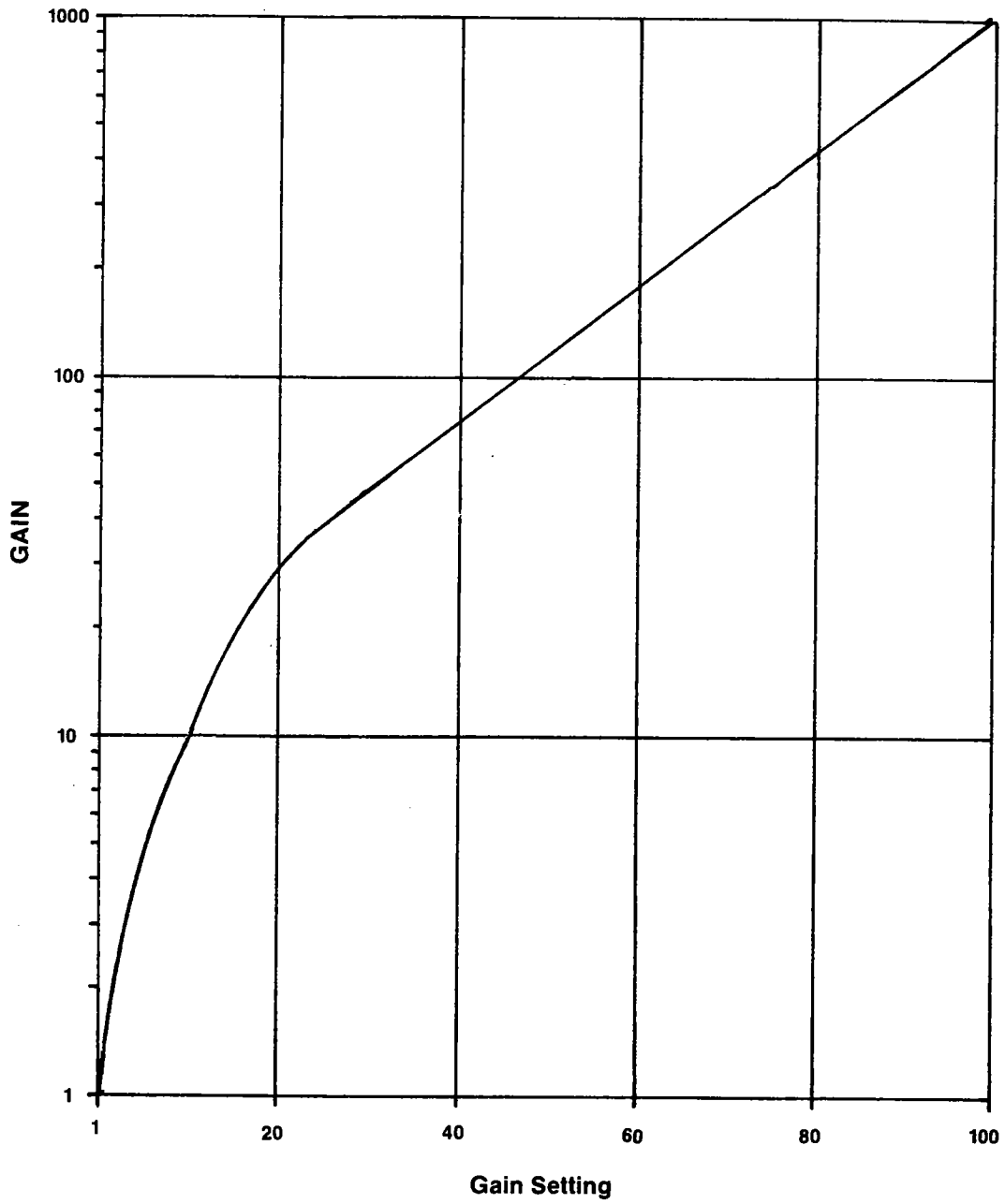
3-22. GAIN DISPLAY. Displays the magnitude of the gain (proportional) component of the control function in a nominal log percent as shown by Table 3-1 and Figure 3-3.

Table 3-1. Decile Nominal Gain Values

SETTING	GAIN
00	OFF
01	01
10	10
20	30
30	50
40	77

SETTING	GAIN
50	119
60	184
70	284
80	439
90	677
99	1000

Figure 3-3. GAIN Magnitude versus Gain Setting



3-23. RATE DISPLAY. Displays the magnitude of the rate (derivative) time constant of the control function in per cent ranging from 00 to 99%. 00% turns off the rate function while 99% represents a time constant of approximately 2 seconds.

3-24. RESET DISPLAY. Displays the magnitude of the reset (integral) time constant of the control function in per cent ranging from 00 to 99%. 00% turns off the reset function while 99% represents a time constant of approximately 10 seconds.

3-25. HEATER POWER. Displays the magnitude of the heater power in per cent of full scale. Full scale is defined as the product of the maximum heater current of one ampere times the heater resistance times the range setting.

3-26. The range setting is determined by the annunciators directly below the heater power display. MAX corresponds to a 10^0 or 1 multiplier, while -1, -2, -3, and -4 corresponds to a 10^{-1} , 10^{-2} , 10^{-3} , and 10^{-4} multiplier respectively. The OFF button turns off the output power independent of the set point and the control parameters.

3-27. A fixed value of heater power can be set using manual reset independent of the control circuit. This value is indicated by a blinking digit at the per cent power at which it has been set. Since this is set as a per cent of full scale, changing the scale changes its effect by the scale change.

3-28. Keyboard.

3-29. GAIN. If the GAIN key is pressed, the gain display units digit begins to blink to indicate that this is the control parameter which is to be changed or updated. This gain change can be implemented in one of the following ways:

1. By pressing the up or down arrow and holding the button down, the display is incremented or decremented at an approximate two counts per second rate through ten units. If the button is still held down, the rate changes to ten counts per second until the desired final value is reached and the button is released. Minor changes in the final value can then be made by incrementing or decrementing with the appropriate button. This new value is then entered by pressing the ENTER button.
2. By pressing a digit, the gain display is blanked with the exception of that new digit which now blinks to continue to remind the operator that the gain display is not yet updated. Upon pressing another digit, the previously entered digit scrolls to the tens place with the newly entered digit in the units place. Any attempt to enter more digits will be rejected by the controller.

- a. This new value will replace the old value when the ENTER button is now pressed.
- b. The old value can be incremented or decremented by the new value by simply pressing the up arrow button or the down arrow button as appropriate and then pressing the ENTER button.

3-30. As long as the last operation involves the increment and decrement button and the ENTER button has not been pressed, any of the above operations can be added to the changes just made in gain setting.

3-31. The display rolls over at both the upper end and the lower end of its range. For example, adding 15 to a set value of 90 will result in a setting of 5, while decrementing a set value of 20 by 32 will result in a setting of 88.

3-32. Refer to Paragraphs 3-22, Figure 3-3 and Table 3-1 for nominal values of gain in terms of the two digit number which can be entered for gain.

3-33. RATE. The value of Rate (derivative) is changed in the same manner as that described for GAIN changes (3-29. through 3-31.).

3-34. RESET. The value of Reset (integral) is changed in the same manner as that described for GAIN changes (3-29. through 3-31.).

3-35. SET POINT. If the SET POINT Key is pressed with the set point in Kelvin, the units digit begins to blink to indicate that this is the control parameter which is to be updated. Pressing any digit displays that digit in the units position while blanking the two leading digits and placing an implied zero (a blank) in the tenths position. Two more digits can be added by scrolling before the display is full through the hundreds position. Attempts to add additional digits will be ignored by the controller. To enter a digit in the tenths position, the decimal point must be pushed and a digit then entered. Any further digits will be ignored. The choices for updating the display from this point forward are similar to those described in Paragraphs 3-29, 3-30 and 3-31.

3-36. If the set point is in the voltage mode, the operation is quite similar except that additional digits to the right of the decimal point may be entered with a resolution of 100 microvolts. Implied zeros will fill these positions if numbers are not entered. The operations then continue as described under the GAIN entry operations.

3-37. MANUAL HEATER. The manual heater value is indicated by a blinking digit at the per cent power at which it is set. When the MANUAL HEATER key is pressed under control conditions, the HEATER POWER display is blanked with the exception of the current setting

of the manual heater value. The only difference from the operation of, for example, Gain is that the display is a linear graph representation rather than two digits.

3-38. CLEAR. The CLEAR key is used to return the instrument to the condition which it was at just after the last operation which involved the ENTER key.

3-39. ENTER. The ENTER key is used to carry out the operations which have just preceded the pressing of this key. Note that only one function operation can be performed at a time.

3-40. LOCAL. The LOCAL key is used to return the instrument from remote control by the IEEE-488 BUS, the RS-232C optional interface, or the HP-IL optional interface to front-panel control.

3-41. REM. The REM (remote) key is used to place the controller under remote control and to disable the front panel.

3-42. REAR PANEL DESCRIPTION.

3-43. Input Block.

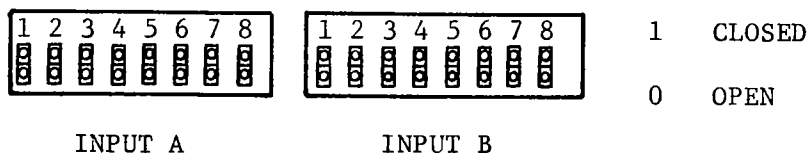
3-44. SAMPLE. Both the INPUT A and the INPUT B voltages are fed to the main board microprocessor through their respective input cards. The SAMPLE switch selects by a logic signal which of these will be displayed as either a voltage or its equivalent temperature. This choice can therefore be changed remotely over the IEEE Bus but will revert to the back panel selection on return to LOCAL operation.

3-45. CONTROL. The CONTROL switch selects either the INPUT A or the INPUT B voltage to be fed to the control section of the controller as well as determining which channel will be displayed as either a voltage or its equivalent temperature. Since this selection is hard-wired through the switch, this choice cannot be changed under remote control.

3-46. SENSOR ID. The sensor ID switches determine the display units, whether averaging occurs, select between stored curves and indicate whether a multiple input is being used. The switch information is described in Figure 3-4.

3-47. REMOTE SENSOR ID. The REMOTE SENSOR ID connector receives position data from a Model 8084 Sensor Scanner or a Model SW-10A ten position switch. This input allows the user to call up different curves for different sensor/channel positions when the instrument is used with either remote switch. The Parallel input data format is given in Table 3-2.

Figure 3-4. SENSOR ID Definitions



Switch No.	Description
1	OPEN - K { Left Sensor ID - SAMPLE } CLOSED - V { Right Sensor ID - CONTROL }
2	OPEN - Continuous Update CLOSED - Mean of 10 readings
3	RESERVED
4 (1)	OPEN - No multiple position in CLOSED - Multiple position entered on switches 5-8 or if a position is not present on remote position input
5	Multiple bit 3
6	bit 2
7	bit 1
8	bit 0

Due to the actual internal connections of the unit, the Sensor ID definitions that are output and input by the unit are given below.

Sensor ID Switch #	5	6	7	8	4	3	2	1
Internal ID Bit #	8	7	6	5	4	3	2	1

The Internal ID is put out in the form of 2 hexadecimal characters from 00-FF (0000 corresponds to 0 and 1111 to F).

For example, if the A Sensor ID has Switch #1 "ON" (1) and all others "OFF" (0), which selects Volts as the units, the Internal ID would be output as A01.

*Notes: 1) See Appendix B for a detailed discussion of the Multiple position switch and bits.

**Table 3-2. Pin Assignments for the J5
REMOTE SENSOR ID Connector
(Refer to Figure 3-2.)**

J5	Function
4	Bit 0 (LSB)
6	Bit 1
8	Bit 2
10	Bit 3 (MSB)
12	DIGITAL GROUND

ALL OTHER PINS NOT USED

Even pins bottom row; increasing right to left.

3-48. The user may supply to the REMOTE SENSOR ID his own parallel BCD 5 volt signal referred to the DIGITAL GROUND on pin 12.

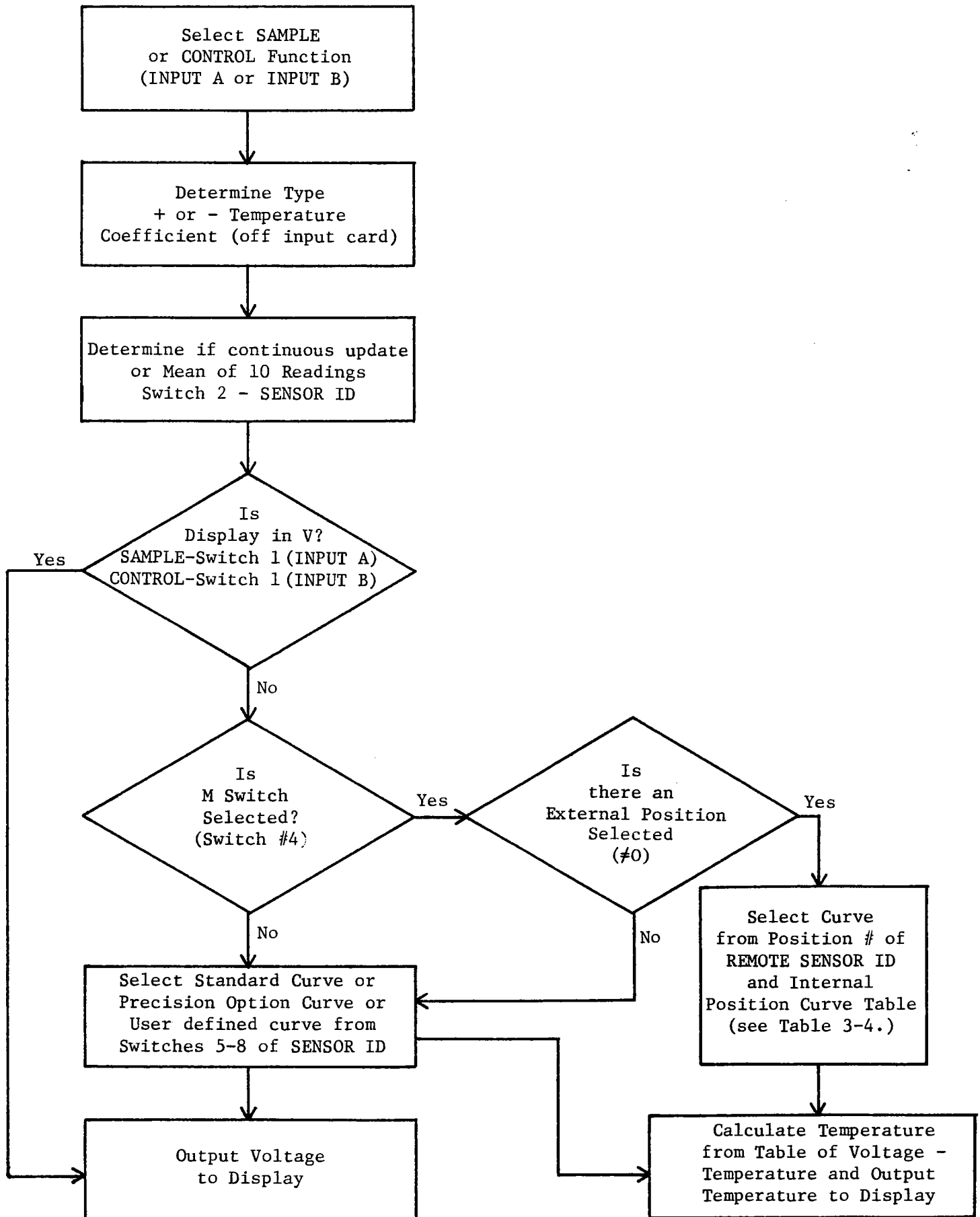
3-49. Figure 3-5 shows the logic associated with the display of the SAMPLE or CONTROL function in either temperature or voltage. The software selects either Sensor A or Sensor B input and also determines whether the input calculation of voltage is to be displayed as voltage or the equivalent temperature in Kelvin.

3-50. All SENSOR ID switches with the exception of Switch 1 are associated with their respective inputs, i.e., INPUT A or INPUT B. SENSOR ID Switch 1 of Input A determines whether the SAMPLE sensor display is in Kelvin or voltage. SENSOR ID Switch 1 of Input B determines whether the CONTROL sensor display and set point are in Kelvin or voltage. This exception for Switch 1 of both SENSOR ID's allows the use of a single sensor with its display in both Kelvin and voltage since two displays are available.

3-51. Although the set point may be selected in Kelvin or voltage, it is output to the summing amplifier as an equivalent voltage by means of a D/A converter.

3-52. The software also determines if Switch 2 of the appropriate SENSOR ID is open or closed. If open, the display is continuously updated at the rate which is indicated by the blinking voltage or Kelvin annunciator. If closed and the temperature is within 0.5 Kelvin of the SET POINT temperature, the indicated display reading is the average of 10 readings. This might be an appropriate setting if the environment is noisy or for a mechanical refrigerator where the

Figure 3-5. Flow Diagram for Curve Selection



second stage temperature cyclical variation is not of interest. A thorough discussion of this problem is given in Section IV of this manual under system operation.

3-53. If voltage has been chosen, there is no need to determine which curve is associated with the input and the determined voltage can be output to the appropriate display.

3-54. If Kelvin is chosen, the software looks at the appropriate SENSOR ID (i.e., A or B) to determine if the multiple position switch (Switch #4) has been selected.

3-55. If SENSOR ID Switch #4 is open(No), the software then checks to determine which DRC curve, Precision Option curve or user generated curve has been selected (Switches 5-8). The standard DRC curves, their switch position, their number of points and their internal starting address are given in Table 3-3.

Table 3-3. Standard Curve Information

Curve Type	Curve No.	# of Points	Internal Starting Address
D	00	31	1D40
E1	01	31	1DFO
CRV 10	02	31	1EAO
Pt	03	31	1F50

For example, if the standard platinum DIN curve were desired, and Option 8219 installed, Switches #7 and 8 for the appropriate SENSOR ID would be closed.

3-56. If a Precision Option is ordered from the factory, its curve number will be specified for the user and included in the manual as an addenda to the manual (see Appendix B).

3-57. A discussion of user generated curves and how to enter them into the instrument is covered under the IEEE-488 Interface discussion (see Section 3-98).

3-58. If the M switch #4 is closed (Yes), the sensor curve is determined by the external position selected and indicated through pins 4,6,8 and 10 of the REMOTE SENSOR ID interface. These positions are related to a particular curve by an internal table which may be set up by the user through one of the controller interfaces such as the IEEE-488 interface. The form of this internal Table is shown in Table 3-4. Note that the table may be different for both inputs. (Refer to Appendix B for a Curve Number -vs- Position # Correlation Table detailed explanation.)

Table 3-4. REMOTE SENSOR ID Position-Curve Definitions

Remote Position (M)	Curve #(A)*	Curve #(B)*
0	Default to SENSOR ID	
1	00	00
2	00	00
3	00	00
4	00	00
5	00	00
6	00	00
7	00	00
8	00	00
9	00	00
A	00	00

Note: Remote Position numbers are in HEX and are restricted to 10 positions (1-A). The internal table is configured for all 16 binary combinations for Remote Position. Curves are decimile 00-15. *Curve #00 is from Table 3-3., a DRC-D curve is the Factory setting unless otherwise specified.

3-59. Once the appropriate curve has been determined, the temperature equivalent to the measured voltage is determined and output to the appropriate display.

3-60. IEEE-488 Interface.

3-61. The IEEE Interface for the DRC-82C fully complies with the IEEE 488-1978 standard and incorporates the functional, electrical and mechanical specifications of the standard. It also follows the proposed update to that standard titled "Code and Format Conventions for use with IEEE Standard 488-1978".

3-62. General IEEE Specifications and Operation.

3-63. The following discussion covers the general operation of the IEEE-488 interface. For a more detailed description of signal level and interaction, refer to the IEEE Std. 488-1978 publication "IEEE Standard Digital Interface for Programmable Instrumentation".

3-64. All instruments on the interface bus must be able to perform the interface functions of TALKER, LISTENER, or CONTROLLER. A TALKER transmits data onto the bus to other devices. A LISTENER receives data from other devices through the bus. Some devices perform both functions. The CONTROLLER designates to the devices on the bus which function to perform.

3-65. The IEEE works on a party line basis with all devices on the bus connected in parallel. All the active circuitry of the bus is contained within the individual devices with the cable connecting all the devices in parallel to allow the transfer of data between all devices on the bus.

There are 16 signal lines contained on the bus:

- A) 8 Data Lines
- B) 3 Byte Transfer Control Lines
- C) 5 General Interface Management Lines

3-66. The data lines consist of 8 signal lines that carry data in a bit parallel, byte serial format. These lines carry universal commands, addresses, program data, measurement data, and status to all the devices on the bus. The controller designates the functions of the units on the bus by setting the ATN line low (true) and sending talk or listen addresses on the DATA lines. When the ATN line is low, all devices listen to the DATA lines. When the ATN line goes high (false), then the devices addressed to send or receive data perform their functions while all others ignore the DATA lines.

3-67. Transfer of the information on the data lines is accomplished through the use of three signal line: DAV (Data Valid), NRFD (Not Ready for Data), and NDAC (Not Data Accepted). These signals operate in an interlocking handshake mode. The two signal lines, NRFD, and NDAC are each connected in a logical AND to all devices connected to the bus. The DAV is sent by the talker and received by listeners while the NRFD and NDAC are sent by listeners back to the talker.

3-68. The General Interface Management Lines manage the bus and control the orderly flow of commands on the bus. The IFC (Interface Clear) message basically clears the interface to a known state appropriate to the device being addressed. SRQ (Service Request) is used by a device to indicate the need for attention or service and to request an interruption of data flow. REN (Remote Enable) is used to select between two sources of device data (as an example: front panel or rear panel controls on a measurement device). EOI (End or Identify) indicates the end of a multiple byte transfer sequence, or along with the ATN line, executes a polling sequence.

3-69. DRC-82C Interface Capabilities.

3-70. The DRC-82C IEEE-488 Interface capabilities are listed in Table 3-6. For quick operator reference, the DRC-82C's interface functional capabilities are also listed in mnemonic format on the instrument's rear panel.

Table 3-5.

ASCII & IEEE (GPIB) CODE CHART

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

KEY octal 25 PPU GPIB code
 NAK ASCII character
 hex 15 21 decimal

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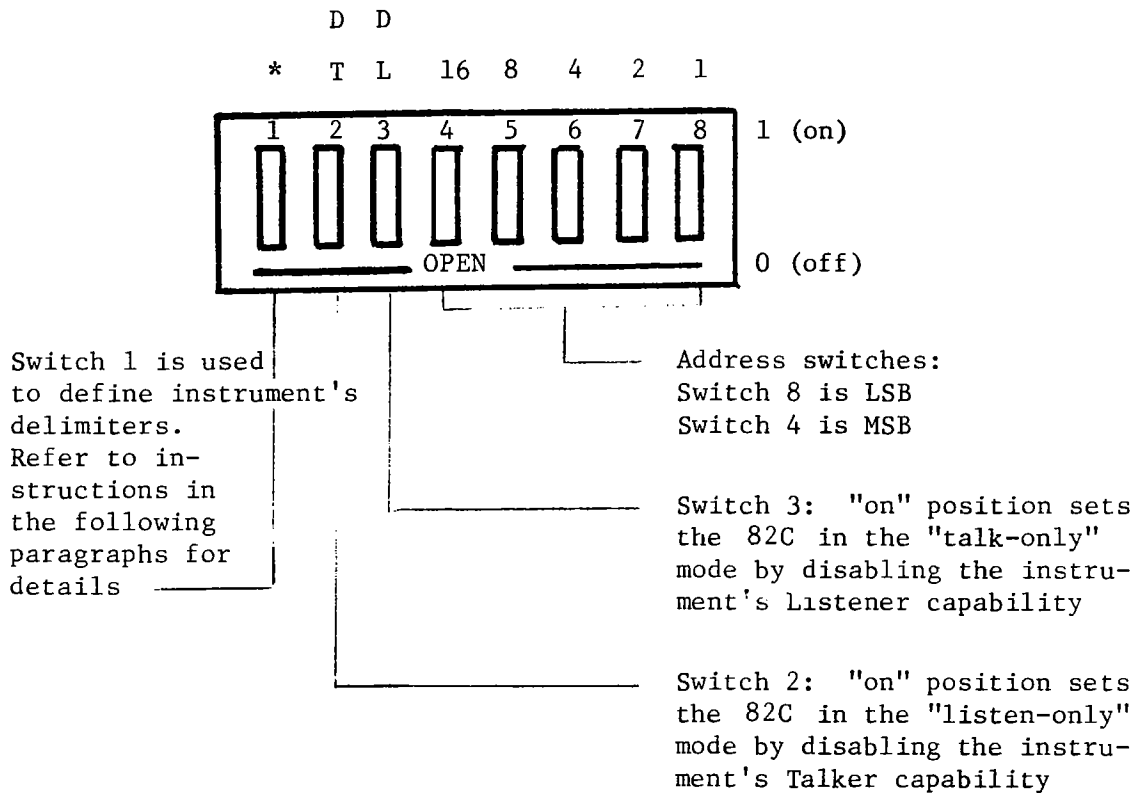
Table 3-6. Interface Capabilities of the DRC-82C

Mnemonic Code	Interface Function
SH1	Full Source Handshake Capability
AH1	Full Acceptor Handshake Capability
T7	Basic Talker, no serial poll capability, Talk only mode, Unaddressed to Talk if it is addressed to Listen
L3	Basic Listener, Listen only mode, Unaddressed to Listen if it is addressed to Talk
SRØ	No Service Request capability
RL1	Complete Remote/Local capability
PPØ	No Parallel Poll capability
DC1	Full Device Clear capability
DTØ	No Device Trigger capability
CØ	No system Controller capability
E2	Open Collector driver Electronics

3-71. Model DRC-82C Addressing.

3-72. The IEEE-488 Interface Bus address of the DRC-82C is set by the address switch located on the instrument's rear panel. The switch is an eight-station DIP switch with five switches (#4-#8) reserved for the address selection, with #4 the MSB and #8 the LSB.

Figure 3-6. IEEE-488 Address Switch for the Model DRC-82C



3-73. Switch 1 (*) on the DRC-82C's address DIP switch is used to define the instrument's terminating characters (delimiters). The "off" position selects the ASCII characters CR and LF (Carriage Return and Line Feed) as the terminating characters for input and output data. For the output data the EOI line is set by the DRC-82C with the output of the Line Feed (LF).

3-74. When address Switch 1 (*) is "on", a variable terminating character format is selected for the input and output data. In this configuration the power-up (default) terminating characters are LF and CR with the EOI line being set by the DRC-82C with the output of the Carriage Return (CR). However, the 2 terminating characters can be changed via input data to the DRC-82C as detailed in Table 3-8, DRC-82C Programming Codes.

**Table 3-7. Allowable Address Codes for the DRC-82C
(Factory preset address is decimal 12)**

ASCII Code Character		Bit		Address Switches					5-bit Decimal Code
Listen	Talk	2*	3	4	5	6	7	8	
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
Ø	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
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



Factory preset address

* Only the first five bits of the binary code are listed. These bits are the same for the TALK and LISTEN address. The sixth and seventh bits (controller originated) determine whether the instrument is being addressed to TALK or LISTEN.

Function	Bit	
	2	3
Talk	1	0
Listen	0	1

3-75. Since the controller is both a Talker and a Listener, normally switches two and three should both be off. These switches are usually of use when one instrument is a Talker and another instrument is a Listener and they are to share the same address.

3-76. The factory preset address of this instrument is 12. Thus, when the instrument is initially received, address switch numbers 5 and 6 should be on which will result in the Address Switch having the following preset factory code (00001100).

3-77. PROGRAMMING INSTRUCTIONS

3-78. For the following discussion, we will assume that the bus controller has an Address of 21 (Table 3-7). Therefore, its Talk ASCII Code is U and its Listener ASCII Code is 5. The bus controller is normally a computer and should not be confused with the DRC-82C controller in the following discussion.

3-79. Input Data Format and Program Codes.

3-80. In addition to the Universal Bus Message Commands which most IEEE instruments respond to, the DRC-82C receives the Program Codes which are given in Table 3-8. The DRC-82C must be addressed as a "listener" to receive any instruction or string of instructions from the Program Code list.

3-81. The Model DRC-82C input data format does not require a set number or set sequence of Program Codes to implement proper instrument set-up. These Program Codes are processed only after the terminators[DELM1][DELM2] are sent across the bus. The listing and explanation of the DRC-82C's programming codes are given in Table 3-8.

3-82. The following examples are for the programming string "S123.4P45I30D25R4W1" which with the set point in Kelvin sets the set point to 123.4 Kelvin, the gain to 45, the integral to 30, the derivative to 25, the heater power or current range (see 3-123 for how to change from power to current) to 10^{-1} and the output statement to be sent to be W1.

A. HPL (HP9825A) Format:

```

      wrt  712,  "S123.4P45I30D25R4W1"
           |      ^
           |      |
           |      |----- Data
           |
Write Data |-----
Command   |
           |
           | 12 = DRC-82C's preset address
           | 7  = IEEE-488 card address in 9825A

```

TABLE 3-8. DRC-82C Program Code Summary

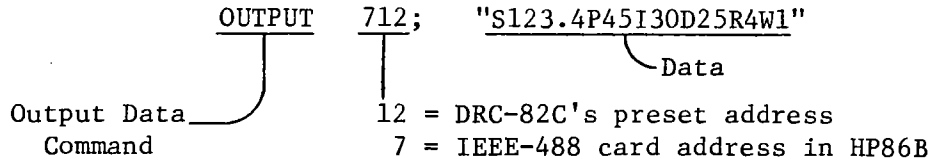
PROGRAMMING CODES - Program Code Handshake occurs with the DRC-82C in Remote, Addressed to Listen, and ATN false.

Program Code (ASCII Character)	Functional Description																												
TN ₁	Determines terminating characters when address switch #1 is "ON". Terminator(s) * N ₁ = 0 (CR)(END ^ LF) N ₁ = 1 (LF)(END ^ CR) N ₁ = 2 (END ^ NL) N ₁ = 3 (END ^ DAB)																												
MN ₁	Selects operational mode: N ₁ = 0 Local N ₁ = 1 Remote N ₁ = 2 Remote with Local Lockout																												
ZN ₁	Selects EOI status: N ₁ = 0 EOI set/accepted on last character N ₁ = 1 EOI not set/not accepted on last character																												
S[---.---]	Set point input same as front panel input For K - last three input are hundreds, tens, units. - Decimal point may be implied or entered.																												
PN ₁ N ₂	Log % Proportional Value (Gain) - will take last two numeric values until another command is input. N ₁ and N ₂ are same as front-panel display																												
IN ₁ N ₂	% Integral (Reset) - N ₁ N ₂ have same definition as gain																												
DN ₁ N ₂	% Derivative (Rate) - N ₁ N ₂ have same definition as gain																												
RN ₁	<table border="1"> <thead> <tr> <th></th> <th>Heater Range</th> <th>25 Load Watts (f)</th> <th>Current mA</th> </tr> </thead> <tbody> <tr> <td>N₁ = 0</td> <td>OFF</td> <td></td> <td></td> </tr> <tr> <td>N₁ = 1</td> <td>10⁻⁴</td> <td>.0025</td> <td>10</td> </tr> <tr> <td>N₁ = 2</td> <td>10⁻³</td> <td>.025</td> <td>30</td> </tr> <tr> <td>N₁ = 3</td> <td>10⁻²</td> <td>.25</td> <td>100</td> </tr> <tr> <td>N₁ = 4</td> <td>10⁻¹</td> <td>2.5</td> <td>300</td> </tr> <tr> <td>N₁ = 5</td> <td>10⁰</td> <td>25</td> <td>1000</td> </tr> </tbody> </table>		Heater Range	25 Load Watts (f)	Current mA	N ₁ = 0	OFF			N ₁ = 1	10 ⁻⁴	.0025	10	N ₁ = 2	10 ⁻³	.025	30	N ₁ = 3	10 ⁻²	.25	100	N ₁ = 4	10 ⁻¹	2.5	300	N ₁ = 5	10 ⁰	25	1000
	Heater Range	25 Load Watts (f)	Current mA																										
N ₁ = 0	OFF																												
N ₁ = 1	10 ⁻⁴	.0025	10																										
N ₁ = 2	10 ⁻³	.025	30																										
N ₁ = 3	10 ⁻²	.25	100																										
N ₁ = 4	10 ⁻¹	2.5	300																										
N ₁ = 5	10 ⁰	25	1000																										
HN ₁ N ₂	% Manual Heater Power - N ₁ N ₂ have same definition as gain																												
AS	A is SAMPLE SENSOR																												
BS	B is SAMPLE SENSOR																												
AH ₁ H ₂ (g)	SENSOR A ID																												
BH ₁ H ₂ (g)	SENSOR B ID																												
C	"clear" command. Returns the unit to the power-up settings except for Remote/Local Status																												

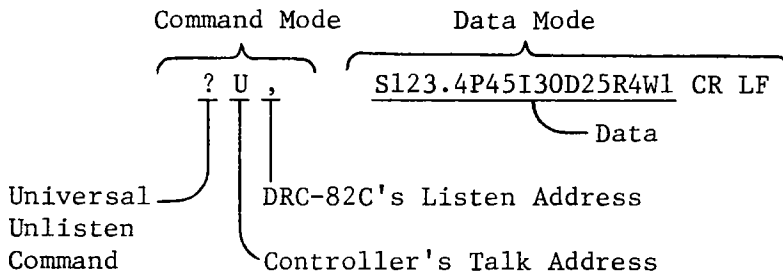
* Notes:

- a) The AND symbol (^) is used to indicate messages sent concurrently.
- b) DAB = last data byte
- c) END = EOI
- d) Within commands S,P,I,D and H special control characters U (up arrow) and W (down arrow) can be used.
- e) N_i corresponds to a numeric value (0-9); H_i corresponds to a hex value (0-F).
- f) This assumes a 25 ohm load.
- g) See Figure 3-4. and Table 3-9. for Sensor ID definitions.

B. HP Basic (HP86B) Format:



3-83. If the user were to monitor the IEEE-488 Bus when either of the above computers sent its command string over the Bus, they would observe the following IEEE-488 Format.



The Universal Unlisten Command is sent so that no other instruments on the Bus will eavesdrop on the Bus and assume that the data being sent is for their attention. The controller's Talk Address is sent to unaddress any existing talker. Note that the controller could have designated another instrument as the talker. Therefore to keep the format consistent, it must send a Talk Address even when the controller is going to be that talker. The Listen Address must be sent to tell which instrument on the Bus is to receive the Data String. Note that [DELM1][DELM2] have been indicated to be CR LF (carriage return, line feed); these are the correct terminators for the two HP computer examples.

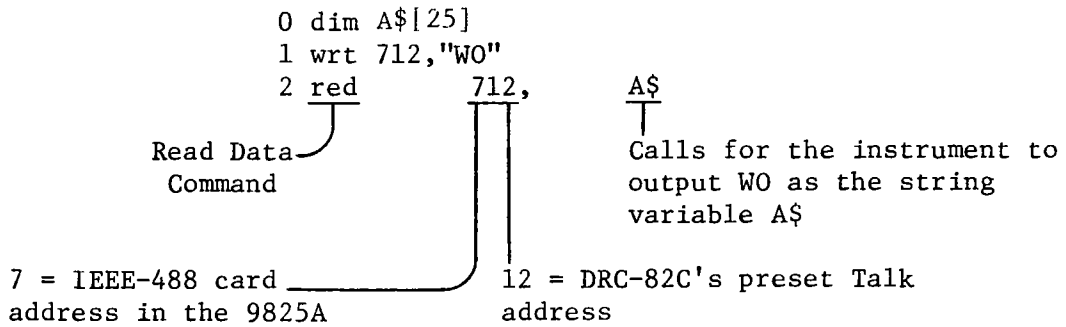
3-84. Note that the string "P45I30P40" would result in a gain of 40 and an integral value of 30, i.e., only the last value sent over the bus for that program code will be entered after the appropriate terminators have been sent over the bus.

3-85. Output Data Format and Codes.

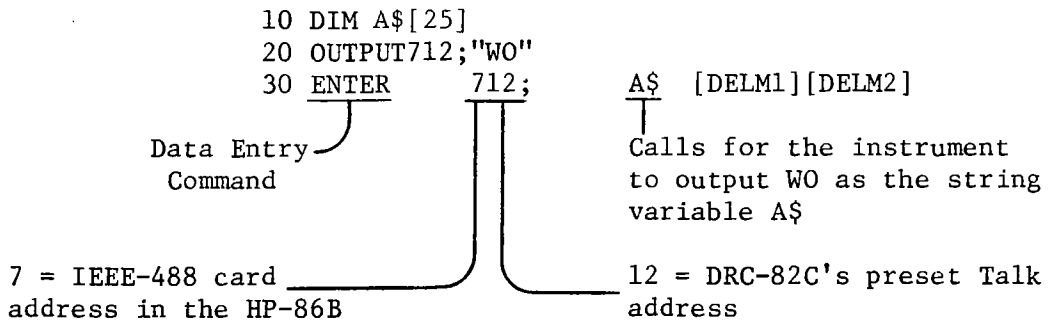
3-86. To request data from the DRC-82C, use output format statements as given in Table 3-9.

3-87. The following two examples illustrate the commands associated with obtaining output data onto the bus from the DRC-82C.

A. HPL (HP9825A) Format:

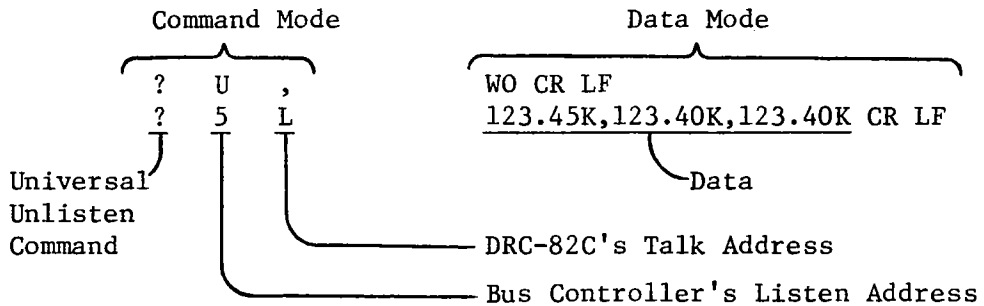


B. HP Basic (HP86B) Format:



3-88. The following information is sent across the Bus as a result of one of the above software commands.

IEEE-488 Format:



3-89. The data above indicates that the set point is at 123.4 Kelvin and the controller is controlling at the set point. Also, the sample sensor is reading 123.45K, indicating very little offset between the sample temperature and the control temperature.

Table 3-9. DRC-82C Output Statement Formats

	SAMPLE	CONTROL	SET POINT	NON-DISPLAYED CHARACTERS
WO	$S_5 S_4 S_3 \cdot S_2 S_1 K, C_5 C_4 C_3 \cdot C_2 OK, SP_5 SP_4 SP_3 \cdot SP_2 OK$			[DELM1][DELM2]
			or	
	$S_5 \cdot S_4 S_3 S_2 S_1 V, C_5 C_4 C_3 \cdot C_2 OK, SP_5 SP_4 SP_3 \cdot SP_2 OK$			[DELM1][DELM2]
			or	
	$S_5 S_4 S_3 S_2 S_1 V, C_5 \cdot C_4 C_3 C_2 C_1 V, SP_5 \cdot SP_4 SP_3 SP_2 SP_1 V$			[DELM1][DELM2]
			or	
	$S_5 S_4 S_3 \cdot S_2 S_1 K, C_5 \cdot C_4 C_3 C_2 C_1 V, SP_5 \cdot SP_4 SP_3 SP_2 SP_1 V$			[DELM1][DELM2]
WS	$S_5 S_4 S_3 \cdot S_2 S_1 K$			[DELM1][DELM2] or $S_5 \cdot S_4 S_3 S_2 S_1 V$ [DELM1][DELM2]
WC	$C_5 C_4 C_3 \cdot C_2 OK$			[DELM1][DELM2] or $C_5 \cdot C_4 C_3 C_2 C_1 V$ [DELM1][DELM2]
WP	$SP_5 SP_4 SP_3 \cdot SP_2 OK$			[DELM1][DELM2] or $SP_5 \cdot SP_4 SP_3 SP_2 SP_1 V$ [DELM1][DELM2]
	S, C and SP are numeric digits Position of decimal point and units are defined by the two SENSOR ID's (see 3-50).			
	POSITION, SAMPLE, CONTROL, GAIN, RATE, RESET, HEATER RANGE, % of MANUAL HEATER POWER OR CURRENT, % of HEATER POWER OR CURRENT			
W1	$[]_1, []_2 H_1 H_2, []_2 H_1 H_2, N_1 N_2, N_1 N_2, N_1 N_2, N_1, N_1 N_2, N_1 N_2 N_3$			[DELM1][DELM2]
	$[]_1 = 0$ or (1-A); i.e., 0 if no position data is present or position (1-A) if a multiple position is indicated (see 3-58).			
	$[]_2 H_1 H_2, []_2 H_1 H_2$ are the Sample Sensor ID and the Control Sensor ID respectively. Note that this is a different format than the Sensor ID's described in Figure 3-4.			
	$[]_2 = A$ or B; i.e., INPUT A or INPUT B. H_1 is the address bits from the SENSOR ID. H_2 is the first four bits of the SENSOR ID in reverse order.			
W2	ZN_1, MN_1, TN_1			[DELM1][DELM2]
	Z, M and T are defined in Table 3-8.			
	Note that although [DELM1][DELM2] are non-displayed characters, they must be considered as two characters in defining the string length.			

Table 3-10. Universal Bus Commands

Message/ Mnemonic	HP9825A Command	HP85 Command	IEEE-488 Bus Format
Go To Local/GTL	lc1712	LOCAL712	?U, (GTL)
Local Lock- out/LLO	llo7	LOCAL LOCKOUT 7	?U(LLO)
Selected Device Clear/SDC	clr712	CLEAR712	?U, (SDC)
Device Clear/DCL	clr7	CLEAR7	?U(DCL)
Unlisten/ UNL			?
Untalk/ UNT			-
Interface Clear/IFC			
Remote/ REN	rem712	REMOTE712	?U,

3-90. Consider the following data mode string:

023.42K,2.1321V,2.1345V

This data string indicates that one input is in Kelvin and the other is in voltage; that the temperature is not at the control point and assuming the same sensor for both inputs and disregarding timing differences between the two input cards, then 23.42 Kelvin corresponds to 2.1321 volts for this sensor calibration.

3-91. If instead of W0, W1 or W2 had been transmitted to the DRC-82C, the appropriate data string would have been transmitted from the temperature controller. For the case of W1, the data string would have the following format:

2,A2B,B40,45,30,25,4,00,047[DELM1][DELM2]

The above string indicates from the first "2" that the sensor multiple position is 2; the string A2B indicates INPUT A, from the SENSOR ID (Table 3-3.) the 2 indicates a 10 Curve, and from the B that the sample sensor is reading in voltage, the readings are averaged, and that the multiple switch is on. See both Figure 3-4 (1101) and Table 3-9 which defines H₂ as the reverse order (1011); hence the ASCII character B. Note, however, that this does not mean that the sensor in position 2 will be considered as Curve 10 sensor. Its curve will be determined from the remote curve table associated with the REMOTE SENSOR ID input which generated the leading 2 (see Table 3-4). If that table has not been changed by the user, then the curve associated with position 2 will be the DRC-D curve (see Figure 3-5).

3-92. The string B40 indicates input B with the 4 indicating that either a precision option is present or the user has entered a user generated curve as curve number 4. The 0 (0000) tells us that the reading is in Kelvin, there is no averaging and no multiple position present.

3-93. For the case of W2, the data string might be

Z0,M2,T1[DELM1][DELM2]

where the Z0,M2 and T1 are defined in Table 3-8.

3-94. Samples of Universal Bus Commands which the DRC-82C responds to are given in Table 3-10.

3-95. Sample Programming.

3-96. Set the address switch for the DRC-82C to 12 by putting address switches 5 and 6 on, 4,7 and 8 off and make sure switch 1 is off to select (CR)(LF) as the delimiters. Note that this should be done prior to turning on the instrument since the IEEE-488 only looks for the address information on power up.

3-97. A sample program for the HP-86B to exercise the various IEEE commands is listed below:

```
1 REM Address switch to 12
2 REM Address switch 1 off to get (CR)(LF)
5 I = 1
10 DIM A$(23) ! 7+7+7+2=23
20 REM Any string variable longer than 18 characters
30 REM must be dimensioned
40 OUTPUT 712; "S24.5P40I20D25R2H50WO" ! Note WO
50 ENTER 712;A$ ! Asks for string WO
60 DISP A$ ! Displays string WO
70 DISP ! Displays blank line
80 OUTPUT 712; "WS" ! Set for SAMPLE word
90 DIM B$(8),C$(8),D$(8) ! Remember the delimiters
100 ENTER 712;B$ ! Asks for SAMPLE word
110 DISP"SAMPLE =";B$ ! Displays SAMPLE word
120 OUTPUT 712;"WC" ! Set for CONTROL word
130 ENTER 712;C$ ! Ask
140 DISP"CONTROL =";C$ ! Display
150 OUTPUT 712;"WP" ! Set for SET POINT word
160 ENTER 712;D$ ! Ask
170 DISP"SET POINT =";D$ ! Display
180 OUTPUT 712;"W1" ! Set for W1
190 ENTER 712;E$ ! Default of 18 characters
200 DISP"W1 =";E$ ! How long was it?
210 DIM E$(29) ! 29 characters - right?
220 ENTER 712;E$
230 DISP"W1 =";E$
240 OUTPUT 712;"A01B03" ! Both inputs voltage, B
! 10 readings
250 I = I + 1
260 IF I < 3 THEN 80
270 END
```

3-98. Curve Programming Instructions.

3-99. The commands which will either output or change the curve information in various degrees of completeness are given in Table 3-11.

3-100. The XDT Command.

3-101. The format associated with the output of the standard curves stored, precision options stored and the format associated with the REMOTE SENSOR ID position-curve data is given in Table 3-12.

3-102. The information lines for curves 4 through 15 will only be present if these curves are actually present either as user generated curves or as precision option curves.

3-103. The XDA Command.

3-104. If the command XDA is used, the controller will output Table 3-12 followed by a comma and continue with the information indicated in Table 3-13, repeating that format until all curves have been output at which time the DRC-82C will send the delimiters and an E.O.I. signal to the bus controller indicating the end of the data transfer.

Table 3-11. Program Curve Commands and Their Description

Commands	Functional Description
XDT	Output of information contained in Tables 3-3 and 3-4. See Table 3-12 for the format of this output.
XDA	Output of XDT information and detail for all curves stored in memory. See Table 3-13 for the format associated with the detail on the curve dump.
XDN ₁ N ₂	Dumps curve number N ₁ N ₂ , where N ₁ N ₂ is a two digit number which ranges between 00 and 15. See Table 3-13 for format.
XAC=N ₁ N ₂ * XBC=N ₁ N ₂ *	A or B is INPUT A or INPUT B. C is a character (0-9,A-F). N ₁ N ₂ is curve 00-15. This command allows the changing of the values of Table 3-4.
XCN ₁ N ₂ , C ₁ =C ₁₈ , X.XXXXX,XXX.X, - - - - *	Curve Input N ₁ N ₂ ranges from 0 to 15 18 characters including blanks (Temperature coefficient determined at end of input of data) V up to 6 digits, T up to 4 digits. Replaces last comma and terminates curve input.
XEN ₁ N ₂ , X.XXXXX,XXX.X *	Adds the point to curve N ₁ N ₂ if curve N ₁ N ₂ is present. Terminates data point input.
XKN ₁ N ₂ *	Erases curve N ₁ N ₂ and repacks all data.

Table 3-12. Output Format for XDT File Management

```
(N1N2N3N4) BYTES FREE,
(H1H2H3H4) IS NEXT LOCATION,
00,31,1D40,DRC-D ,
01,31,1DFO,DRC-E1,
02,31,1EAO,CRV 10,
03,31,1F50,DIN-PT,
-
-
-
15,---
H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,
H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,
H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,
H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2,H1H2[DELM1][DELM2]
```

Note that the actual output of the file management data will be a long string unless the user writes a program to count characters and insert at the end of each information line the appropriate line feed and carriage return.

Table 3-13. Output Format for Curve Data

<pre>NN, CCCCCCCCCCCCCCCCCC, C, N₁N₂, V.VVVVV,TTT.T, - - - V.VVVVV,TTT.T[DELM1][DELM2]</pre>	<pre>Curve Number Information Line Temperature Coefficient (P or N) Number of Breakpoints Volts,Kelvin - - - N₁N₂ lines</pre>
--	---

The above format is repeated until all curves have been output. the Delimiters will be present for the last line output for each curve. NOTE that this data will normally come out as a long string separated by the commas, i.e., the implied line feed and carriage return will not be present as shown in the table. For the case of the standard curves stored within the DRC-82C, the number of data points N₁N₂ will be 31.

3-105. The XDN₁N₂ Command.

3-106. If the user is only interested in dumping a particular curve rather than all curves stored within the instrument, that option is available to him through the command XDN₁N₂ with N₁N₂ being the particular curve of interest. The format of that output is described in Table 3-13.

3-107. As an example of what to expect from each of these commands, the following programs written for the HP-86B and the resulting outputs are given as examples for a standard DRC-82C.

```
10 REM Program to output File Management Tables.
20 DIM FileTable$(207)
30 OUTPUT 712;"XDT"      ! Calls for file management table
40 ENTER 712;FileTable$
50 DISP   FileTable#[1,16]      ! Bytes Free
60 DISP   FileTable#[17,38]     ! Next Location
70 DISP   FileTable$[39,56]     ! Curve 0
80 DISP   FileTable$[57,74]     ! Curve 1
90 DISP   FileTable$[75,92]     ! Curve 2
100 DISP  FileTable$[93,110]    ! Curve 3
110 DISP  FileTable$[111,134]   1 INPUT A assignments
120 DISP  FileTable$[135,158]   ! for REMOTE SENSOR ID
130 DISP  FileTable$[159,182]   ! INPUT B assignments
140 DISP  FileTable$[183,205]   ! for REMOTE SENSOR ID
150 END
```

Note that we end with character 205 since we do not display the last two characters in the string (CR)(LF). The resulting output display will appear as follows for a standard DRC-82C instrument.

```
1792 BYTES FREE,
0100 IS NEXT LOCATION,
0,31,1D40,DRC-D ,
1,31,1DFO,DRC-E1,
2,31,1EAO,CRV 10,
3,31,1F50,DIN-PT,
00,00,00,00,00,00,00,00,
00,00,00,00,00,00,00,00,
00,00,00,00,00,00,00,00,
00,00,00,00,00,00,00,00
```

Note that the curve overall starting address of 0100 is valid for units without the 053 Update Kit. The starting address for units with the 053 Update Kit is 0200.

3-108. If the command XD00 had been transmitted to the DRC-82C by means of the following sample program for the HP-86B,

```
10 REM Program to output Curve Table
20 DIM Curve$(462)
30 OUTPUT 712;"XD00"
40 ENTER 712;Curve$
50 REM Display Curve number,Title,Temperature coefficient
60 REM and number of breakpoints
70 DISP Curve$(1,27)
80 REM Display voltage and temperature data points
90 I = 28
100 DISP Curve$ [I,I+41] ! Voltage;Temperature
110 IF I>447 THEN 140 ! I=447 for data point31
120 I = I + 42
130 GOTO 100
140 DISP CURVE$ [448,460]
150 END
```

then the following output would be displayed.

```
00, STANDARD DRC-D ,N,31,
0.00000,499.9,0.19083,365.0,0.24739,345.0,
0.36397,305.0,0.42019,285.0,0.47403,265.0,
0.53960,240.0,0.59455,220.0,0.73582,170.0,
0.84606,130.0,0.95327,090.0,1.00460,070.0,
1,04070,055.0,1.07460,040.0,1.09020,034.0,
1.09700,032.0,1.10580,030.0,1.11160,029.0,
1.11900,028.0,1.13080,027.0,1.14860,026.0,
1.17200,025.0,1.25070,023.0,1.35050,021.0,
1.63590,017.0,1.76100,015.0,1.90660,013.0,
2.11720,009.0,2.53660,003.0,2.59840,001.4,
6.55360,000.0
```

The N corresponds to the fact that the silicon diode is a negative temperature coefficient device. For the platinum curve, which is a positive temperature coefficient device, a P will appear at that position.

3-109. The XAC = N₁N₂* and XBC = N₁N₂* Commands.

3-110. The above commands allow the user to change Table 3-4 which defines the correlation between the position and the curve for the REMOTE SENSOR ID. Note that this correlation exists for both inputs and normally only one input would select the REMOTE SENSOR ID position data. Once this data has been changed, it would be good practice to read out the changed table by means of the XDT command. C is the hex remote position 0-A and N₁N₂ are the decimal curve number 00-15. (See Appendix B for a detailed description of Curve Number -vs- Position # Correlation.)

3-111. The XCN₁N₂ Command String.

3-112. The XCN_1N_2 command string allows the user to input his own curve over the IEEE-488 bus. Note that the first four curves (0-3) are defined within the instrument and are stored in the EPROM of that instrument. Therefore, the first number available to the user, provided that there are no precision options present, is $N_1N_2=04$. This command must be followed by a comma and then a file management string of up to 18 characters. The user does not input whether the curve is a positive or negative temperature coefficient curve. This is determined from the data input and stored in the table after the input of the data. The data points are then input with voltage first and temperature second with the comma used as a separator between the two variables as well as the data points.

3-113. Note that the first point and the last point are put in automatically. One point will be associated with 0 temperature and the other point will be associated with 0 voltage. This will assure that the input A/D is always working within a curve and can always calculate a temperature.

3-114. Therefore, the minimum number of points which the user can input for a curve is 1 and the maximum number of data points is 97 ($97+2=99$).

3-115. The software is set up so that data should be input in ascending order from the lowest voltage to the highest voltage. Inattention to this detail will result in a useless curve at best.

3-116. Curve numbers 4-15 (curves 5-16) are stored in a 16K E^2 PROM where the first 0100 Hex bytes (256 bytes) are reserved⁽¹⁾ for REMOTE SENSOR ID file management. This leaves 1792 bytes free for the storage of curves. If the curve stored has 31 data points, it will take up 177 bytes. For this length curve, the user can store ten curves. Note that each data pair requires 5 bytes. Note also that curves are stored sequential in order of entry and not in order of curve number.

3-117. See Appendix B for additional information on curve entry and how the curves are generated.

3-118. The $XKN_1N_2^*$ Command.

3-119. The command $XKN_1N_2^*$ erases curve number N_1N_2 with all its data and its title and repacks the remaining curves stored within the E^2 PROM. Note that it is not possible to erase any of the first 4 curves (0-3) since they are not stored in the E^2 PROM.

(1) Note that the 053 Update Kit reserves the first 0200 Hex bytes for file management.

3-120. The XEN₁N₂ Command.

3-121. The command XEN₁N₂, X.XXXXX,XXX.X* add a point to the N₁N₂ curve provided that this curve is present. The * terminates the data point input.

NOTE

The * added to the end of the XAC, XBC, XCN₁N₂, XEN₁N₂ and XK commands is required for the command to operate properly. The E PROM requires approximately 10msec per character for updating. The IEEE updates the characters as they are received. Appropriate time outs must be allowed when performing these functions. If a hardware problem is detected in modifying one of E²PROM locations, an Err01 error will be displayed in the Sample Display and instrument operation is halted. Consult a factory representative if this error occurs.

3-122. POWER OR CURRENT METER.

3-123. The DRC-82C Temperature Controller is shipped from the factory with the front panel meter indicating power. If the user prefers, he can change this to a current meter by turning on switch 1 of the six station dip switch located at the rear center of the main board.

3-124. HEATER RESISTANCE SWITCH.

3-125. The DRC-82C Temperature Controller has a current drive output rather than a voltage drive output with a maximum current rating of one ampere. In order to minimize the power dissipation within the box due to the output stage, the maximum voltage is selectable by the user. The user should select the heater resistance range which matches his system heater. Failure to do so may either reduce the maximum power available to the heater or cause excessive power dissipation by the output stage of the controller. For example, if the switch is set for the 35-50 ohm range and the heater is 10 ohms, although the controller will deliver 10 watts to the load (I^2R), the power dissipated by the output stage will be greater than 40 watts. If the switch had been set to the 10-25 ohm range, this power dissipation would have been reduced to slightly over 15 watts resulting in far less heat build-up within the box and less chance of premature component failure associated with excessive temperatures.

CAUTION: Do not switch this switch with the instrument on as it will short the secondary windings of the output transformer which will blow the input fuse and possibly ruin the switch.

CAUTION

The following procedure will delete all precision options and any curves stored in the unit by the user. Lake Shore's standard curves will not be deleted.

NOVRAM INITIALIZATION PROCEDURE FOR DRC-82C M82C.OBJ 5-1-87 (113-125B)

1. With the power OFF, turn ON (CLOSED) switches 3, 4 and 5 and turn OFF (OPEN) switches 1, 2 and 6 of the 6 DIP Switch Internal ID (S8 on the Main Board). Configure switches 5 thru 8 of the SENSOR A ID for the curve to be assigned to the A0-AF and B0-BF Remote Position Correlation Table.
2. Turn the unit ON. It should go through the normal POWER-ON sequence of all eights. When the Sample and Control Displays go to all dashes the unit has completed initializing the NOVRAM. The unit will then wait with the all dashes display.
3. Turn the unit OFF and configure the Internal ID for the Input Card configuration to be used and continue testing.

SECTION IV SYSTEM OPERATION

4-1. INTRODUCTION.

4-2. The DRC-82C Temperature Controller is a Microprocessor controlled dual thermometer as well as an analog temperature controller. Both inputs can be displayed as a voltage covering the range from 0 to 2.9999 volts, or directly in Kelvin.

4.3 Isolation between the input and output stages as well as isolation of the digital circuitry from the analog circuitry eliminates any possible unwanted noise feedback between the input and output stages.

4-4. The IEEE-488 interface is standard in all DRC-82C's. All front panel functions are programmable and the ability to enter and store a user generated curve is a standard feature.

4-5. Figure 4-1 illustrates the three isolated sections of the controller and their various functions which are described in the following paragraphs.

4-6. ANALOG SECTION.

4-7. Two silicon diode sensor input cards are standard in the DRC-82C. These cards each have a 10 microampere current source with a compliance voltage of approximately 7 volts. Also present are a 16 bit analog to digital converter, parallel to serial shift registers and opto-couplers which isolate the analog card from the digital section.

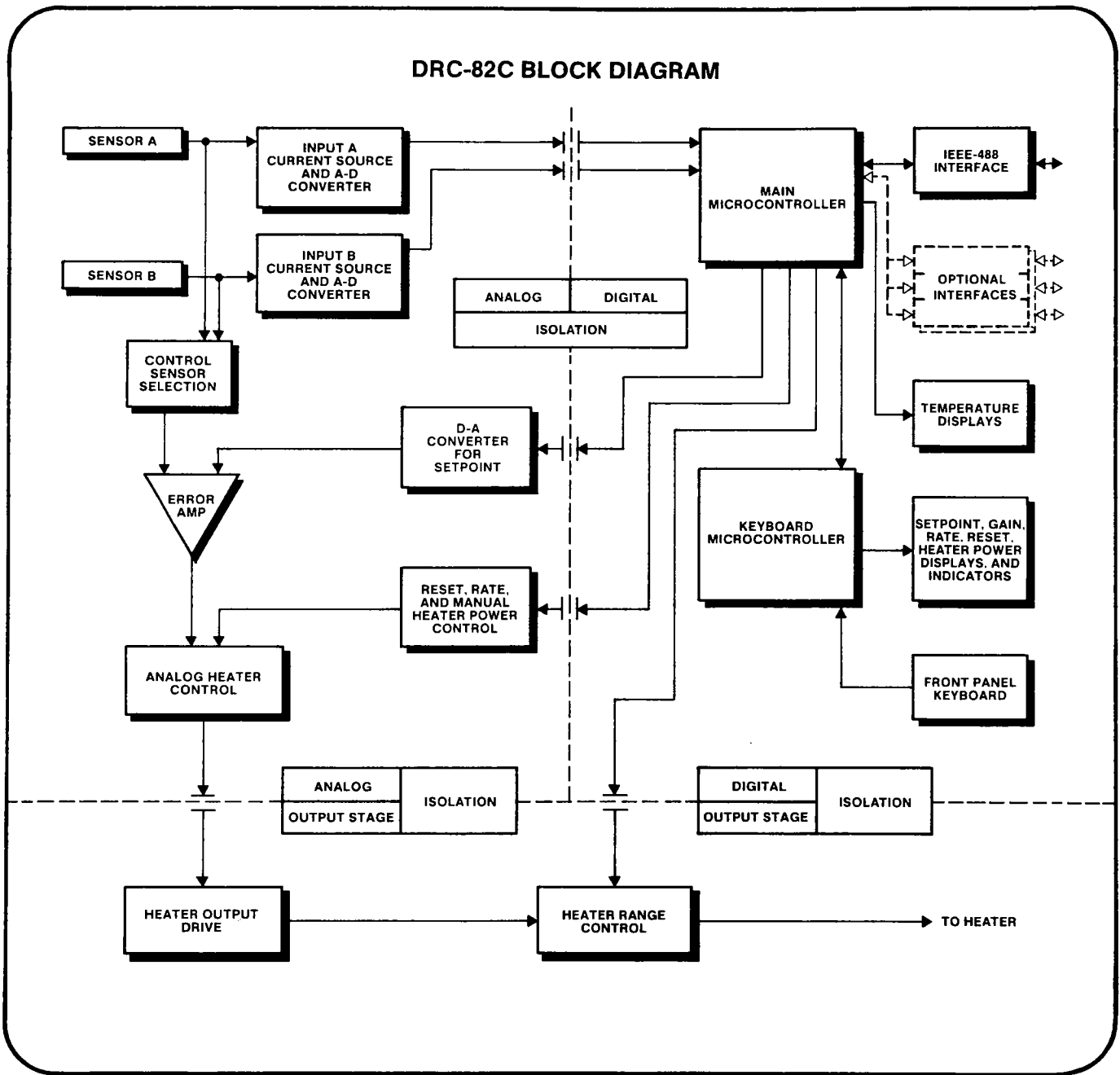
4-8. Both input signals to the input cards are buffered and sent to the monitor plug (Figure 3.2, Key 8). In addition, they are sent to the control selector switch (Key 5), where either input A or B is selected and the buffered positive voltage signal is sent to control card number 1.

4-9. In the case of a Platinum or Rhodium-Iron option input card (8219), the input signal is amplified by (-10) which results in a negative signal being sent to control card number 1.

4-10. The control signal from the selected input is compared to an analog setpoint signal of opposite sign which is derived from a 16 bit digital to analog converter, serial to parallel converters and optocouplers.

4-11. The resulting error signal is amplified by the gain amplifier whose gain is controlled by a 10 Bit DAC. This gives an approximate range in gain (proportional) of 0 to 1000 and by design a resolution of 99 parts (see Figure 3-3) with 00 being 0 gain (off).

Figure 4-1. DRC-82C Block Diagram



4-12. The amplified error signal is sent to control card number 2 which contains the reset (integral), rate (derivative) and manual heater control circuits. These three analog circuits are controlled by 8 bit DACS which receive their settings from the main board microprocessor. The four signals are summed by the analog heater control circuitry and the resultant signal is taken to the main board.

4-13. POWER OUTPUT SECTION.

4-14. The analog heater control signal is passed through a voltage-to-frequency and frequency-to-voltage convertor pair to give isolation between the analog stage and the output power stage. In addition, the heater range control signal from the main board microprocessor controls relays which give electrical isolation as well as the power range selection. The resulting output is fed to the heater with the output voltage power supply selected by means of the heater resistance switch located on the rear panel. By matching the output supply range to the heater resistance, less power is dissipated within the instrument for load currents near or above 0.5 ampere.

4-15. DIGITAL SECTION.

4-16. The DRC-82C uses two microprocessors in a master-slave configuration with communication over a serial USART line. The keyboard microprocessor receives information from the front panel keyboard as well as controlling the displays of setpoint, gain, rate, reset, heater power and other indicators. This information is sent over the serial line to the mainboard microprocessor which controls the digital signals to the analog section as well as sending the correct information to the sample and control displays. The main board microprocessor also controls the IEEE-488 and optional interfaces.

4-17. PROGRAM EXAMPLES.

4-18. The following example programs are for a Hewlett-Packard 86B.

4-19. Display of DRC-82C Parameters.

4-20. The following program will display the normal parameters which are associated with operation of the DRC-82C when operating under control of the IEEE-488 Bus.


```

10 REM DISPLAY      6/25/84
20 REM PROGRAM TO READ ALL PARAMETERS FROM THE DRC-82C VIA THE IEEE BUS
30 REM THE PARAMETERS ARE THEN PRINTED IN A SUITABLE FORMAT
40 DIM A$(29) ! W1 IS THE LONGEST STRING - INCLUDES DELIMITERS
50 DIM DLIM$(3)[12] ! VARIABLE FOR TERMINATING CHARACTER STRINGS
60 DATA (CR)(END-LF),(LF)(END-CR),(END-NL),(END-DAB)
70 FOR I=0 TO 3 ! READ IN TERMINATING CHARACTER STRINGS
80   READ DLIM$(I)@ NEXT I
90 DIM FS_POWER(5) ! FULL SCALE POWER ARRAY IN WATTS
100 DATA 0,.0025,.025,.25,2.5,25
110 FOR I=0 TO 5 ! READ IN FULL SCALE POWER ARRAY
120   READ FS_POWER(I)@ NEXT I
130 CLEAR ! CLEAR THE SCREEN
140 REM REQUEST THE DRC-82C TO OUTPUT THE SAMPLE SENSOR TEMPERATURE
150 REM OR VOLTAGE, CONTROL SENSOR TEMPERATURE OR VOLTAGE,
160 REM AND SETPOINT TEMPERATURE OR VOLTAGE.
170 OUTPUT 712 ;"WO" @ ENTER 712 ; A$ ! READ WO
180 DISP "WO = ";A$
190 SAMPLE=VAL (A$[1,6]) ! PICK OFF SAMPLE TEMPERATURE OR VOLTAGE
200 CNTROL=VAL (A$[9,14]) ! PICK OFF CONTROL TEMP. OR VOLTAGE
210 SETPOINT=VAL (A$[17,22]) ! PICK OFF SETPOINT T OR V
220 IF A$[7,7]="K" THEN DISP "SAMPLE TEMPERATURE  =";SAMPLE;" K"
230 IF A$[7,7]="V" THEN DISP "SAMPLE VOLTAGE      =";SAMPLE;" V"
240 IF A$[15,15]="K" THEN DISP "CONTROL TEMPERATURE =";CNTROL;" K"
250 IF A$[15,15]="V" THEN DISP "CONTROL VOLTAGE      =";CNTROL;" V"
260 IF A$[23,23]="K" THEN DISP "SETPOINT TEMPERATURE =";SETPOINT;" K"
270 IF A$[23,23]="V" THEN DISP "SETPOINT VOLTAGE      =";SETPOINT;" V"
280 REM REQUEST THE DRC 82C TO OUTPUT POSITION, SAMPLE ID,
290 REM CONTROL ID, GAIN, RATE, RESET, HEATER RANGE, % OF MANUAL
300 REM HEATER POWER OR CURRENT, % OF HEATER POWER OR CURRENT
310 OUTPUT 712 ;"W1" @ ENTER 712 ; A$ ! READ W1
320 DISP @ DISP "W1 = ";A$
330 POSITION=VAL (A$[1])
340 SAMPLE_ID$=A$[3,5]
350 CONTROL_ID$=A$[7,9]
360 GAIN=VAL (A$[11,12])
370 RATE=VAL (A$[14,15])
380 RESET1=VAL (A$[17,18])
390 HEATER_RANGE=VAL (A$[20])
400 M_PERCENT=VAL (A$[22,23])
410 P_SETPOINT=.01*M_PERCENT*FS_POWER(HEATER_RANGE)
420 PERCENT=VAL (A$[25,27])
430 POWER=.01*PERCENT*FS_POWER(HEATER_RANGE)
440 DISP "REMOTE SENSOR POSITION = ";POSITION
450 DISP "SAMPLE SENSOR ID = ";SAMPLE_ID$
460 DISP "CONTROL SENSOR ID = ";CONTROL_ID$
470 DISP "GAIN = ";GAIN
480 DISP "RATE = ";RATE
490 DISP "RESET = ";RESET1
500 DISP "HEATER POWER RANGE = ";FS_POWER(HEATER_RANGE);" WATTS"
510 DISP "MANUAL POWER          = ";M_PERCENT;" % OR ";P_SETPOINT;" WATTS"
520 DISP "HEATER POWER          = ";PERCENT;" % OR ";POWER;" WATTS"
530 REM REQUEST THE DRC 82C TO OUTPUT THE FOLLOWING ON THE IEEE BUS
540 REM EOI STATUS, OPERATIONAL MODE, AND TERMINATING CHARACTERS
550 OUTPUT 712 ;"W2" @ ENTER 712 ; A$ ! READ W2
560 DISP @ DISP "W2 = ";A$
570 EIO_STATUS=VAL (A$[2])
580 MODE=VAL (A$[5])
590 DELIMS=VAL (A$[8])
600 IF EIO_STATUS=0 THEN DISP "EOI SET/ACCEPTED"
610 IF EIO_STATUS=1 THEN DISP "EOI NOT SET/NOT ACCEPTED"
620 IF MODE=0 THEN DISP "LOCAL"
630 IF MODE=1 THEN DISP "REMOTE"
640 IF MODE=2 THEN DISP "REMOTE WITH LOCAL LOCKOUT"
650 DISP "TERMINATING CHARACTERS = ";DLIM$(DELIMS)
660 END

```

4-21. If the above program is run, the following display will result with an instrument which has just been shipped from the factory and which does not have any precision options. The following is the normal power-up state for the instrument with regards to setpoint, gain, rate, reset and power. The remote sensor position, remote sensor ID, and control sensor ID are read on power-up and display their current settings.

```
W0 = 250.73K,250.70K,000.00K
SAMPLE TEMPERATURE = 250.73 K
CONTROL TEMPERATURE = 250.7 K
SETPOINT TEMPERATURE = 0 K
```

```
W1 = 0,A00,A00,00,00,0,0,000
REMOTE SENSOR POSITION = 0
SAMPLE SENSOR ID = A00
CONTROL SENSOR ID = A00
GAIN = 0
RATE = 0
RESET = 0
HEATER POWER RANGE = 0 WATTS
MANUAL POWER = 0 % OR 0 WATTS
HEATER POWER = 0 % OR 0 WATTS
```

```
W2 = Z0,M1,T0
EOI SET/ACCEPTED
REMOTE
TERMINATING CHARACTERS = (CR)(END-LF)
```

4-22. TEMPERATURE CONTROL.

4-23. The temperature controller is only one part of an overall cryogenic system and as such cannot overcome problems in the overall system design. The following discussion is centered around a CTI Cryogenics Model 21 Closed Cycle Refrigerator used with the DRC-82C Temperature Controller. Examples of good and bad system design along with sample programs will be given to help the user evaluate his own system and hopefully get the maximum performance out of the controller and other components of the system.

4-24. Cooldown Program for System Evaluation.

4-25. The following program allows the user of the DRC-82C to monitor and record the cooldown of his system in time and temperature either as a function of incremental time or incremental temperature.

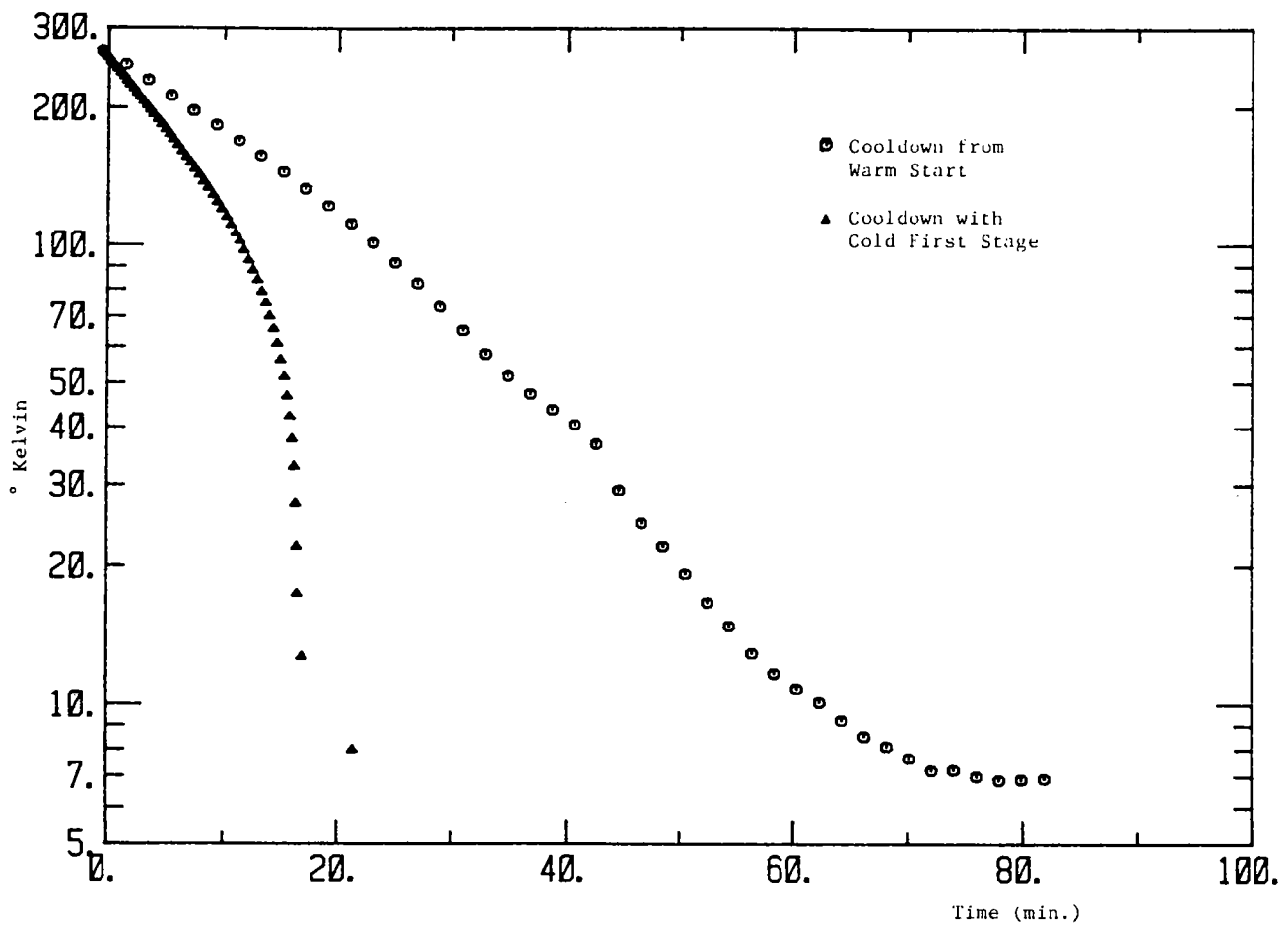
```

10 REM COOLDOWN PROGRAM 7/21/84
20 REM THIS PROGRAM USES THE DRC 82C TO MEASURE THE SAMPLE TEMPERATURE WITH
30 REM NO POWER APPLIED.
40 REM THE USER HAS A CHOICE OF DISPLAYING (PRINTING) AND STORING THE TIME IN
50 REM SECONDS AND THE TEMPERATURE IN EQUAL INCREMENTS OF TIME OR EQUAL
60 REM INCREMENTS OF TEMPERATURE.
70 REM THE INCREMENT OF TEMPERATURE IS REQUESTED AND ENTERED VIA THE
80 REM KEYBOARD. THE ACTUAL INCREMENT VARIES DUE TO SAMPLE TIME.
90 REM THE SAMPLING TIME IS THE TIME BETWEEN WHICH THE DRC 82C SAMPLE
100 REM TEMPERATURE IS MONITORED. THE SAMPLING TIME IS SET AT 0.5 SECONDS
110 REM WHEN THE INCREMENT IS TO BE TEMPERATURE.
120 REM WHEN THE DESIRED INCREMENT HAS DROPPED THE REQUESTED TIME OR
130 REM TEMPERATURE THE DATA (TIME AND TEMPERATURE) IS STORED AND DISPLAYED.
140 DIM A$(9)
150 DIM TEMP(1000),SECONDS(1000) ! DIMENSIONED FOR 1000 POINTS
160 PRINTER IS 704
170 OUTPUT 712 ;"C" ! CLEAR THE DRC 82C AND PLACE IN REMOTE MODE
180 CLEAR ! CLEAR THE DISPLAY
190 DISP "EQUAL INCREMENTS OF TEMPERATURE? (YES OR NO)";@ INPUT PREF$
200 T_INC=.5 ! SAMPLE TIME IN SECONDS IF PREF$ = YES
210 IF PREF$[1]="Y" THEN DISP "MEASUREMENT INCREMENT IN K" @ INPUT K_INC
220 IF PREF$[1]="N" THEN DISP "SAMPLING TIME IN SECONDS";@ INPUT T_INC
230 DISP "DISPLAY AND PRINT (YES OR NO)." @ INPUT ANS$
240 REM BEGIN TAKING MEASUREMENTS
250 I=0 @ SECONDS(0)=0 ! INITIALIZE COUNTER AND TIME
260 REM OBTAIN SAMPLE TEMPERATURE FOR THE INITIAL VALUE
270 OUTPUT 712 ;"WS" @ ENTER 712 ; A$ ! READ SAMPLE TEMPERATURE
280 TEMP(0)=VAL (A$[1,6])
290 DISPLAY1: DISP "T = ";TEMP(I);" K      t = ";SECONDS(I);" SECONDS";I
300 BEEP
310 IF ANS$[1]="Y" THEN PRINT SECONDS(I);"SECONDS ; "; "TEMPERATURE = ";TEMP(I);"
    K"
320   KO=TEMP(I) ! SAVE THE PRESENT TEMPERATURE
330   IF I=0 THEN START ! MUST TURN ON TIMER INITIALLY
340   IF I<= 1000 THEN PROCEED ! CHECK TO SEE IF MEMORY IS FULL
350   DISP "OUT OF MEMORY" @ STOP
360   START: ON TIMER# 1,1000*T_INC GOTO GO
370     PROCEED: GOTO PROCEED
380     GO: OUTPUT 712 ;"WS" @ ENTER 712 ; A$ ! TAKE THE MEASUREMENT
390     IF PREF$[1]="N" THEN SKIP
400     SECONDS(I)=SECONDS(I)+T_INC ! STORE THE TIME
410     IF ABS (KO-VAL (A$[1,6]))<K_INC THEN PROCEED
420     SKIP: I=I+1
430     SECONDS(I)=SECONDS(I-1)+T_INC ! STORE THE TIME
440     TEMP(I)=VAL (A$[1,6]) ! STORE THE TEMPERATURE
450 GOTO DISPLAY1
460 END

```

4-26. Figure 4-2 shows a cooldown curve for the second stage of a CTI Model 21 Closed Cycle Refrigerator where data was taken at 2 minute increments of time and a second curve where data was taken at 5 degree increments of temperature. For the first curve, the refrigerator was cooled from a warm start, while for the second curve, the second stage was heated to room temperature with the first stage cold with an appreciable decrease in cooldown time. Note that adding mass to the second stage, such as a sample holder, would increase the cooldown time in either instance.

Figure 4-2. Cooldown Curve for CTI Model 21



4-27. Load Program for System Evaluation.

4-28. In order to evaluate your systems power requirements, it would be worthwhile to determine a curve of the temperature versus heater power. This can be done using the following program where the manual reset is used exclusively to generate the appropriate data. Note that this program assumes a 25 ohm heater. Also note that the refrigerator was allowed to stabilize for at least 30 minutes before running the program. This was to allow the first stage of the refrigerator to equilibrate prior to running the load curve.

```
10 REM LOADCURVE 7/25/84

20 REM THE DRC 82C WILL USE THE MANUAL RESET OUTPUT TO THE HEATER ONLY.
30 REM THE INITIAL, INCREMENTAL, AND FINAL POWER DESIRED
40 REM ARE REQUESTED VIA THE KEYBOARD.
50 REM THE HEATER RESISTANCE IS SPECIFIED AT 25 OHMS.
60 REM FOR OTHER HEATER RESISTANCES THE USER MUST CHANGE THE VARIABLE
70 REM 'RESISTANCE' IN THE TWO FUNCTION ROUTINES AT THE END OF THIS PROGRAM.
80 DIM A$(27) ! DIMENSION FOR READING THE DRC 82C
90 DIM POWER(100),TEMP(100) ! DIMENSION FOR 100 POINTS
100 T_INC=30 ! SAMPLING RATE IN SECONDS
110 K_EQB=.05 ! INCREMENTAL CHANGE IN TEMPERATURE WHICH IMPLIES EQUILIBRIUM
120 CLEAR ! CLEAR THE DISPLAY
130 REM REQUEST THE INITIAL, INCREMENTAL AND FINAL POWER LEVELS
140 DISP "INITIAL POWER IN WATTS";@ INPUT P_INITIAL
150 DISP "INCREMENTAL POWER IN WATTS",@ INPUT P_INC
160 DISP "FINAL POWER IN WATTS";@ INPUT P_FINAL
170 OUTPUT 712 ;"C" ! CLEAR THE DRC-82C AND PLACE IN REMOTE
180 PWR=P_INITIAL ! SET THE VARIABLE 'PWR' TO THE INITIAL POWER
190 I=0 ! SET THE VARIABLE 'I' TO ZERO FOR STORING FIRST POINT
200 AGAIN: ! BEGIN A MEASUREMENT
210 RANGE=FNRANGE(PWR) ! SET MANUAL HEATER RANGE FOR 82C
220 OUTPUT 712 ;"R";VAL$ (RANGE)
230 REM SET THE MANUAL HEATER TO THE CORRECT PERCENT
240 OUTPUT 712 ;"H";VAL$ (INT (100*PWR/FNFSCALE(RANGE)))
250 OUTPUT 712 ;"WS" @ ENTER 712 ; A$ ! OBTAIN STARTING SAMPLE TEMPERATURE
260 WAIT1: K0=VAL (A$[1,6])
270 WAIT 1000*T_INC ! CONVERTS TO SECONDS
280 OUTPUT 712 ;"WS" @ ENTER 712 ; A$
290 IF VAL (A$[1,6])>330 THEN ABORT
300 IF ABS (VAL (A$[1,6])-K0)>K_EQB THEN WAIT1 ! EQUILIBRIUM REACHED?
310 POWER(I)=PWR @ TEMP(I)=VAL (A$[1,6]) ! EQUILIBRIUM REACHED - SAVE DATA
320 DISP PWR;" WATTS "; "T=" ;TEMP(I);" K"
330 OUTPUT 712 ;"W1" @ ENTER 712 ; A$ @ DISP A$
340 I=I+1 ! INCREMENT TO NEXT POINT
350 IF I<= 100 THEN PROCEED
360 I=100 @ DISP "MEMORY OVERFLOW" @ STOP
370 PROCEED: PWR=PWR+P_INC ! INCREMENT THE VARIABLE 'PWR'
380 IF PWR<= P_FINAL THEN AGAIN ELSE DISP "MEASUREMENT COMPLETE."
390 DISP "HEATER POWER LEFT AT ";PWR-P_INC;" WATT."
400 STOP
410 ABORT: ! ABORT---TURN POWER OFF
420 OUTPUT 712 ;"RO"
430 DISP "TEMPERATURE EXCEEDING 330 K. POWER TURNED OFF."
440 STOP
450 DEF FNRANGE(POWER) ! FUNCTION TO DETERMINE HEATER RANGE
460 RESISTANCE=25 ! HEATER RESISTANCE = 25 OHMS
470 C2=POWER/RESISTANCE ! FIND CURRENT SQUARED
480 RANGE=LGIT (C2)+5 ! COMPUTE RANGE
490 IF FP (RANGE)=0 THEN FNRANGE=INT (RANGE)
500 IF FP (RANGE) 0 THEN FNRANGE=INT (RANGE)+1
510 FN END
520 DEF FNFSCALE(RANGE) ! FUNCTION TO DETERMINE
530 REM THE FULL SCALE POWER GIVEN THE RANGE AND HEATER RESISTANCE
540 RESISTANCE=25 ! HEATER RESISTANCE OF 25 OHMS
550 FNSCALE=RESISTANCE*10^(RANGE-5)
560 FN END
```

4-29. Figure 4-3 shows the resulting power curve for our sample refrigerator. This data can now be used by the programmer to determine the correct power scale for a given desired temperature. Note, however, that if mass is added to the refrigerator, the resulting curve will be radically different. It is recommended that this type of data be generated for your system so that the proper power scale can be programmed into your programs when covering a wide range of temperature.

4-30. The second stage of a Model 21 Closed Cycle Refrigerator will normally bottom out at or near 10 Kelvin. The refrigerator operates at a frequency of 3.3 Hertz on a 60 Hertz, 110 volt power and the peak to peak variation in the second stage temperature with no mass on the second stage can approach two degrees.

4-31. The objective, of course, is to have the controller take out this temperature variation by adding and then reducing power to exactly compensate for the varying cooling power of the Model 21. The ability of any controller to achieve this objective is greatly dependent on the relative position of the heater with respect to the source of the cooling. Due to the geometrical construction of the refrigerator, the placement of the heater cannot be at the source of the cooling power and therefore the controller cannot completely eliminate this cyclic variation with temperature.

4-32. Fortunately, as the temperature increases, the magnitude of the problem decreases due to the increase in the heat capacity and the radical variation in thermal conductivity of the cold head materials.

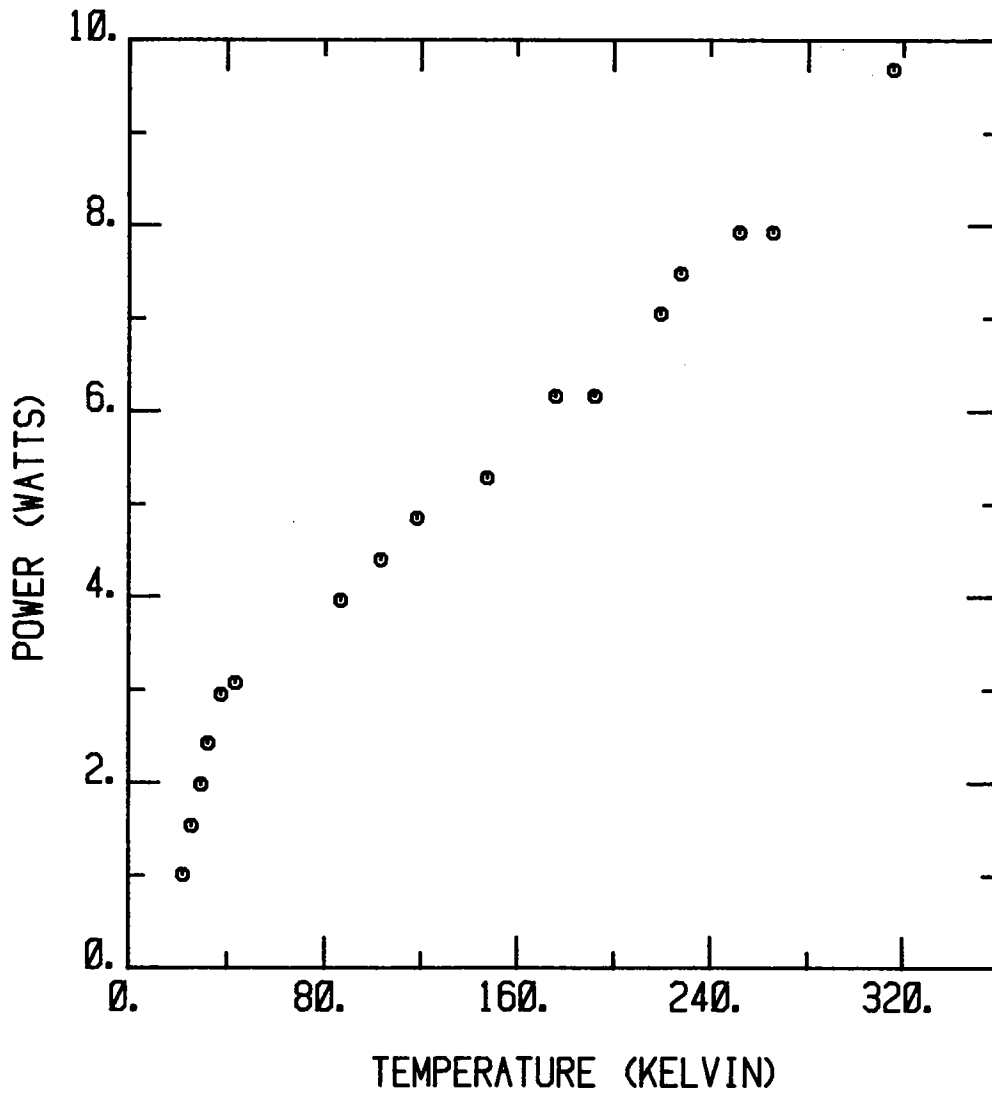
4-33. There are several ways for the system designer to reduce the magnitude of this cyclic variation. Almost all of these involve compromises of one type or another. Adding mass will reduce the magnitude of the peak-to-peak variation substantially. Although the increase in mass has stabilized the temperature, the penalty for this increased stabilization is the reduction in temperature response and increased time to reach stabilization when a change in temperature is required, plus longer cooldown.

4-34. Note that the temperature variation can be divided into two components; a dc component, and an ac component. Sometimes the user can be misled by the controller into believing that the ac component does not exist. This can occur if the integration time of the A/D convertor were to just match or be a multiple of the period of the refrigerator. Under that condition, the ac component would not be seen and the user might be completely unaware of its existence. In the case of the DRC-82C, the integration time for the A/D convertor is approximately 0.65 seconds (2.15 periods) which will tend to mask the magnitude of the ac component. Where the line frequency is 50 hertz, the displacer frequency would be 2.75 Hz and the A/D integration number of periods would be 1.79 periods, which again will tend to mask the magnitude of the ac component.

4-35. **Temperature Ramping.**

4-36. Some experiments require that data be taken as the temperature is ramped from one temperature to another. The following is a sample program which will allow the DRC-81C to ramp temperature either upwards or downwards in temperature.

Figure 4-3. Refrigerator Power Curve



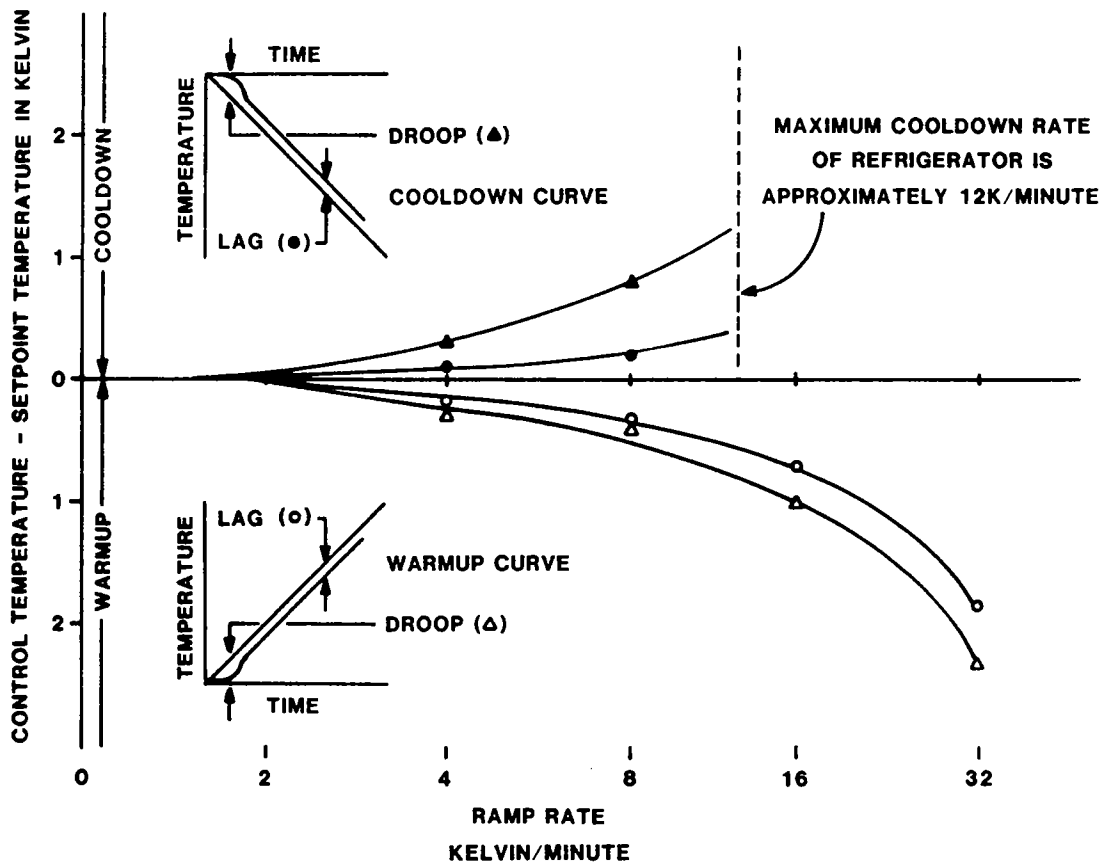
```

10 REM RAMP82 - RAMPING PROGRAM FOR THE DRC 82C 7/21/84 - 15:00
20 REM HEATER POWER,GAIN,RATE AND RESET ARE SET MANUALLY BY THE USER.
30 REM THE INITIAL SETPOINT TEMPERATURE IS ENTERED VIA THE KEYBOARD.
40 REM THE TIME IN SECONDS AND DESIRED FINAL TEMPERATURE ARE REQUESTED.
50 REM THE 82C WILL RAMP THE SET POINT TO THE FINAL TEMPERATURE LINEARLY
60 REM WITH A QUANTIZED TEMPERATURE INCREMENT 0.1K FOR NORMAL RAMP SPEEDS.
70 PRINTER IS 704
80 DIM A$[27] ! DIMENSION FOR READING THE DRC 82C
90 T_WAIT=20 ! SAMPLING RATE IN SECONDS
100 K_EQB=.1 ! INCREMENTAL CHANGE IN CONTROL T WHICH IMPLIES EQUILIBRIUM.
110 CLEAR ! CLEAR THE DISPLAY
120 REM REQUEST THE INITIAL SETPOINT TEMPERATURE.
130 DISP "INITIAL TEMPERATURE";@ INPUT K INITIAL
140 BEGIN: DISP "SELECT A HEATER POWER,GAIN,RATE AND RESET MANUALLY"
150 DISP "ON THE DRC-82C TO OBTAIN THE DESIRED INITIAL TEMPERATURE."
160 DISP
170 DISP "TEMPERATURE TO RAMP TO";@ INPUT K_FINAL
180 DISP "TIME TO REACH ";K_FINAL;" K"; IN SECONDS";@ INPUT T_FINAL
190 DISP "DISPLAY AND PRINT (YES OR NO)." @ INPUT ANS$
200 DISP "INCREMENT OF TEMPERATURE TO TAKE DATA." @ INPUT K_INC
210 REM ADJUST THE DRC 82C TO OBTAIN EQUILIBRIUM AT THE INITIAL SETPOINT
220 OUTPUT 712 ;"S";VAL$ (K_INITIAL)
230 K=K_INITIAL
240 WAIT1: WAIT 1000*T_WAIT ! WAIT T_WAIT SECONDS
250 KO=K
260 OUTPUT 712 ;"WC" @ ENTER 712 ; A$ ! READ CONTROL TEMPERATURE
270 K=VAL (A$[1,6])
280 IF ABS (K-KO)>K_EQB OR ABS (K-K_INITIAL)>.2 THEN WAIT1
290 OUTPUT 712 ;"W1" @ ENTER 712 ; A$ ! READ W1
300 DISP "W1 = ";A$
310 IF ANS$[1]="Y" THEN PRINT "W1 =";A$
320 T=0
330 K_SPINC=.1 ! NORMAL INCREMENT OF SETPOINT
340 SETPOINT=K_INITIAL
350 SLOPE=(K_FINAL-K_INITIAL)/T_FINAL ! COMPUTE RAMP SLOPE (K/SEC.)
360 DISP "RAMP = ";60*SLOPE;"KELVIN PER MINUTE ";SLOPE;"KELVIN PER SECOND"
370 IF ANS$[1]="Y" THEN PRINT "RAMP = ";60*SLOPE;"K/MIN. ";SLOPE;"K/SEC."
380 T_INC=K_SPINC/ABS (SLOPE) ! TIME TO INCREMENT SETPOINT IN SECONDS
390 IF T_INC<.9 THEN K_SPINC=.2 @ T_INC=2*T_INC
400 IF T_INC<1 and K_SPINC=.2 THEN T_INC=2.5*T_INC @ K_SPINC=.5
410 ON TIMER# 1,1000*T_INC GOTO GO ! TIMEOUT T_INC SECONDS - RESTART TIMER
420 PROCEED: GOTO PROCEED ! YES, THIS STATEMENT IS CORRECT
430 GO: OUTPUT 712 ;"WC" @ ENTER 712 ; A$ ! 80 MS READ TIME
440 IF FP (ABS (SETPOINT-K_INITIAL)/K_INC)>0 THEN SKIP
450 DISP T;" SECONDS : ";SETPOINT="";SETPOINT;"K ";
460 DISP "CONTROL TEMPERATURE = ";A$ ! ALL DISP TAKE .23 SECONDS
470 IF ANS$[1]="N" THEN SKIP
480 PRINT T;" SECONDS : ";SETPOINT="";SETPOINT;"K : ";
490 PRINT "CONTROL TEMPERATURE = ";A$ ! ALL PRINT TAKE .4 SECONDS
500 SKIP: T=T+T_INC ! ADD TIME FOR K SPINC
510 IF T>T_FINAL THEN COMPLETE ! IS RAMP TIME PERIOD COMPLETE?
520 SETPOINT=SETPOINT+K_SPINC*SGN (SLOPE) ! INCREMENT THE SETPOINT
530 OUTPUT 712 ;"S";VAL$ (SETPOINT)
540 GOTO PROCEED
550 COMPLETE: DISP "RAMPING COMPLETE." @ OFF TIMER$ 1
560 K_INITIAL=K_FINAL
570 FOR I=10 TO 160 STEP 50 @ BEEP I,500 @ NEXT I
580 GOTO BEGIN ! START A NEW RAMP
590 END

```


4-37. Figure 4-4 shows the results from using this program for both warmup and cooldown over the temperature range of 50 Kelvin to 100 Kelvin. Since the cooldown speed of the refrigerator was approximately 12 Kelvin per minute, cooldown rates can not exceed that value. The droop is associated with the relative inertia of the refrigerator and is normally gone within the first few degrees, but the exact time is obviously a function of the ramp speed. Although lag does increase with ramp speed, it is interesting to note that it remains constant for a given ramp speed and therefore can be treated as a constant offset.

Figure 4-4. Temperature Ramping Results



SECTION V MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains maintenance information for the DRC-82C including general maintenance and a performance test. The performance test is designed to test the general operation of the unit as well as verification of the specifications for the unit. This section also includes an illustrated parts breakdown as well as schematics for the unit.

5-3. The 82C is warranted for a period of two years upon delivery to the original purchaser. The complete warranty statement is located in the front of this manual.

5-4. GENERAL MAINTENANCE.

5-5. Clean the 82C periodically to remove dust, grease and other contaminants. Use the following procedure.

1. Clean the front and back panels and case with a soft cloth dampened with a mild detergent and water solution. Caution: Do not use aromatic hydrocarbons or chlorinated solvents to clean the 82C. They may react with the plastic materials used in the unit or the silk screen printing on the back panel.
2. Clean the surface of the printed circuit boards (PCB) using clean, dry air at low pressure. If grease is encountered, spray with Freon T.F. degreaser and remove grime with dry, low-pressure air.

5-6. ACCESS INFORMATION.

5-7. Fuse Replacement.

5-8. The line fuse is accessible from the rear of the 82C. Use the following procedure to check and/or replace the fuse.

1. Set the POWER switch to OFF and disconnect the power cord from the unit. The fuse compartment is located just to the right of the power connector.
2. Open the fuse compartment by sliding the see-thru cover toward the power connector.

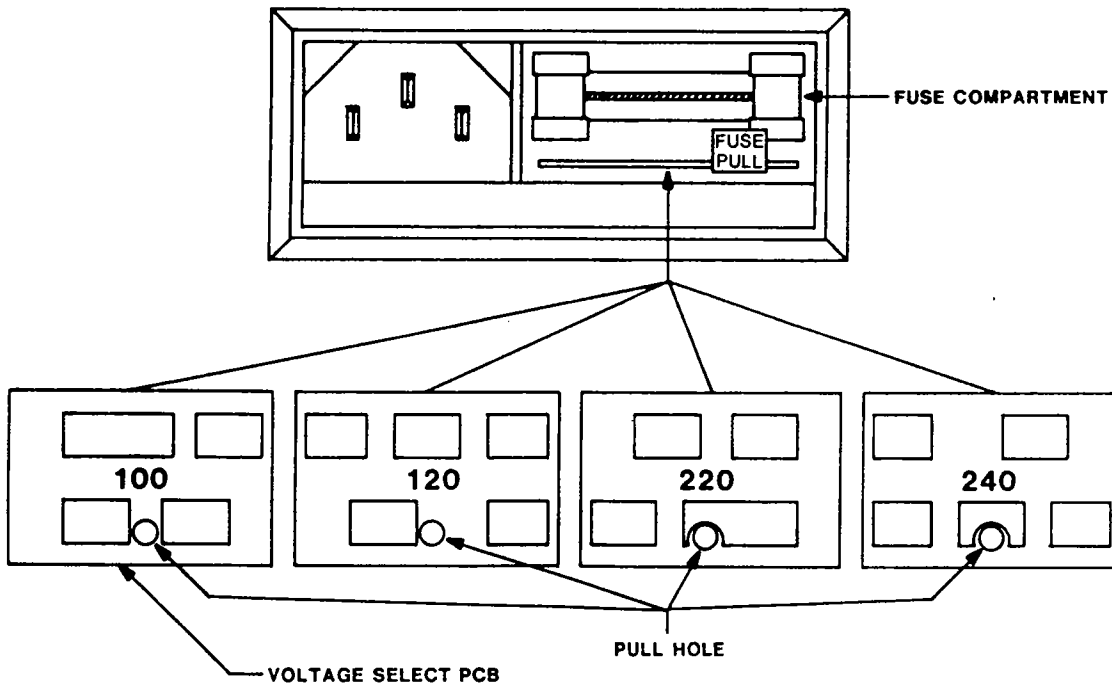
3. Locate FUSE PULL tab and gently lift up. This unlocks and releases one end of the fuse.
4. Remove and inspect fuse. If replacement is required, use 3AG-SB 2 amp fuse for 100/120 VAC operation and 3AG-SB 1 amp fuse for 220/240 VAC operation.
5. Lower FUSE PULL tab and press good fuse into the fuse holder.
6. Close fuse compartment and connect power cord.

5-9. Line Voltage Selection.

5-10. The rear-panel, three-pronged line power connector permits the DRC-82C to be connected to 100, 120, 220 or 240 VAC line voltages. Use the following procedure to check or change the line voltage.

1. Pull fuse using procedure found in Section 5-7.
2. Locate voltage select PCB in fuse compartment and pull PCB from its slot by inserting a needle nose pliers or other tool into the pull hole.
3. Position PCB so that the desired voltage appears upright on the top of the PCB. See Figure 5.1 for PCB position for various line selections.

Figure 5-1. Line Voltage Selection



4. Position the PCB in its slot and press into place. Verify that the desired voltage is showing beneath the fuse location.
5. Verify that the fuse is of the proper rating; 2A 3AG-SB for 100 or 120 VAC and 1A 3AG-SB for 220 or 240 VAC.
6. Install fuse and close fuse compartment and connect power cord.

5-11. IEEE-488 Address Selection.

5-12. The procedure for setting the 82C's IEEE-488 interface address is given in Section 3-71 of this manual.

5-13. Performance Test Connector.

5-14. A test connector to simulate the diode sensor inputs is required for performance testing the DRC-82C. A test connector can be made by taking a 5-pin male mating connector (supplied with the unit) and configuring a resistor to simulate the diode sensor in the 2 wire configuration as shown in Figure 2.2. A 100K ohm, 1% resistor is used in the performance test.

5-15. PERFORMANCE TEST.

5-16. The performance test is designed to verify the overall operation of the 82C and can be used as a periodic maintenance check. The following equipment is used in the test:

1. Digital Voltmeter (DVM) - 4-1/2 digit resolution or better.
2. Performance test connector - fabricated according to Section 5-13.
3. Power resistor to simulate the heater - 25 ohm 25 watt ceramic or equivalent.

5-17. Set-Up Procedure.

5-18. Before executing the performance tests, complete the following set-up procedure:

1. Set CONTROL and SAMPLE back panel switches to A Input. Set the HEATER RESISTANCE switch to 10-25 ohm and put the 25 ohm load resistor across the HEATER POWER terminals and plug the test connector into the A Input.

Set the Sample units to Volts by turning "on" (1) switch 1 of the A SENSOR ID and the Control units to K by turning "off" (0) switch 1 of the B SENSOR ID.

2. Connect the DVM across the 100K resistor on the test connector.
3. Connect the DRC-82C to line power and press the POWER switch ON. Check that the 82C initializes to the proper POWER-ON state as noted in Section 4-21.

5-19. Test Procedure.

5-20. The following procedure is used to test the overall operation of the DRC-82C. (Note: the unit should be allowed a one-hour warm-up time to achieve rated specifications).

1. The DVM across the test resistor should read 1.0000 +/- .01 V dc. The Sample display should match that reading within +/- 100 μ V dc. The control temperature for the D curve for 1.0000 Vdc should read 71.8 K. (Curve on A SENSOR ID = 00). For the E1 curve the control temperature should be 71.5 K and for Curve 10 it should read 87.7. (Curves 01 and 02 respectively).

2. Plug the test resistor into the B input, switch the SAMPLE and CONTROL switches over to B and repeat procedure 1.

3. Connect the DVM across the 25 ohm heater resistor. Enter a set point 10 above the control point (i.e., 81.8 K). Enter a GAIN of 30. Enter MAX for heater power range.

The HEATER POWER bar graph should go to about 20% of scale. Verify that there is approximately 11.4V dc across the heater resistor.

4. Change the Heater Power Range and verify that 20% output power is maintained on all ranges as well as nominal voltages of 3.44V, 1.14V, .344V, and .114V dc are present across the load for the -1, -2, -3, and -4 scales respectively.
5. Enter a RESET of 50 and note that the output power slowly integrates up at the rate of about 10% every 10 seconds.
6. Turn the RESET off (00). Enter a MANUAL HEATER power of 10%. Verify that the Manual Heater Power blinking LED is present and that the HEATER POWER bar graph reads approximately half scale. Enter a GAIN of 00 and note that the HEATER POWER drops to 10%. Enter a GAIN of 99 and note that the Heater Power goes to full scale output.

5-21. CALIBRATION.

5-22. The DRC-82C has been calibrated to specification prior to shipment. If recalibration is needed, refer to the following procedure. The following equipment is used to calibrate the 82C:

1. Digital Voltmeter (DVM) - 4-1/2 digit resolution or better, including a current scale.
2. Precision Standard Resistor - 100K ohm with a tolerance of +/- 0.01% or better.
3. Precision Voltage Standard - 100 uV out of 3V resolution or better.
4. Load resistor to simulate the heater - 25 ohm, 25 watt ceramic.
5. Oscilloscope - Tektronix Model 7704A or equivalent.

5-23. Use the following procedure to calibrate the DRC-82C. (Note: as in the Test Procedure, the unit should be allowed a one-hour warm-up time to achieve rated specs).

1. Remove the three top panel screws and slide panel off.
2. Connect the precision 100K ohm resistor across pins A and B of Diode Input A. Connect the DVM across the 100K resistor. The voltage should read 1.0000V +/- 100 uV dc. If needed, adjust the trimpot marked I for the A-CHANNEL INPUT CARD on the cal-cover.
3. Connect the precision voltage standard across pins D and E of Diode Input A. Set the Sample units to Volts by turning "on" (1) switch 1 of the A SENSOR ID. Set the back panel SAMPLE switch to Input A. Enter a voltage near the full scale input of the unit, i.e., 2.8000V. Adjust the trimpot marked A/D for the A-CHANNEL INPUT CARD on the calibration cover to within +/- 100 uV of the input voltage.
4. Connect the DVM across pins E and F of the MONITORS connector. Adjust trimpot marked B (for input buffer) on the calibration cover to as close to the input voltage as possible.
5. Set the DISPLAY and CONTROL switches to B and repeat steps 2-4 for the B-CHANNEL INPUT CARD. Pins A and B of the MONITORS connector are used for the input buffer adjustment.

6. Change the control units to volts by turning "on" (1) switch 1 of the B SENSOR ID. Remove the 4 screws that secure the calibration cover to its clips and remove cover (Note: The cover rests on fibre washers on the clips; when removing the cover, care must be taken to avoid losing the washers into the unit). Connect the DVM across the set point voltage test points near the front edge of the ANALOG CONTROL CARD 1 PCB. The V+ test point is closest to the front of the unit and the GND is closest to the rear of the unit. Enter a set point of 0.0000V. Adjust the trimpot marked SETPOINT Z on the calibration cover until the DVM reads 0.0000V. Enter a setpoint of 2.9999V and adjust the trimpot marked SETPOINT S until the DVM reads - 2.9999V. Repeat the 0.0000V and 2.9999V entries until there is no variation.
7. Set the HEATER POWER bar graph to current display mode by turning on Switch 1 of the six station dip switch located at the rear center of the main board.

Connect the 25 ohm load resistor in place of the heater and put a current meter in series with the load. Switch range on the front panel to MAX. Connect the voltage standard across pins D and E of the Control Channel input (A or B) and enter a voltage of 1.0000 V dc. Enter a set point of 0.9000V. Enter a GAIN of 00 and adjust trimpot R9 on main PCB until output current reaches 0 AMP within 1%. Enter a gain of 50. The Heater Power bar graph should be at full scale (as long as the load resistor is 25 ohm or less; larger resistance values would restrict the maximum current due to the compliance voltage limits for the output stage). Adjust trimpot R20 on main PCB until full scale output reaches 1 AMP within 1%. Enter a gain of 00 and a MANUAL HEATER power of 50%. Adjust trimpot R36 on main PCB until HEATER POWER bar graph reads 50% output. Return display to Power mode by turning off switch 1 of the six station dip switch.

8. Turn off POWER. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clip washers and starting the screws. Carefully move any misaligned card to its proper position and tighten cover screws.

5-24. TROUBLESHOOTING.

5-25. When troubleshooting the DRC-82C use the following precautions to prevent damage due to static discharge:

1. Set the 82C POWER switch to OFF before removing or installing components or PCBs.
2. Minimize handling of static sensitive components.
3. Use ground straps to discharge repair personnel static before handling device.
4. Use conductive or anti-static containers for storage and transport of components or circuit boards.
5. Keep parts in their original containers.
6. Pick up static sensitive components only by the body.
7. Do not slide static sensitive components over any surface.
8. Avoid plastic, vinyl and styrofoam in the work area.
9. Perform all repairs at a static-free work station.
10. Only grounded tip soldering irons and anti-static type de-soldering devices should be used.

5-26. A troubleshooting guide for the 82C is given in Table 5.1. To properly use the guide, complete the performance test given earlier in this section and note any discrepancies. Locate the problem in the Symptom column and perform the appropriate tests for the possible causes as listed next to the Symptom. Corrective actions are given for the various possible causes. Schematics and component layouts for the various PCB assemblies are given later in this section.

The test equipment necessary for troubleshooting is as follows:

1. Digital voltmeter/multimeter, 4 digit resolution or better.
2. Device capable of detecting high-speed digital pulses, e.g., a logic probe or storage oscilloscope.

5-27. When measuring signals in the DRC-82C extreme caution must be used to measure the signals against the proper ground point. There are three isolated ground potentials within the unit and measuring a signal against the wrong ground could cause serious damage to the unit.

Table 5-1. Troubleshooting Guide for Model DRC-82C

Symptom	Possible Cause/Corrective Action
<p>1. Unit does not power up, or line fuse blows as soon as unit is powered up.</p>	<ol style="list-style-type: none"> 1. Verify that the proper line voltage and fuse rating were selected as outlined in Section V. 2. Make sure Heater Resistance switch is in the proper position for the heater being used and that the switch is not in between positions. If the switch is in between positions and not locked into place, the secondary windings of the heater output transformer could be shorted together possibly causing damage to the output stage, output transformer or both.
<p>2. General failure (unit does not go through initialization sequence properly or erratic operation).</p>	<ol style="list-style-type: none"> 1. Verify that none of the upright cards or wiring harnesses have come loose during shipment or use. With the unit off, remove the top cover and calibration cover. Make sure all the cards are thoroughly seated. Make sure cables to main board connectors JA, JB, JC and JE are locked in place by pushing down on them. Verify that the A and B input wiring harnesses are locked onto their respective input cards and that there are no broken wires at either of the input connectors, the Sample and Control switches, the Monitor connector and the Heater Power terminals. Also make sure the two-wire header from the Control switch is plugged into the two-prong connector on Analog Control Card #1. Make sure none of the socketed IC's have "popped" out of their sockets (Note: only machine pin sockets are used in the unit, should a component be loose, gently remove it from the socket, rebend its leads and re-insert). There is a two-wire serial communications link between the Microprocessor Card and the Display Driver Board. Labeled as RXD and TXD on their respective boards, RXD of the Microprocessor Card should go to TXD of the Display Driver and vice-versa. 2. Power supply failure. There are three isolated ground potentials within the unit: Digital, Analog, and Heater Output. Check the Digital supplies as follows: Connect the DVM ground to the DIG GND test point TP1 on the main board and measure the following dc voltage: Main board +5 on Slot 1-Pin 42, -5 on Slot 1-Pin 44; +15 on Slot 1-Pin 48, -15 on Slot 1-Pin 50; Microprocessor +5 on Slot 0-Pin 49, Display Board raw voltage of between 8 and 10 volts on JB pin 19 (the regulated display board +5 is present at pin 3 of U24 which is mounted on the left side rail).

Table 5-1.

Troubleshooting Guide for Model DRC-82C, cont'd.

Symptom	Possible Cause/Corrective Action
<p>2. General failure (cont'd.)</p>	<p>2. Power supply failure, cont'd. Check the Analog supplies as follows: Connect the DVM ground to the AN GND test point TP2 on the main board and measure the following dc voltage: +5 on Slot 6-Pin 33; +8 on Slot 6-Pin 35; +15 on Slot 6-Pin 31; -8 on Slot 6-Pin 36; -15 on Slot 6-Pin 32. There is one isolated supply for each Analog Input Card current source. Measure the A-Channel supply by putting the DVM on Slot 4-Pin 5 and measuring either +15 or +12 on Slot 4-Pin 3 and the raw voltage of around +21 on Slot 4-Pin 6. Measure the B-Channel supply on the same pins on Slot 5.</p> <p>Check the Heater Output supplies as follows: Connect the DVM ground to the Heater Output ground test point TP5 on the main board and the plus at the joint of C50 and K6 on the main board. Measure the following dc voltages: 30-32V for the 10-25 ohm range; 40-42V for the 25-35 ohm range with no heater across the HEATER POWER terminals.</p>
<p>3. Display of Or, incorrect display value or blank display.</p>	<p>1. Verify that the sensor has been installed properly as outlined in Section 2-20. Verify the polarity of the voltage is correct.</p> <p>The following checks are for a standard Diode Analog Input card or 8219 Platinum Input Option card. For any input cards other than these, consult a factory representative.</p> <p>2. Check that the excitation current is correct for the type of input card installed. If not, verify that the voltage between pins 1 and 2 of U1 of the input Card is approximately 6.9V dc. If not present, replace U1. Verify that approximately 5V dc is present across R5. If not present, fault is in resistor network R1, R2, R3 and R4. If present, problem is with U2, U3 or the connections to the back panel.</p> <p>3. Verify input buffer. The voltage present between Pins P2-3 and P2-4 should be present at the output of U5 as measured at the appropriate MONITORS connector pins. If not present, replace U5. For an 8219 Option, the signal is amplified by -10 by U4. If the input signal present at input connector pins P2-3 and P2-4 is not present in its amplified form at pin 3 of U5, replace U4.</p>

Table 5-1.

Troubleshooting Guide for Model DRC-82C, cont'd.

Symptom	Possible Cause/Corrective Action
3. Display of Or, cont'd.	<p>4. Check for proper A/D converter operation. With the oscilloscope gnd on the AN gnd TP2 on the main board. Verify that an A/D clock of 200K Hz is present on U9-Pin 25. If not replace U14. Look at the signal present at U8-Pin 2. For a Diode input card and a positive voltage input at U9-Pin 32, the signal should be a negative signal that remains flat for a period of time, ramps negative and then back positive to form a triangular wave form. For an 8219 input card the signal present at U9-Pin 32 should be a negative signal and the signal would ramp positive to form the triangular wave form. If not present, replace U8. The VREF signal present at U9-Pin 37 should be approximately 1.5V dc. If not present, verify that between 1.5 and 2.0V dc are present at U8-Pin 6. If present, check resistor divider network R13, R14, R23 and R29. If not present, replace U8. Check the STTS signal present at U9-Pin 3. Signal should pulse from high to lo and back to high again with a period equal to the update cycle of approximately .65 seconds. If not present, replace U9. Verify that for an input signal present at U9-Pin 3 of less than 3.0000V dc the OR signal at U9-Pin 5 is low. If the signal is pulsing or remains high, replace U9. The data and signals are optically coupled onto and off the card. Verify that the signals present on U6, U7, U12 and U13 are coupled through properly. If not, replace the faulty device. Note: Signals should be measured with respect to their proper ground potentials.</p>
4. Display value is correct, heater output is not present or operates incorrectly	<p>The heater output check is very involved and requires the verification of several individual functions that contribute to the proper operation of the heater output. The checks are as follows:</p> <ol style="list-style-type: none"> 1. Verify Analog Control Card #1. This card performs the Set Point Voltage generation and Gain function. Set the CONTROL units to Volts. Connect the DVM gnd lead to Analog Control Card #1 TP2. Connect the plus lead to Control Card #1 TP1. Enter a Set Point of 0.0000V and verify that a signal of $0.0000 \pm 100\mu\text{V}$ dc is present across the test points. Enter a Set Point of 1.0000V and verify that a signal of $-1.0000 \pm 100\mu\text{V}$ dc is present for a Diode Control input. If not present, check U8, U9, U10, U1 U3 or U2. U8, U9, U10 and U1 optically couple data from the Microprocessor to the Analog stage. U3 is a serial-to-parallel shift register that latches the serial data for the Set Point and Gain DAC's. A Set Point of -1.0000V dc corresponds to the binary pattern of 0000100101010101 on pins 1-16 of U2. (A Set Point of + 1.0000V dc corresponds to the binary pattern of 1101010101101010 on pin 1-16 of U2).

Table 5-1.

Troubleshooting Guide for Model DRC-82C, cont'd.

Symptom	Possible Cause/Corrective Action
<p>4. Display value is correct, cont'd.</p>	<ol style="list-style-type: none"> <li data-bbox="532 260 1516 831"> <p>1. Verify Analog Control Card #1, cont'd. If the data is not coupled through on a Set Point or Gain change, replace U8, U9, U10 or U1. If the data is present but the output is incorrect, replace U2. The Control Input Voltage is buffered by U6. If the voltage present across pins P2-1 and P2-2 is not present at the output of U6, replace U6. Input a voltage that would generate a 1mV error (i.e., 1.0010V dc). With a GAIN of 00, verify that the voltage present at U5-Pin 10 is 0.0000V dc. Enter a GAIN of 01. The voltage present at U5-Pin 10 should be 1x the error, or approximately 1mV dc. Enter a GAIN of 10 and verify that the voltage goes to 10x the error, or approximately 10mV dc. The binary pattern for a GAIN of 10 is 0101000000 on pins 4-13 of U2. If the data is present, but the output is incorrect, replace U4, U5 or U7. Verify that the amplified error voltage is present at the output driver summing resistor R7 on Analog Control Card #2.</p> <li data-bbox="532 869 1581 1860"> <p>2. Verify Analog Control Card #2. This card performs the Reset, Rate and Manual Heater functions and obtains the isolated data and clock from Control Card #1 to shift data into U1. Connect the DVM ground lead to the AN GND TP2 on the main board. Measure the Manual Heater Power setting voltage present at U5-pin 10 with a Manual Heater setting of 00. Verify that the voltage is approximately 0V dc. A setting of 99 percent will result in approximately 7.7V dc while 50 percent should be approximately 5.5V dc. The binary pattern for Manual Heater of 50 is 10110111 on pins 4-11 of U4. If the data is present but the output is incorrect, replace U4 or U5. If the data is not present, replace U1. Measure the Reset setting voltage present at U7-Pin 10 with a Reset setting of 00. (The error is still 1mV dc, GAIN 10 so the amplified error signal is 10mV dc). Verify that the voltage is approximately 0V dc. A setting of 99 percent will result in an output of approximately 10 mV dc (the maximum amplified error value) while a setting of 50 percent will result in an output of approximately 5mV (one-half the amplified error value). The binary pattern for Reset of 50 is 1000 0001 on pins 4-11 of U6. If the data is not present, replace U1. If the data is present but the output is incorrect, replace U6 or U7. With the Reset at 00 verify that the integrated Reset signal at U10-Pin 10 is approximately 0V dc. Enter a Reset setting of 50 percent. The voltage at U10-Pin 10 should integrate at a rate of approximately .5mV/sec. Enter a setting of 99. The integration should increase to approximately 1mV/sec. If the signal does not integrate and the output of U7 was correct, make sure that the solid state switch package U8 is operating properly.</p>

Table 5-1. Troubleshooting Guide for Model DRC-82C, cont'd.

Symptom	Possible Cause/Corrective Action
<p>4. Display value is correct, cont'd.</p>	<p>2. Verify Analog Control Card #2, cont'd.</p> <p>When the Reset is set to 00, U8-Pin 15 should be high, and with a setting of anything but 00, the pin should be low. If the drive value is incorrect, replace U1. If the drive pin is correct but U10 does not integrate, replace U8 or U10. Measure the Rate setting voltage present at U3-Pin 10 with a Rate setting of 50 (the error is still 1mV dc, GAIN 10 and the amplified error signal is 10mV dc). The voltage should be approximately 5mV (one-half the amplified error value). The binary pattern for Rate of 50 is 10000001 on pins 4-11 of U2. If the data is not present, replace U1. If the data is present but the output is not present, replace U2 or U3. Look at the output of Rate amplifier U9 with a Rate setting of 50. Make a step change in the input voltage and note that the output changes and then returns to the original value. If the signal does not change, check the solid state switch package U8 as in the Reset check. Return the Gain, Rate and Reset to 00 and set a Manual Heater value of 50. Verify that the Manual Heater voltage of approximately 5.5v dc is present on U12-pin 10. If not present, replace U11 or U12. Move the DVM ground to the Heater Output ground TP5 on the main board and verify that the same 5.5V signal is present at the input of the heater output drive amplifier U26 measured on TP6 on the main board. With a 25 ohm load across the Heater Power terminals and the Heater Resistance range switch set to 10-25 ohm, select a heater range other than OFF. Verify that the Power across the load goes to approximately 50% of full scale. If the output is not present, verify the relay drive line for that range is activated (low). U25 generates the drive signals with the following assignments: -4 Pin 4; -3 Pin 2, -2 Pin 6; -1 Pin 10, and MAX Pin 8. If the drive is present but there is no output, fault is in U26, U27, Q2 or Q3. If the output appears correct but the bar graph indicates incorrect values, fault is in U28, U29, U30, U32, U33 or U34.</p>
<p>5. General Problem not covered in this table.</p>	<p>1. Consult a factory representative.</p>

5-28. REPLACEABLE PARTS.

5-29. Below is a list of Tables and Figures for the DRC-82C schematics, replaceable parts lists and illustrated component layouts.

Block Diagram	Model DRC-82C Interconnect Diagram	Figure 5-2
Parts List	A1 Model DRC-82C Main Board Assembly	Table 5-2
Component Layout	DRC-82C Main Board Component Layout	Figure 5-3
Schematic	Main Board Power Supply	Figure 5-4
Schematic	Main Board Output Power Supply	Figure 5-5
Schematic	Main Board Digital Input Data	Figure 5-6
Schematic	Main Board Output Stage	Figure 5-7
Schematic	Main Board Card Interconnections	Figure 5-8
Parts List	A1A2 Microprocessor and Memory Card	Table 5-3
Component Layout	A1A2 Microprocessor and Memory Card	Figure 5-9
Schematic	A1A2 Microprocessor and Memory Card	Figure 5-10
Parts List	A1A3 Analog Input Card	Table 5-4
Component Layout	A1A3 Analog Input Card	Figure 5-11
Schematic	A1A3 Analog Input Card	Figure 5-12
Parts List	A1A4 Analog Control Card #1	Table 5-5
Component Layout	A1A4 Analog Control Card #1	Figure 5-13
Schematic	A1A4 Analog Control Card #1	Figure 5-14
Parts List	A1A5 Analog Control Card #2	Table 5-6
Component Layout	A1A5 Analog Control Card #2	Figure 5-15
Schematic	A1A2 Analog Control Card #2	Figure 5-16
Parts List	A2A1 Display Board Assembly	Table 5-7
Parts List	A2A2 Display Board Driver Assembly	Table 5-8

Component Layout	A2A1 Display Board Assembly	Figure 5-17
Component Layout	A2A2 Display Board Driver Assembly	Figure 5-18
Schematic	A2A1, A2A2 Display Board Assembly	Figure 5-19
Schematic	A2A1, A2A2 Display Board Assembly	Figure 5-20
Parts List	A3 Front Panel Assembly	Table 5-9
Parts List	A4 Rear Panel Assembly	Table 5-10
Parts List	A5 Main Transformer Assembly	Table 5-11
Parts List	A6 Output Transformer Assembly	Table 5-12
Parts List	A7 Enclosure Assembly	Table 5-13
Parts List	A8 Bottom Panel Assembly	Table 5-14
Parts List	DRC-82C Final Assembly	Table 5-15

5-30. The parts lists include the following information:

1. Reference Designation or Item Number
2. Description of each part
3. LSCI Stock Number
4. Abbreviated Manufacturer (see end of section for Cross Reference of Manufacturers, Table 5-16).
5. Manufacturer Part Number or Type
6. Total Quantity per assembly or component
7. Recommended spare parts (denoted as *) necessary to support the unit over the warranty period of two years. A quantity of one of each of the denoted parts should be sufficient.

5-31. HOW TO OBTAIN PARTS.

5-32. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from LSCI or authorized LSCI representative by using the LSCI part number.

5-33. To ensure proper handling of your order, include the following information:

1. Quantity
2. LSCI Stock Number
3. Description
4. Reference designation or item number
5. Assembly number
6. Instrument model and serial number

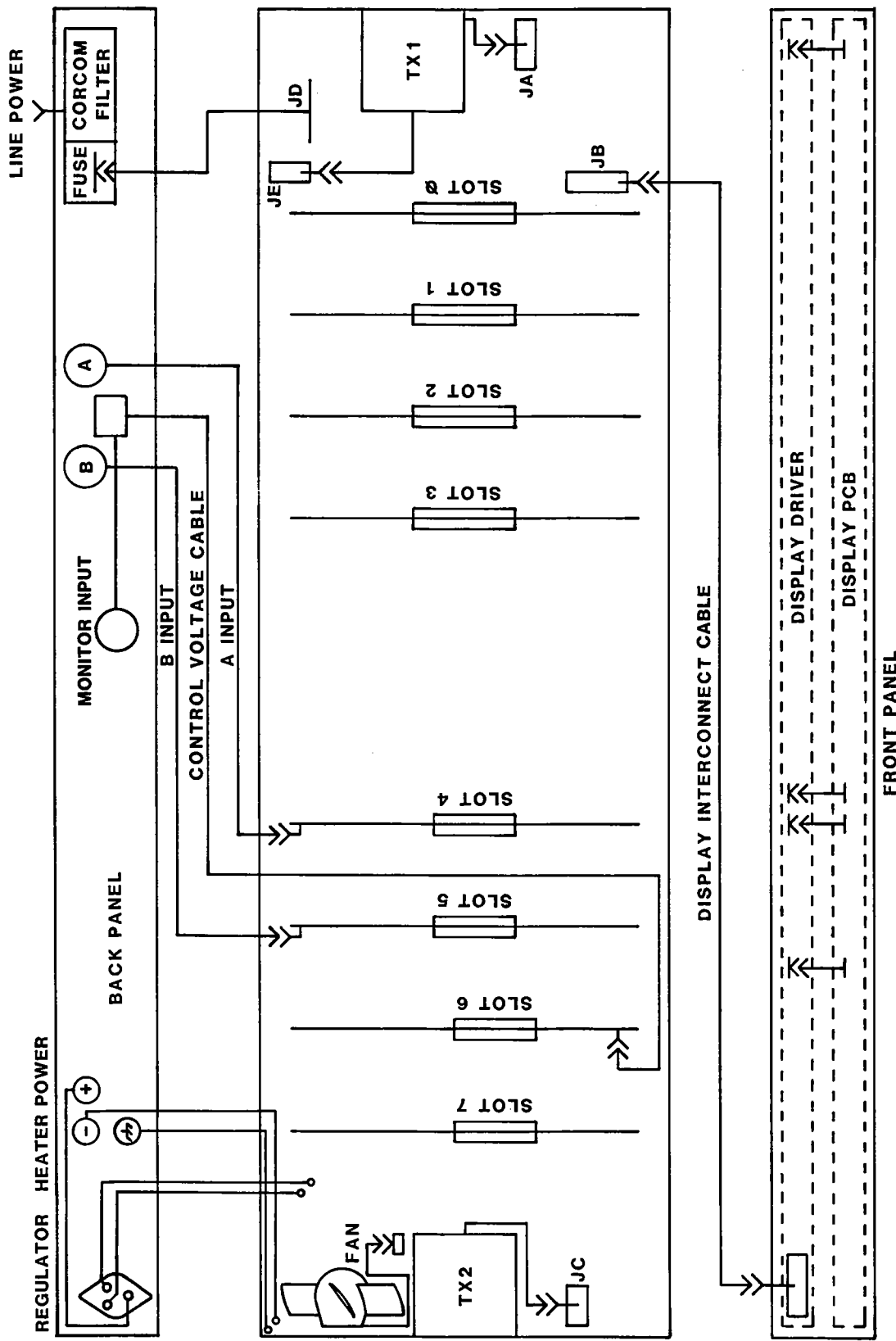


Figure 5-2.
Model DRC-82C Interconnect Diagram
V-17

Table 5-2. A1 - DRC-82C Main Board

LSCI Part Number 113-120

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1A1	DRC-82C Main Board P.C. Board Artwork #: D-233-83-01E	111-042	LSCI	111-042	1
C1	CAP, ELECT, 9500 MF, 15V	101-275	MEP/EL	3188BA952U015AMA1	1
C2	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	8
C3	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	16
C4	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C5	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C6	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C7	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C8	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C9	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C10	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C11	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C12	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C13	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C14	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C15	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C16	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C17	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C18	CAP, ELECT, 470 MF, 35V	101-226	PAN	ECE-B-1VV-471S	2
C19	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	6
C20	CAP, ELECT, 470 MF, 35V	101-226	PAN	ECE-B-1VV-471S	2
C21	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	7
C22	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C23	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C24	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C25	CAP, ELECT, 2100 MF, 75V	101-238	MEP/EL	3186BA212U075AMA1	1
C26	CAP, Q PAK, .03 MF	101-126	RGRS	UQ40.03	2
C27	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C28	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C29	CAP, ELECT, 470 MF, 35V	101-225	PAN	ECE-A-IVV-4715	REF
C30	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C31	CAP, POLY, .68 MF, 100V	101-046	PLSY	160.68J100G	REF
C32	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	REF
C33	CAP, POLY, 1 MF, 100V	101-032	PLSY	1501K100FC	2
C34	CAP, MYLR, .01 MF, 100V	101-008	SPRG	416P-10391	2
C35	CAP, MYLR, 500 PF, 500V	101-099	CDE	CD15CD501G03	1
C36	CAP, MYLR, .01 MF, 100V	101-008	SPRG	416P-10391	REF
C37	CAP, POLY, 1 MF, 100V	101-032	PLSY	1501K100FC	REF
C38	CAP, TANT, 1.5 MF, 10V	101-132	SPRG	150D155X9010A2	1
C39	CAP, MYLR, 150 PF, 500V	101-085	CDE	CD15CD151G03	1
C40	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	REF
C41	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	REF
C42	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	REF
C44	CAP, Q PAK, .03 MF	101-126	RGRS	UQ40.03	REF
C45	CAP, POLY, 22 MF, 100V	101-210	PAN	ECEA1HV220S	2

Table 5-2. A1 - DRC-82C Main Board

LSCI Part Number 113-120, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
C46	CAP, ELECT, 22 MF, 50V	101-210	PAN	ECEA1HV220S	REF
C47	CAP, ELECT, 22 MF, 50V	101-025	MEP/EL	712A1MM335PK101SF	1
C48	CAP, POLY, .033 MF, 100V	101-013	CDE	WMF1533	2
C49	CAP, POLY, .033 MF, 100V	101-013	CDE	WMF1533	REF
C50	CAP, ELECT, 10 MF, 100V	101-207	SPRG	30D-TE1407	1
C51	CAP, POLY, 0.1 MF, 100V	101-042	PLSY	160.1K100G	REF
CR1A	DIODE, RECTIFIER	102-003	MOT	MR501	8 *
CR1B	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR1C	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR1D	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR2	BRIDGE RECTIFIER	102-008	IR	W02M	4 *
CR3	BRIDGE RECTIFIER	102-008	IR	W02M	REF
CR4	BRIDGE RECTIFIER	102-008	IR	W02M	REF
CR5	DIODE, RECTIFIER	102-001	MOT	IN4006	4 *
CR6	DIODE, RECTIFIER	102-001	MOT	IN4006	REF
CR7	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR8	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR9	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR10	DIODE, RECTIFIER	102-003	MOT	MR501	REF
CR11	BRIDGE RECTIFIER	102-008	IR	W02M	REF
CR12	DIODE, RECTIFIER	102-001	MOT	IN4006	REF
CR13	DIODE, RECTIFIER	102-001	MOT	IN4006	REF
CR14	DIODE, 24V ZENER	102-058	MOT	IN4749A	1 *
CR15	DIODE, 5.1V ZENER	102-053	MOT	IN751A	1 *
H1	HEAT SINK, (U1)	110-064	AV	601-30-020B	1
H2	HEAT SINK, (R33, R46)	110-041	WKF	203-AB	2
H3	HEAT SINK, (R34)	110-040	AV	5781B	1
H4A	HEAT SINK, (U19)	110-028	AV	5000-0125, COAT 151	1
H4B	HEAT SINK, (U19)	110-027	AV	5427B	1
H5	MICA INSULATORS	110-061	TRMLY	43-77-2	2
H6	MICA INSULATORS	110-023	MOT	52600F011	1
H7	#4 FIBER WASHERS				10
H8	#6 NYLON WASHERS				4
H9	TEST POINT TERMINALS	110-155	CBN	0-1026-01-02-01	6
H10	3 PIN TERMINAL	106-129	SMTC	TSW-12-10-GS	3/20
H11	STANDOFF, #6-32 x 3/4"		HHS	8425	2
H12	STANDOFF, #4-40 x 5/16"		HHS	9285	8
H13	SCREW, 4-40 x 1/4"				3
H14	SCREW, 4-40 x 3/8"				2
H15	SCREW, 4-40 x 3/4"				8
H16	#4-40 KEP NUTS				3
H17	#4-40 NUTS				2
H18	SCREW, #4 x 1/4" METAL				2
H19	SCREW, #6-32 x 3/8" PHMS				4
H20	SCREW, #6-32 x 3/4" PHMS				2

Table 5-2. A1 - DRC-82C Main Board

LSCI Part Number 113-120, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
JA	16 PIN MALE TRANS. CONN.	106-107	AMP	350-214-1	1
JB	20 PIN MALE HEADER	106-244	TBA	609-2022M	1
JC	12 PIN MALE TRANS. CONN.	106-105	AMP	350-213-1	1
J4	IEEE CONNECTOR	106-310	AML	57-92245-12	1
J5	16 PIN PCB MALE HEADER	106-420	TBA	609-1602M	1
JE	6 PIN MALE HEADER	106-143	MOL	2630-09-74-1061	1
K1	DRY REED RELAY, 20W	105-302	EAC	B1A5AH	6 *
K2	DRY REED RELAY, 20W	105-302	EAC	B1A5AH	REF
K3	DRY REED RELAY, 20W	105-302	EAC	B1A5AH	REF
K4	DRY REED RELAY, 20W	105-302	EAC	B1A5AH	REF
K5	DRY REED RELAY, 20W	105-302	EAC	B1A5AH	REF
K6	DRY REED RELAY, 50W	105-304	EAC	P1A5A	1 *
K7	DRY REED RELAY, 20W	105-302	EAC	B1A5AH	REF
Q1	PNP TRANSISTOR	102-072	MOT	2N3906	1 *
Q2	POWER MOSFET 90V N-CH	102-104	SPTX	VN0109N5	1 *
R1	RES, CAR, 1.5K, 1%, 3W	103-628			2
R2	RES, MTF, 4.75K, 1%, 1/4W	103-306			5
R3	RES, MTF, 215 OHM, 1%, 1/4W	103-228			1
R4	RES, MTF, 4.99K, 1%, 1/4W	103-308			1
R5	RES, MTF, 6.65K, 1%, 1/4W	103-324			3
R6	RES, MTF, 9.31K, 1%, 1/4W	103-353			1
R7	RES, MTF, 100K, 1%, 1/4W	103-420			4
R8	RES, MTF, 6.65K, 1%, 1/4W	103-324			REF
R9	TRIM POT, 50K	103-099	BKMN	66WR50K	1
R10	RES, MTF, 14.7K, 1%, 1/4W	103-362			2
R11	RES, MTF, 100K, 1%, 1/4W	103-420			REF
R12	RES, MTF, 49.9 OHM, 1%, 1/4W	103-210			1
R13	RES, MTF, 14.3K, 1%, 1/4W	103-361			1
R14	RES, MTF, 392 OHM, 1%, 1/4W	103-234			4
R15	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R16	RES, MTF, 10K, 1%, 1/4W	103-358			3
R17	RES, MTF, 64.9K, 1%, 1/4W	103-407			1
R18	RES, MTF, 10K, 1%, 1/4W	103-358			REF
R19	RES, MTF, 12.1K, 1%, 1/4W	103-360			1
R20	TRIMPOT, 5K	103-098	BKMN	66WR5K	2
R21	RES, MTF, 6.65K, 1%, 1/4W	103-324			REF
R22	RES, MTF, 100K, 1%, 1/4W	103-420			REF
R23	RES, MTF, 51.1K, 1%, 1/4W	103-399			2
R24	RES, MTF, 10K, 1%, 1/4W	103-358			REF
R25	RES, MTF, 787 OHM, 1%, 1/4W	103-249			1
R26	RES, MTF, 249 OHM, 1%, 1/4W	103-229			2

Table 5-2. A1 - DRC-82C Main Board

LSCI Part Number 113-120, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
R27	RES, MTF, 1.5K, 1%, 3W	103-628			REF
R28	RES, MTF, 2K, 1%, 1/4W	103-278			1
R29	RES, MTF, 51.1K, 1%, 1/4W	103-399			REF
R30	RES, MTF, 249 OHM, 1%, 1/4W	103-229			REF
R31	RES, MTF, 82.5 OHM, 1%, 1/4W	103-215			1
R32	RES, MTF, 24.9 OHM, 1%, 1/2W	103-505	COR	RN60D-24.9 OHM	1
R33	RES, 8.25 OHM, 1%, 2W	103-574			1
R34	RES, 2.49 OHM, 1%, 4W	103-644			1
R35	RES, MTF, 2.21K, 1%, 1/4W	103-281			1
R36	TRIMPOT, 5K	103-098	BKMN	66WR5F	REF
R37	RES, MTF, 14.7K, 1%, 1/4W	103-362			REF
R38	RES, MTF, 392 OHM, 1%, 1/4W	103-234			REF
R39	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R40	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R41	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R42	RES, MTF, 392 OHM, 1%, 1/4W	103-234			REF
R43	RES, MTF, 392 OHM, 1%, 1/4W	103-234			REF
R44	RES, MTF, 100K, 1%, 1/4W	103-420			REF
RN1	RES,NET, 4.7K(9), 1 COMM	103-103	BOR	4310R-101-472	3
RN2	RES,NET, 4.7K(9), 1 COMM	103-103	BOR	4310R-101-472	REF
RN3	RES,NET, 4.7K(9), 1 COMM	103-103	BOR	4310R-101-472	REF
RN4	RES,NET, 4.7K(7), 1 COMM	103-102	BOR	4308R-101-472	1
RN5	RES,NET, 4.7K(5), 1 COMM	103-101	BOR	4306R-101-472	1
S1	8 POLE DIP SWITCH	105-408	GYH	76SB08	3
S2	8 POLE DIP SWITCH	105-408	GYH	76SB08	REF
S3	8 POLE DIP SWITCH	105-408	GYH	76SB08	REF
S6	3 POS, 4 POLE SLIDE SW.	105-564	ALCO	MSSA 4350R	1
S7	4 POLE POWER SWITCH	105-032	CENT	P10656	1
S8	6 POLE DIP SWITCH	105-406	GYH	76SB06	1
SLOT 0	CARD EDGE CONNECTOR (25/50)	106-229	BRDY	PWBH4DD25-11	4
SLOT 1	CARD EDGE CONNECTOR (18/36)	106-227	BRDY	PWBH4DD18-11	4
SLOT 2	CARD EDGE CONNECTOR (18/36)	106-227	BRDY	PWBH4DD18-11	REF
SLOT 3	CARD EDGE CONNECTOR (25/50)	106-229	BRDY	PWBH4DD25-11	REF
SLOT 4	CARD EDGE CONNECTOR (25/50)	106-229	BRDY	PWBH4DD25-11	REF
SLOT 5	CARD EDGE CONNECTOR (25/50)	106-229	BRDY	PWBH4DD25-11	REF
SLOT 6	CARD EDGE CONNECTOR (18/36)	106-227	BRDY	PWBH4DD18-11	REF
SLOT 7	CARD EDGE CONNECTOR (18/36)	106-227	BRDY	PWBH4DD18-11	REF

Table 5-2. A1 - DRC-82C Main Board

LSCI Part Number 113-120, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
U1	+ 5V REGULATOR	102-011	MOT	MC7805ACT	3*
U2	- 5V REGULATOR	102-021	MOT	MC7905CT	1*
U3	+15V REGULATOR	102-014	NAT	LM7815CT	3*
U4	-15V REGULATOR	102-024	NAT	LM7915CT	3*
U5	+ 8V REGULATOR	102-012	NAT	LM7808CT	1*
U6	+15V REGULATOR	102-014	NAT	LM7815CT	REF
U7	-15V REGULATOR	102-024	NAT	LM7915CT	REF
U8	- 8V REGULATOR	102-022	NAT	LM7908CT	1*
U9	+ 5V REGULATOR	102-0122	MOT	MC7805ACT	REF
U10	+12V REGULATOR	102-013	NAT	LM7812CT	2
U11	+12V REGULATOR	102-013	NAT	LM7812CT	REF
U12	IC, LS INVERTER	104-207	NAT	74LS04	3*
U13	2.5V PROG. REF.	102-041	NAT	LM336MZ-2.5	1*
U14	IC, PORT EXPANDER	104-520	INT	8156H-2	1*
U15	IC, PORT EXPANDER	104-524	INT	P8255A-5	1*
U16	IC, IEEE CHIP	104-712	TI	TMS9914ANL	1*
U17	IC, IEEE SUPPORT CHIP	104-710	TI	SN75160A	1*
U18	IC, IEEE SUPPORT CHIP	104-711	TI	SN75161A	1*
U19	IC, LIN, PROGRAMMABLE REG.	102-036	NAT	LM317HVK-STEEL	1*
U20	+15V REGULATOR	102-014	NAT	LM7815CT	REF
U21	-15V REGULATOR	102-024	NAT	LM7915CT	REF
U22	IC, LIN, V/F, F/V	104-010	NAT	LM331N	2*
U23	IC, OPTO COUPLER	104-352	HP	6N135	2*
U24	IC, LIN, V/F, F/V	104-010	NAT	LM331N	REF
U25	IC, O.C. INVERTER	104-210	NAT	7406	1*
U26	IC, LIH, OP AMP	104-022	NAT	LF356N	1*
U27	IC, LIN, OP AMP	104-068	MOT	MC1458PI	1*
U28	IC, 8-BIT A/D CONVERTER	104-454	NAT	ADC0804LCN	1*
U29	IC, P-S SHIFT REGISTER	104-099	NAT	CD4021BCN	1*
U30	IC, L.S. INVERTER	104-207	NAT	74LS04	REF
U31	+ 5V REGULATOR	102-011	NAT	LM7805ACT	REF
U32	IC, DUAL OPTO COUPLER	104-350	HP	HCPL 2530	1*
U33	IC, OPTO COUPLER	104-352	HP	6N135	REF
U34	IC, L.S. INVERTER	104-207	NAT	74LS04	REF
W1	WIRE ASSEMBLY TO CORCOM WIRE: 3" OF HEAVY 5 CONDUCTOR RIBBON CABLE CONNECTORS:	112-033 110-151	LSCI AMP	 66399-3	1 1 5
W2	WIRE, 15 CONDUCTOR CABLE FOR POWER SUPPLY (1.5 FT.)		BEL	8458	1

Table 5-2. A1 - DRC-82C Main Board

LSCI Part Number 113-120, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
XS1	16 PIN RA HORZ SOCKET	106-543	ARS	16-823-90	3
XS2	16 PIN RA HORZ SOCKET	106-543	ARS	16-823-90	REF
XS3	16 PIN RA HORZ SOCKET	106-543	ARS	16-823-90	REF
XU12	SOCKET, IC, 14-PIN DIP	106-502	AUG	514-AGIID	3
XU14	SOCKET, IC, 40-PIN DIP	106-507	AUG	540-AGIID	3
XU15	SOCKET, IC, 40-PIN DIP	106-507	AUG	540-AGIID	REF
XU16	SOCKET, IC, 40-PIN DIP	106-507	AUG	540-AGIID	REF
XU17	SOCKET, IC, 20-PIN DIP	106-504	AUG	520-AGIID	3
XU18	SOCKET, IC, 20-PIN DIP	106-504	AUG	520-AGIID	REF
XU19	SOCKET, TO-3 XSTR	106-570	AUG	8080-1G1	1
XU22	SOCKET, IC, 8-PIN DIP	106-501	AUG	508-AGIID	7
XU23	SOCKET, IC, 8-PIN DIP	106-501	AUG	508-AGIID	REF
XU24	SOCKET, IC, 8-PIN DIP	106-501	AUG	508-AGIID	REF
XU25	SOCKET, IC, 14-PIN DIP	106-502	AUG	514-AGIID	REF
XU26	SOCKET, IC, 8-PIN DIP	106-501	AUG	508-AGIID	REF
XU27	SOCKET, IC, 8-PIN DIP	106-501	AUG	508-AGIID	REF
XU28	SOCKET, IC, 20-PIN DIP	106-504	AUG	520-AGIID	REF
XU29	SOCKET, IC, 16-PIN DIP	106-503	AUG	516-AGIID	1
XU30	SOCKET, IC, 14-PIN DIP	106-502	AUG	514-AGIID	REF
XU31	XSTR HEADER	112-003	LSCI	112-003	1
XU32	SOCKET, IC, 14-PIN DIP	106-502	AUG	514-AGIID	REF
XU33	SOCKET, IC, 8-PIN DIP	106-501	AUG	508-AGIID	REF

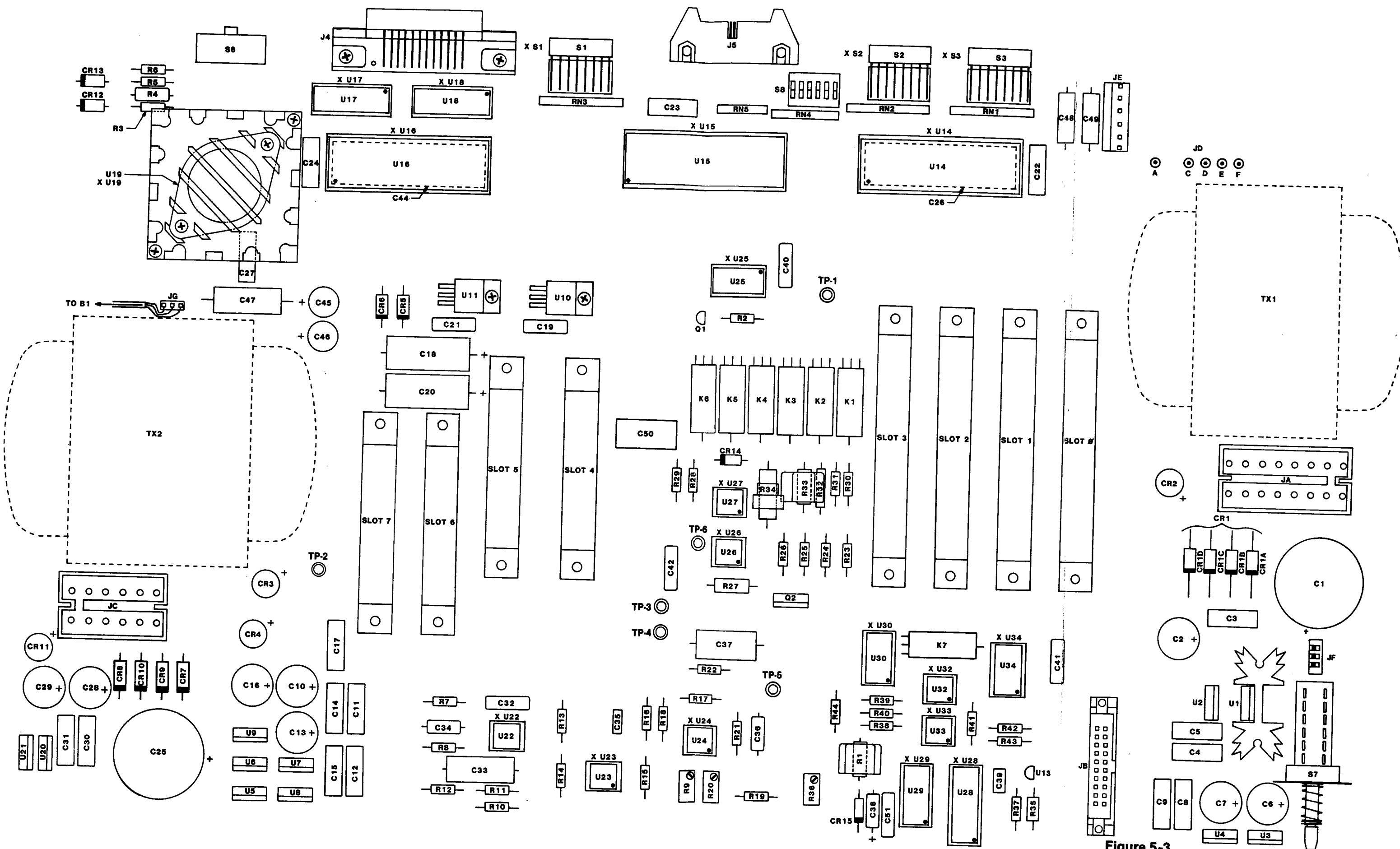


Figure 5-3.
DRC-82C Main Board Component Layout

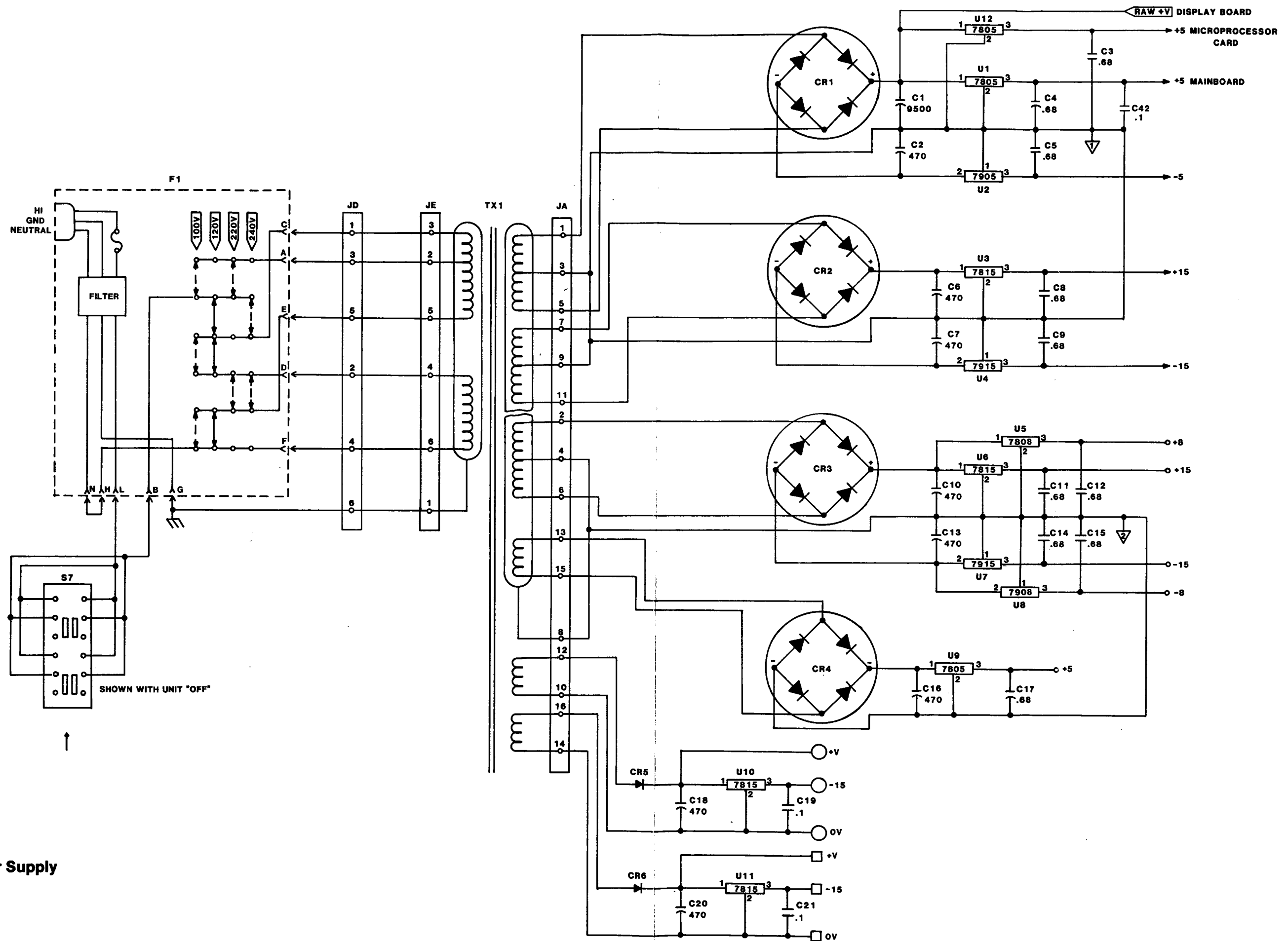


Figure 5-4.
Main Board Power Supply

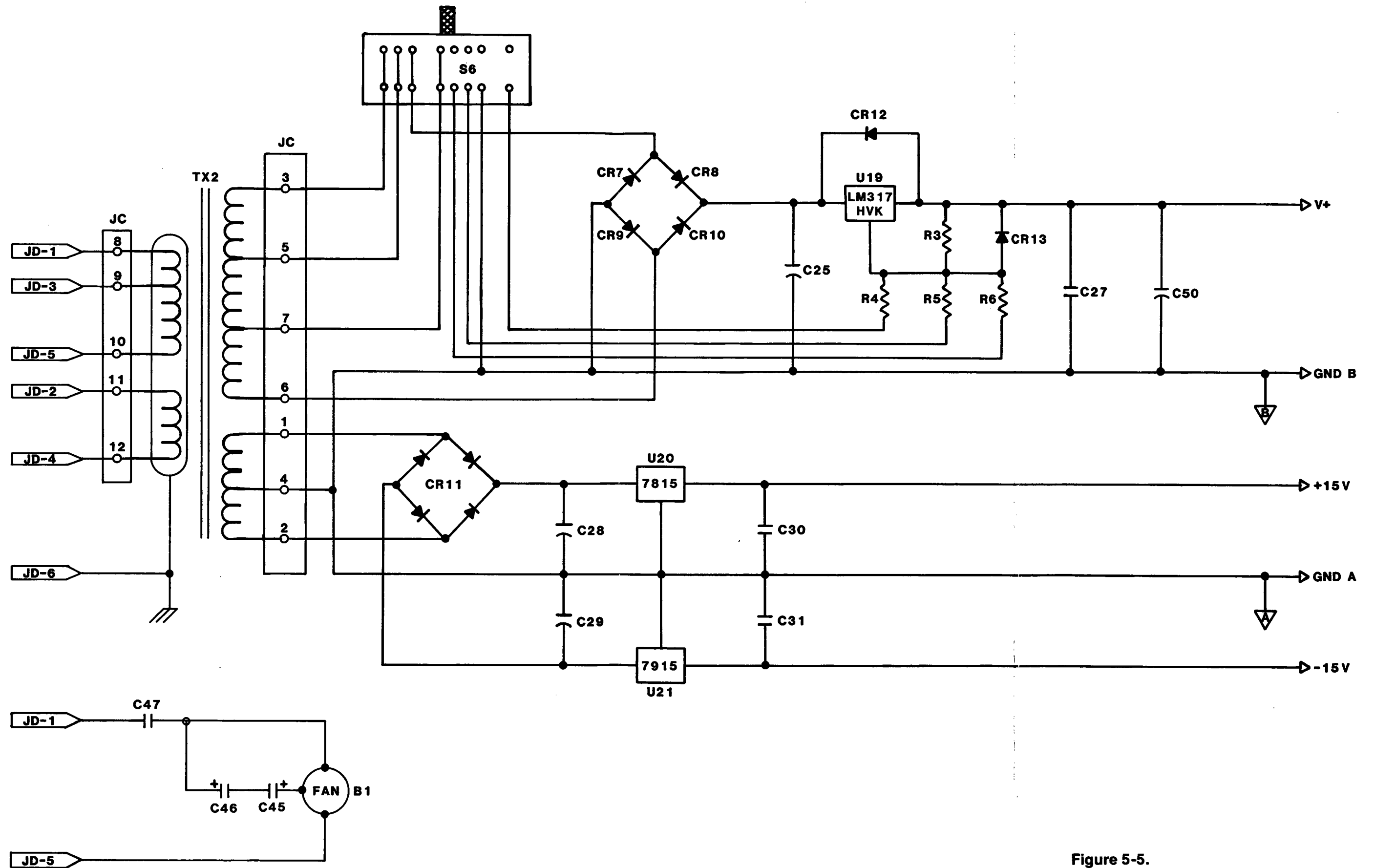


Figure 5-5.

Main Board Output Power Supply

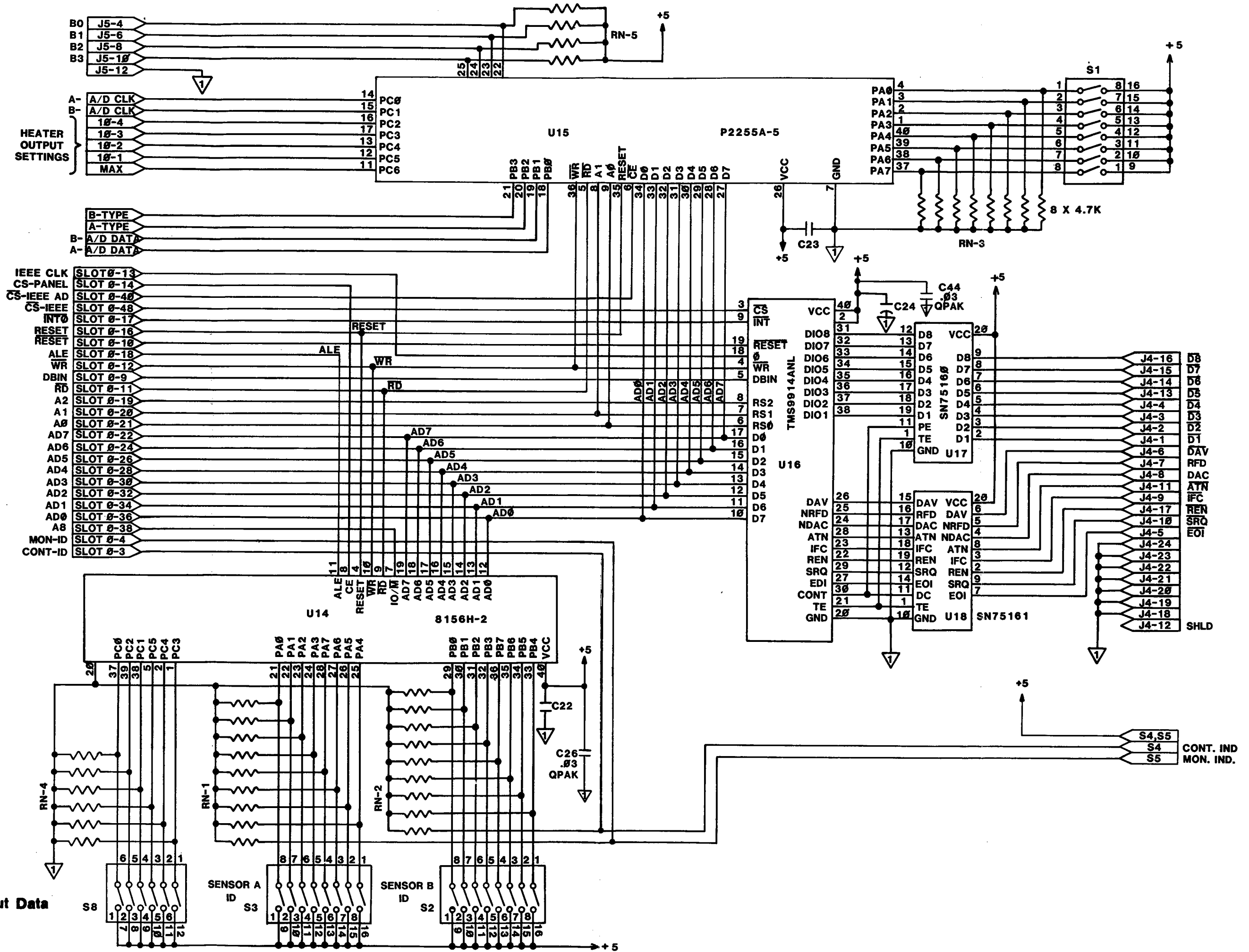


Figure 5-6.

Schematic Main Board Digital Input Data

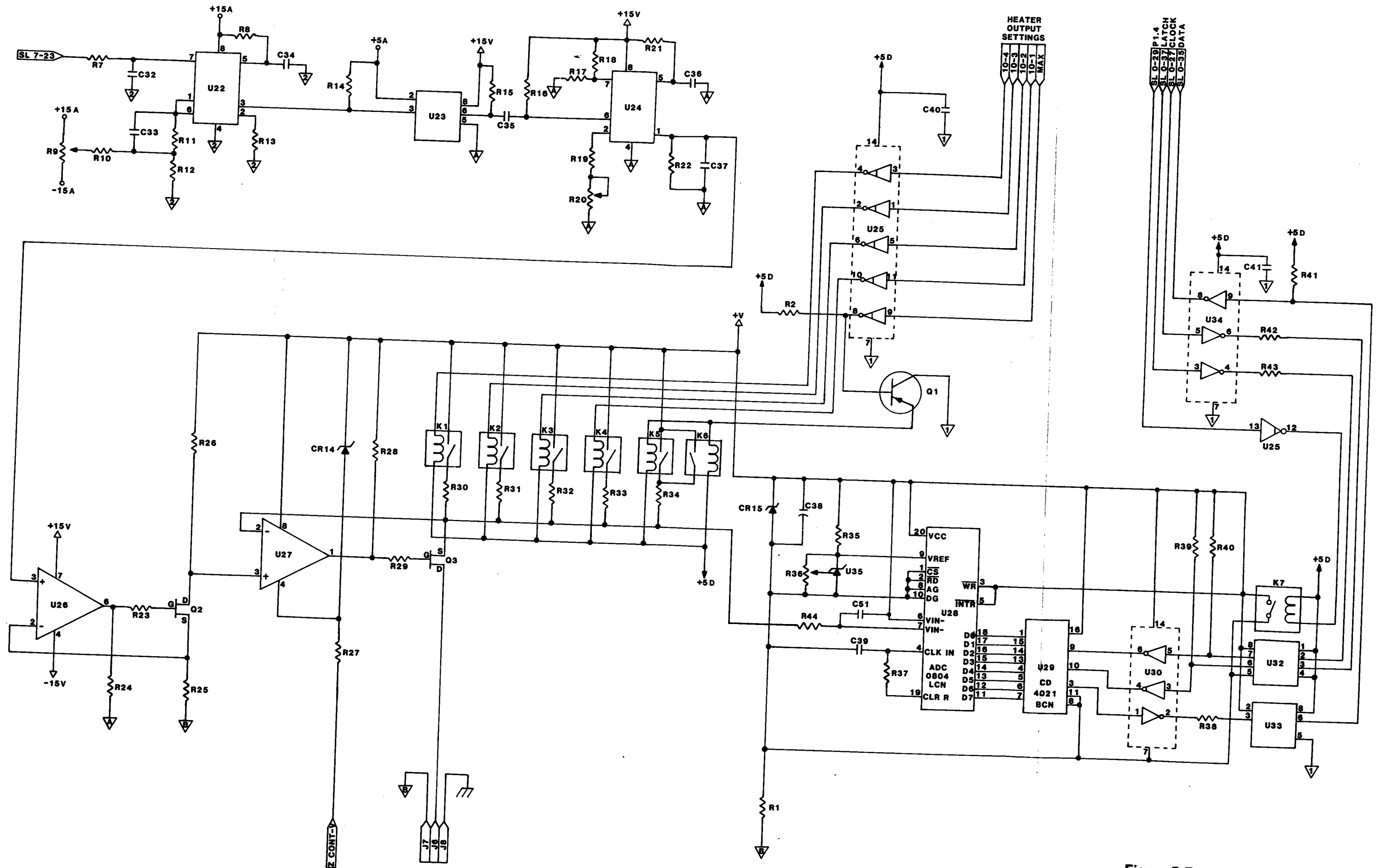


Figure 5-7.
Schematic Main Board Output Stage

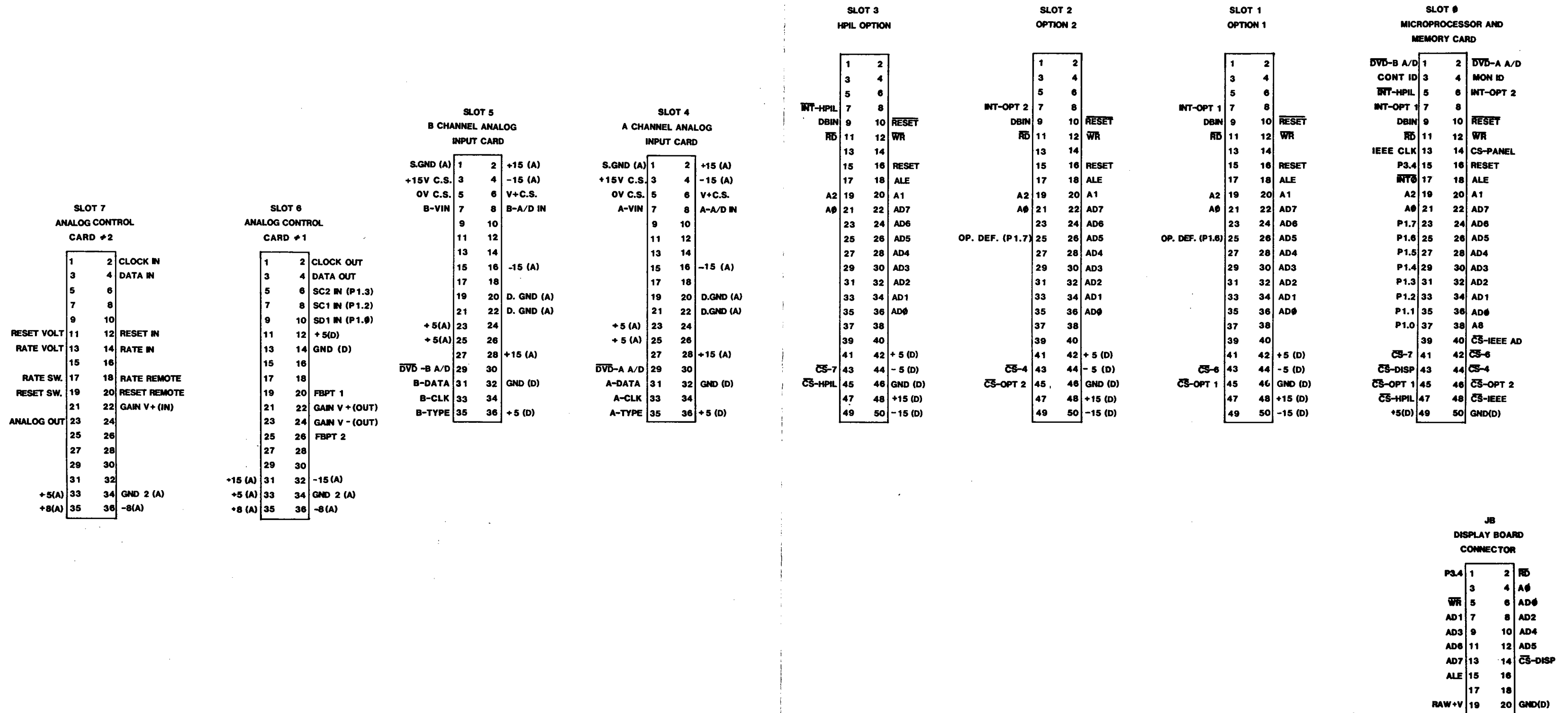


Figure 5-8.
Main Board Card Interconnections

Table 5-3. A1A2 - Microprocessor and Memory Card

LSCI Part Number 113-125

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1A2	Microprocessor and memory card Artwork #: C-260-83-01C	111-045	LSCI	111-045	1
C1	CAP, 1.5MF, 10V, TANT	101-137	SPRG	119D106X0035DB1	2
C2	CAP, 10PF, 500V, MICA	101-059	CDE	CD15CD100D03	1
C3	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	3
C4	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	REF
C5	CAP, .047MF, 600V, POLY	101-018	CDE	WMF6S47	1
C6	CAP, .03MF, QPAK-40	101-126	RGRS	UQ40.03	1
C7	CAP, .03MF, QPAK-20	101-123	RGRS	UQ20.03	2
C8	CAP, .03MF, QPAK-28	101-125	RGRS	UQ28.03	2
C9	CAP, .03MF, QPAK-28	101-125	RGRS	UQ28.03	REF
C10	CAP, .03MF, QPAK-20	101-123	RGRS	UQ20.03	REF
C11	CAP, .03MF, QPAK-24	101-124	RGRS	UQ24.03	1
C12	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	REF
C13	CAP, 1.5MF, 10V, TANT	101-137	SPRG	119D106X0035DB1	REF
Q1	XSTR, PNP	102-072	NAT	2N3906	1*
JMP1	Jumper, for 64K EEPROM		LSCI		2
JMP2	Jumper, for 16K EEPROM		LSCI		REF
JMP3	Jumper, for SC10		LSCI		REF
JMP4	Jumper, for A8		LSCI		REF
JMP5	Jumper, for Opt. 1	106-129	SAMT	TSW-120-04-06	4/20
JMP6	Jumper, for Opt. 2	102-129	SAMT	TSW-120-04-0G	REF
JJ1	Jump Jax for Opt. 1	106-131	SEAL	026-4810-00-0-252	2
JJ2	Jump Jax for Opt. 2	106-131	SEAL	026-4810-00-0-252	REF
R1	RES, 4.7K, 1/4W, 1%, MTF	103-306			3
R2	RES, 1K, 1/4W, 1%, MTF	103-265	COR	CDE RN55D-1K	1
R3	RES, 4.7K, 1/4W, 1%, MTF	103-306			REF
R4	RES, 4.7K, 1/4W, 1%, MTF	103-306			REF
R5	RES, 6.65K, 1/4W, 1%, MTF	103-324			1
R6	RES, 470Ω, 1/4W, 1%, MTF	103-240			2
R7	RES, 470Ω, 1/4W, 1%, MTF	103-240			REF
R8	RES, 8.25K, 1/4W, 1%, MTF	103-340			1
U1	IC, Microprocessor	104-510	INT	P8031AH	1*
U2	IC, 4-to-16 Decoder	104-277	NAT	DM74LS154	1*
U3	IC, 8 bit latch	104-528	INT	P8282	1*
U4	IC, EPROM, 64K (Program)	104-620	INT	D2764-4	1*
U5	IC, EEPROM, 16K (Curves) 64K	104-650	KICOR TBD	X2816AD 300 nsec	1*
U6	IC, 8 bit Multiplexer	104-310	NAT	DM81LS95	1*
U7	IC, Hex Buffer, Open Collector	104-210	NAT	DM7406	1*
U8	IC, Hex Buffer	104-207	NAT	DM74LS04	1*

Table 5-3. A1A2 - Microprocessor and Memory Card

LSCI Part Number 113-125, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
XU1	Socket, DIP, 40 Pin	106-507	AUG	540-AGIID	1
XU2	Socket, DIP, 24 Pin	106-505	AUG	524-AGIID	1
XU3	Socket, DIP, 20 Pin	106-504	AUG	520-AGIID	2
XU4	Socket, DIP, 28 Pin	106-506	AUG	528-AGIID	2
XU5	Socket, DIP, 28 Pin	106-506	AUG	528-AGIID	REF
XU6	Socket, DIP, 20 Pin	106-504	AUG	520-AGIID	REF
XU7	Socket, DIP, 14 Pin	106-502	AUG	514-AGIID	2
XU8	Socket, DIP, 14 Pin	106-502	AUG	514-AGIID	REF
Y1	Crystal, 5.000 MHz	103-990	MTRON	MP1 5.000 MHz	1

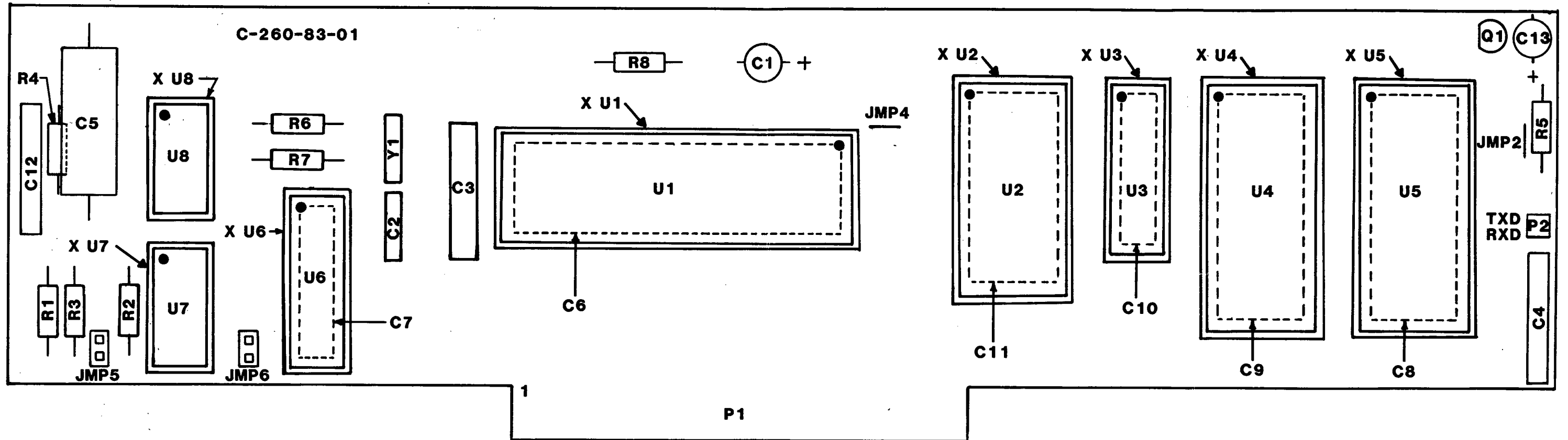


Figure 5-9. Component Layout
A1A2 - Microprocessor and Memory Card

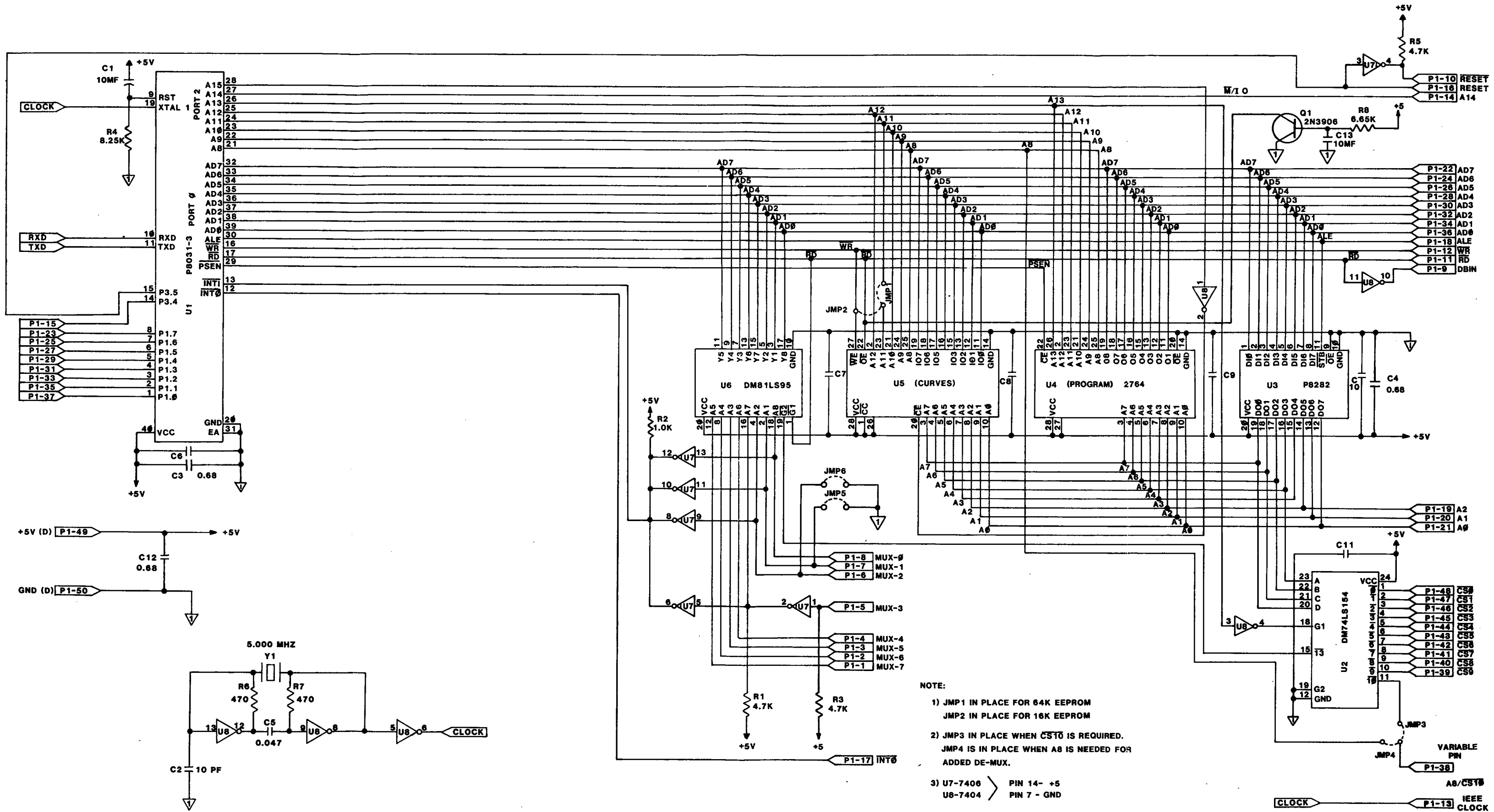


Figure 5-10. Schematic A1A2
- Microprocessor and Memory Card

Table 5-4. - A1A3 - Analog Input Card

LSCI Part Number 113-126

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1A3	Analog input card P.C. Board Artwork #: C-261-83-01D	111-044	LSCI	111-044	1
C1	CAP, MICA, 150PF, 500V	101-085	CDE	CD15CD151G03	1
C2	CAP, POLY, .0015MF, 100V	101-001	CDE	WMF1D15	1
C3	CAP, POLY, .33MF, 100V	101-025	PLSY	150.33K100FC	1
C4	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	3
C5	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	REF
C6	CAP, MICA, 330PF, 500V	101-094	CDE	CD15CD331G03	1
C7	CAP, TANT, 1.5MF, 10V	101-132	SPRG	150D155X9010A2	1
C8	CAP, POLY, 1.0MF, 100V	101-032	PLSY	150.1K100FC	REF
C9	CAP, MYLAR, 50PF, 500V	101-073	CDE	CD15ED500G03	1
C10	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	3
C11	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C12	CAP, POLY, .68MF, 100V	101-046	PLSY	160.68J100G	1
C13	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C14	CAP, MYLAR, 30PF, 500V	101-067	CDE	CD15ED300J03	1
CR1	DIODE, SIL, G.P.	102-062	FLD	IN459A	2*
CR2	DIODE, SIL, G.P.	102-062	FLD	IN459A	REF
JMP1	1/2" Wire Jumper, SIL		LSCI		1
JMP2	NOT PRESENT				
P2	6 Post Locking Conn.	106-142	MOL	2420-09-75-1061	1
R1	RES, MTF, 10K, 1%, $\frac{1}{4}W$	103-358			1
R2	RES, MTF, 1.54K, 1%, $\frac{1}{4}W$	103-272			1
R3	RES, MTF, 3.74K, 1%, $\frac{1}{4}W$	103-296			2
R4	POT, 5K	103-049	BOR	3059Y-1-502	2
R5	RES, MTF, 499K, 1%, $\frac{1}{4}W$	103-461			1
R6	RES, MTF, 442 Ω , 1%, $\frac{1}{4}W$	103-237			1
R7	Not Present				
R8	Not Present				
R9	Not Present				
R10	Not Present				
R11	POT, 20K	103-051			1
R12	RES, MTF, 150K, 1%, $\frac{1}{4}W$	103-431			1
R13	RES, MTF, 64.9 Ω , 1%, $\frac{1}{4}W$	103-214			1
R14	RES, MTF, 196 Ω , 1%, $\frac{1}{4}W$	103-225			1
R15	RES, MTF, 49.9K, 1%, $\frac{1}{4}W$	103-397			1
R16	RES, MTF, 301K, 1%, $\frac{1}{4}W$	103-448			1
R17	RES, MTF, 392 Ω , 1%, $\frac{1}{4}W$	103-234			3

Table 5-4. A1A3 - Analog Input Card

LSCI Part Number 113-126, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
R18	RES, MTF, 392Ω, 1%, 1/2W	103-234			REF
R19	RES, MTF, 4.75K, 1%, 1/2W	103-306			4
R20	RES, MTF, 4.75K, 1%, 1/2W	103-306			REF
R21	RES, MTF, 4.75K, 1%, 1/2W	103-306			REF
R22	RES, MTF, 392Ω, 1%, 1/2W	103-234			REF
R23	RES, MTF, 1.18K, 1%, 1/2W	103-267			1
R24	RES, MTF, 4.75K, 1%, 1/2W	103-306			REF
R25	RES, MTF, 100K, 1%, 1/2W	103-420			1
R26	RES, MTF, 3.74K, 1%, 1/2W	103-296			REF
R27	RES, MTF, 2K, 1%, 1/2W	103-278			1
R28	RES, MTF, 40.2K, 1%, 1/2W	103-388			1
R29	POT, 5K	103-049	BOR	3059Y-1-502	REF
U1	LIN, REF	102-043	NAT	LM399H	1*
U2	IC, LIN, OP AMP	104-005	NAT	LM308N	1*
U3	FET, P-CH ENH.	102-074	SIL	3N163	1*
U4	Not Present				
U5	IC, LIN, OP AMP	104-001	PMI	OP07EP	1*
U6	IC, INVERTER	104-207	NAT	74LS04	2*
U7	IC, INVERTER	104-207	NAT	74LS04	REF
U8	IC, A/D REF	104-460	ISL	ICL8068ACPD	1*
U9	IC, A/D CONVERTER	104-461	ISL	ICL7104-16CPL	1*
U10	IC, P-S SHIFT REG.	104-099	NAT	CD4021BCN	2*
U11	IC, P-S SHIFT REG.	104-099	NAT	CD4021BCN	REF
U12	IC, OPTO-COUPLER	104-350	HP	HCPL-2530	1*
U13	IC, OPTO-COUPLER	104-352	HP	6N135	1*
U14	IC, TIMER	104-051	ISL	ICM7555IPA	1*
XU2	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	5
XU4	Not Present				
XU5	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU6	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	3
XU7	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	REF
XU8	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	REF
XU9	SOCKET, IC, 40 PIN DIP	106-507	AUG	540-AGIID	1
XU10	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	2
XU11	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	REF
XU12	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU13	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU14	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF

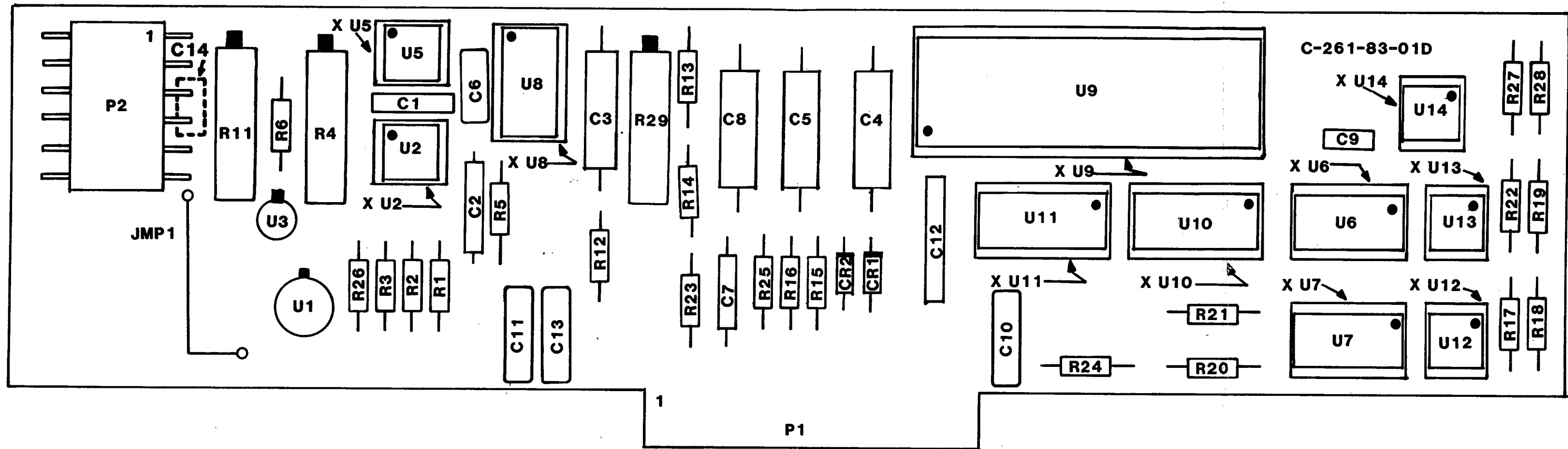


Figure 5-11.
Component Layout A1A3 - Analog Input Card

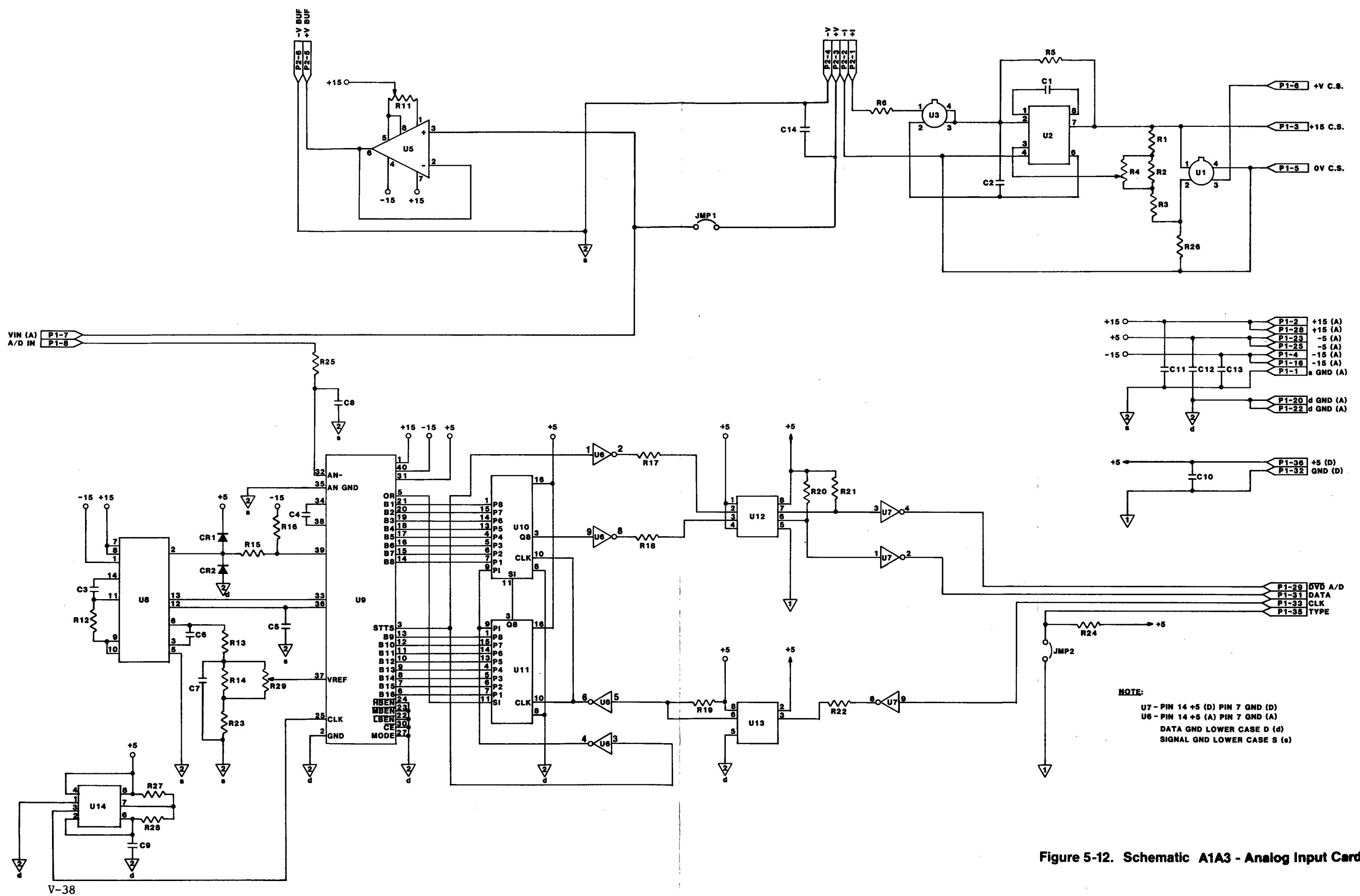


Figure 5-12. Schematic A1A3 - Analog Input Card

Table 5-5. A1A4 - Analog Control Card #1

LSCI Part Number 113-121

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
ALA4	Analog Control Card #1 P.C. Board Artwork #: C-265-83-01C	111-040	LSCI	111-040	1
C1	CAP, MYLR, .01MF, 100V	101-008	CDE	416P-10391	2
C2	CAP, POLY, 0.68MF, 100V	101-046	PLSY	160.68J100G	3
C3	CAP, POLY, 0.68MF, 100V	101-046	PLSY	160.68J100G	REF
C4	CAP, POLY, 0.68MF, 100V	101-046	PLSY	160.68J100G	REF
C5	CAP, MYLR, .01MF, 100V	101-008	CDE	416P-10391	REF
C6	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	8
C7	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C8	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C9	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C10	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C11	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C12	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C13	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
H1	Terminals	110-155	CBN	0-1026-01-02-01	2
P2	Two Pin Terminal	106-129	SAMT	TSW-120-04-G	1/10
R1	RES, MTF, 4.75K, 1%, $\frac{1}{2}W$	103-306			3
R2	RES, MTF, 4.75K, 1%, $\frac{1}{2}W$	103-306			REF
R3	RES, MTF, 4.75K, 1%, $\frac{1}{2}W$	103-306			REF
R4	POT, 100K	103-054	BOR	3059Y-1-104	1
R5	POT, 5K	103-049	BOR	3059Y-1-502	1
R6	RES, MTF, 649 Ω , 1%, $\frac{1}{2}W$	103-247			1
R7	RES, MTF, 174K, 1%, $\frac{1}{2}W$	103-435			2
R8	RES, MTF, 174K, 1%, $\frac{1}{2}W$	103-435			REF
R9	RES, MTF, 82.5K, 1%, $\frac{1}{2}W$	103-414			1
R10	RES, MTF, 3.92K, 1%, $\frac{1}{2}W$	103-298			1
R11	RES, MTF, 1M, 1%, $\frac{1}{2}W$	103-472			2
R12	RES, MTF, 3.09K, 1%, $\frac{1}{2}W$	103-289			1
R13	RES, MTF, 100K, 1%, $\frac{1}{2}W$	103-420			1
R14	RES, VISHAY, 100K, .01%	113-063	VISH	S102C	1 *
R15	RES, VISHAY, 100K, .01%	113-063	VISH	S102C	
R16	RES, MTF, 49.9K, 1%, $\frac{1}{2}W$	103-397			1
R17	RES, MTF, 1M, 1%, $\frac{1}{2}W$	103-472			REF
R18	RES, MTF, 392 Ω , 1%, $\frac{1}{2}W$	103-234			3
R19	RES, MTF, 392 Ω , 1%, $\frac{1}{2}W$	103-234			REF
R20	RES, MTF, 392 Ω , 1%, $\frac{1}{2}W$	103-234			REF
RN1	RES, NETWORK, 4.7K	103-103	BOR	4310R-101-RC	3
RN2	RES, NETWORK, 4.7K	103-103	BOR	4310R-101-RC	REF
RN3	RES, NETWORK, 4.7K	103-103	BOR	4310R-101-RC	REF

Table 5-5. A1A4 - Analog Control Card #1

LSCI Part Number 113-121, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
U1	IC, INVERTER	104-207	NAT	DM74LS04	2*
U2	IC, DAC	104-419	BB	DAC71-COB-V	1*
U3	IC, DISPLAY DRIVER	104-162	NAT	MM5451N	1*
U4	IC, DAC	104-408	ISL	AD7533LN	1*
U5	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	3*
U6	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U7	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U8	IC, INVERTER	104-207	NAT	DM74LS04	REF*
U9	IC, OPTO-COUPLER	104-350	HP	HCPL-2530	1*
U10	IC, OPTO-COUPLER	104-352	HP	6N135	1*
XU1	SOCKET, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	5
XU2	SOCKET, IC, DIP, 24 PIN	106-505	AUG	524-AGIID	1
XU3	SOCKET, IC, DIP, 40 PIN	106-507	AUG	540-AGIID	1
XU4	SOCKET, IC, DIP, 16 PIN	106-503	AUG	516-AGIID	1
XU5	SOCKET, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU6	SOCKET, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU7	SOCKET, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU8	SOCKET, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU9	SOCKET, IC, DIP, 8 PIN	106-501	AUG	508-AGIID	2
XU10	SOCKET, IC, DIP, 8 PIN	106-501	AUG	508-AGIID	REF

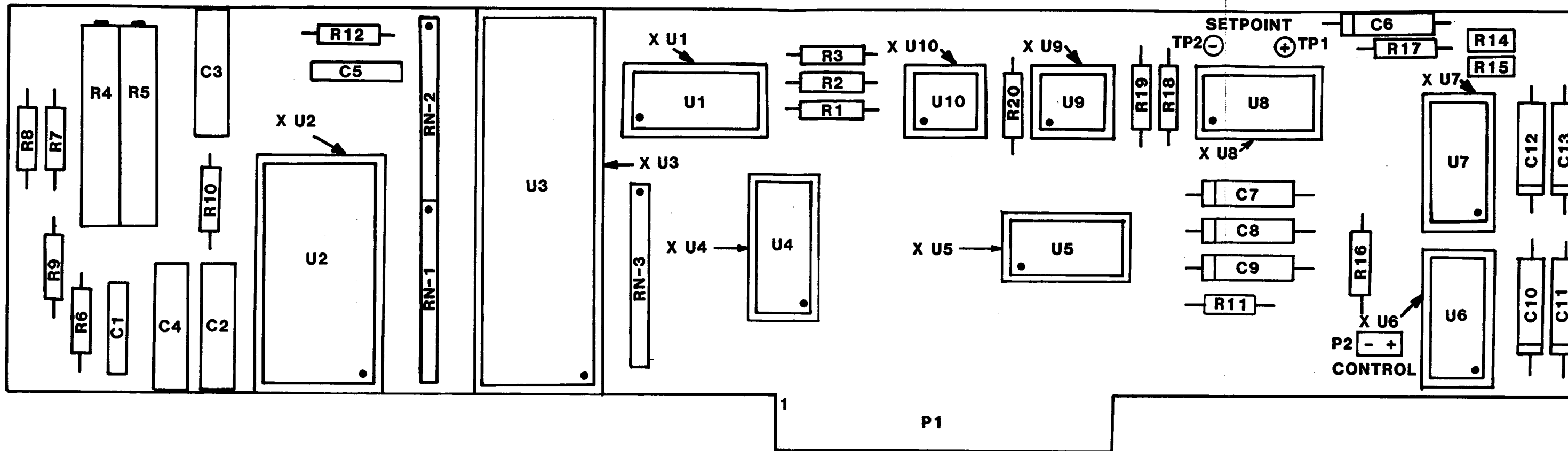


Figure 5-13.
Component Layout A1A4 - Analog Control Card #1

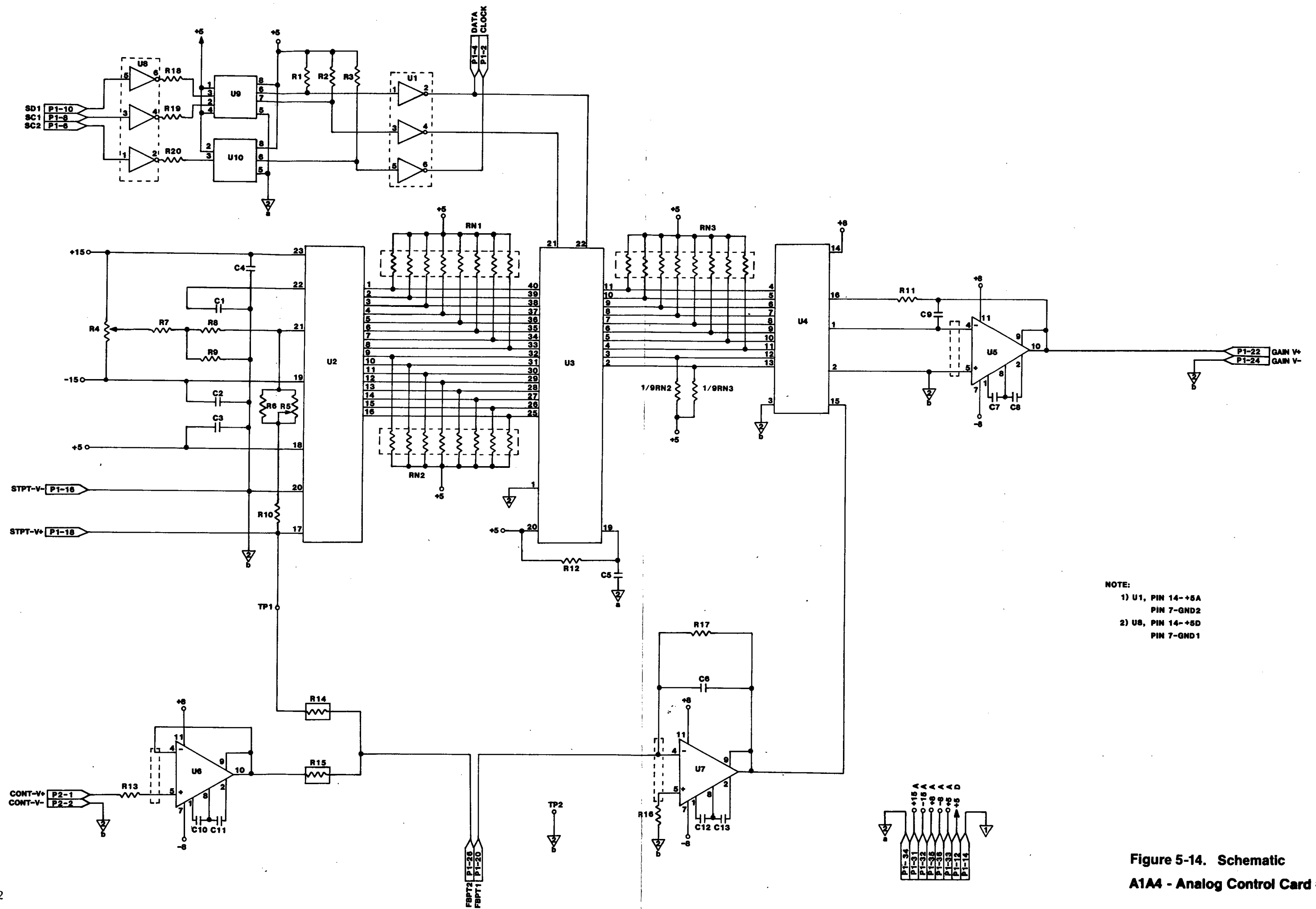


Figure 5-14. Schematic
A1A4 - Analog Control Card #1

Table 5-6. A1A5 - Analog Control Card #2

LSCI Part Number 113-122

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1A5	Analog Control Card #2 P.C. Board Artwork #: C-264-83-01A	111-041	LSCI	111-041	1
C1	CAP, POLY, .01MF, 100V	101-008	CDE	416P-10391	1
C2	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	15
C3	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C4	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C5	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C6	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C7	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C8	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C9	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C10	CAP, POLY, 1MF, 100V	101-032	PLSY	1501K100FC	2
C11	CAP, POLY, 1MF, 100V	101-032	PLSY	1501K100FC	REF
C12	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C13	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C14	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C15	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C16	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C17	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
C18	CAP, MYLR, .033MF, 100V	101-013	CDE	WMF1S33	REF
CR1	Diode, Silicon, G.P.	102-062	FLD	IN459A	3 *
CR2	Diode, Silicon, G.P.	102-062	FLD	IN459A	REF
CR3	Diode, Silicon, G.P.	102-062	FLD	IN459A	REF
H1	Terminals	110-155	CBN	0-1026-01-02-01	8
R1	RES, MTF, 3.09K, 1%, $\frac{1}{4}$ W	103-289			1
R2	RES, MTF, 49.9K, 1%, $\frac{1}{4}$ W	103-397			3
R3	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			8
R4	RES, MTF, 64.9 Ω , 1%, $\frac{1}{4}$ W	103-214			1
R5	RES, MTF, 499K, 1%, $\frac{1}{4}$ W	103-461			1
R6	RES, MTF, 10M, 10%, $\frac{1}{4}$ W	103-486			1
R7	RES, MTF, 49.9K, 1%, $\frac{1}{4}$ W	103-397			REF
R8	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			REF
R9	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			REF
R10	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			REF
R11	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			REF
R12	RES, MTF, 16.2K, 1%, $\frac{1}{4}$ W	103-364			1
R13	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			REF
R14	RES, MTF, 100K, 1%, $\frac{1}{4}$ W	103-420			REF
R15	RES, MTF, 49.9K, 1%, $\frac{1}{4}$ W	103-397			REF

Table 5-6. A1A5 - Analog Control Card #2

LSCI Part Number 113-122, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
RN1	RES, NETWORK, 4.75K	103-103	BOR	4310R-101-RC	3
RN2	RES, NETWORK, 4.75K	103-103	BOR	4310R-101-RC	REF
RN3	RES, NETWORK, 4.75K	103-103	BOR	4310R-101-RC	REF
U1	IC, Display Driver	104-162	NAT	MM5451N	1 *
U2	IC, DAC	104-404	ISL	AD7523JN	3 *
U3	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	7 *
U4	IC, DAC	104-404	ISL	AD7523JN	REF
U5	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U6	IC, DAC	104-404	ISL	AD7523JN	REF
U7	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U8	IC, S.S. Switch	104-076	HAR	HI-5043-5	1 *
U9	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U10	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U11	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
U12	IC, LIN, OP AMP	104-085	ISL	ICL7650CPD	REF
XU1	Socket, IC, DIP, 40 PIN	106-507	AUG	540-AGIID	1
XU2	Socket, IC, DIP, 16 PIN	106-503	AUG	516-AGIID	4
XU3	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	7
XU4	Socket, IC, DIP, 16 PIN	106-503	AUG	516-AGIID	REF
XU5	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU6	Socket, IC, DIP, 16 PIN	106-503	AUG	516-AGIID	REF
XU7	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU8	Socket, IC, DIP, 16 PIN	106-503	AUG	516-AGIID	REF
XU9	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU10	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU11	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF
XU12	Socket, IC, DIP, 14 PIN	106-502	AUG	514-AGIID	REF

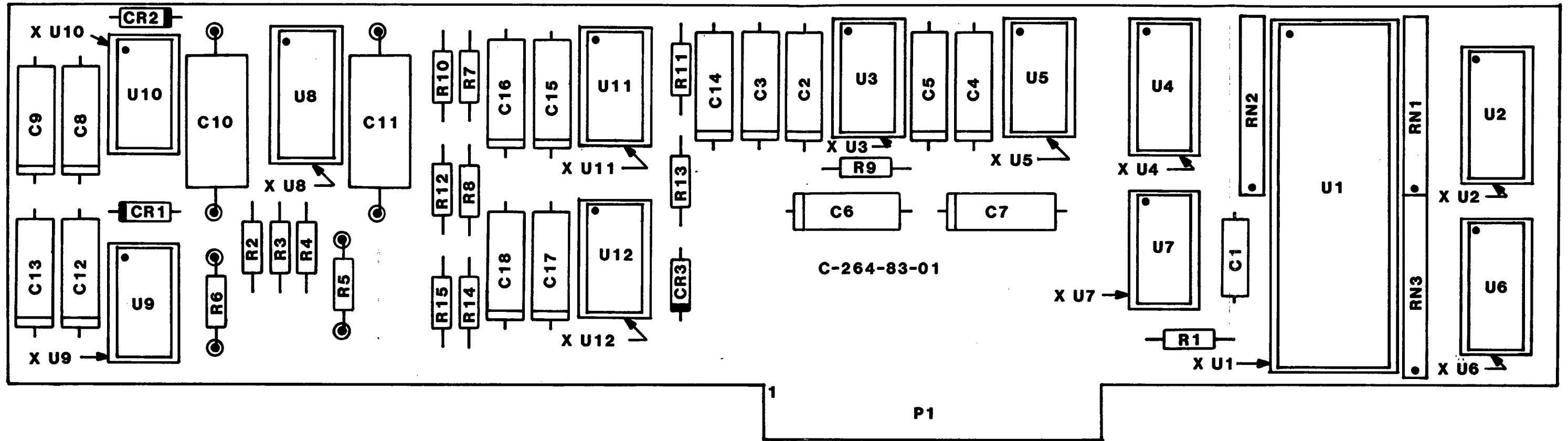


Figure 5-15. Component Layout
A1A5 - Analog Control Card #2

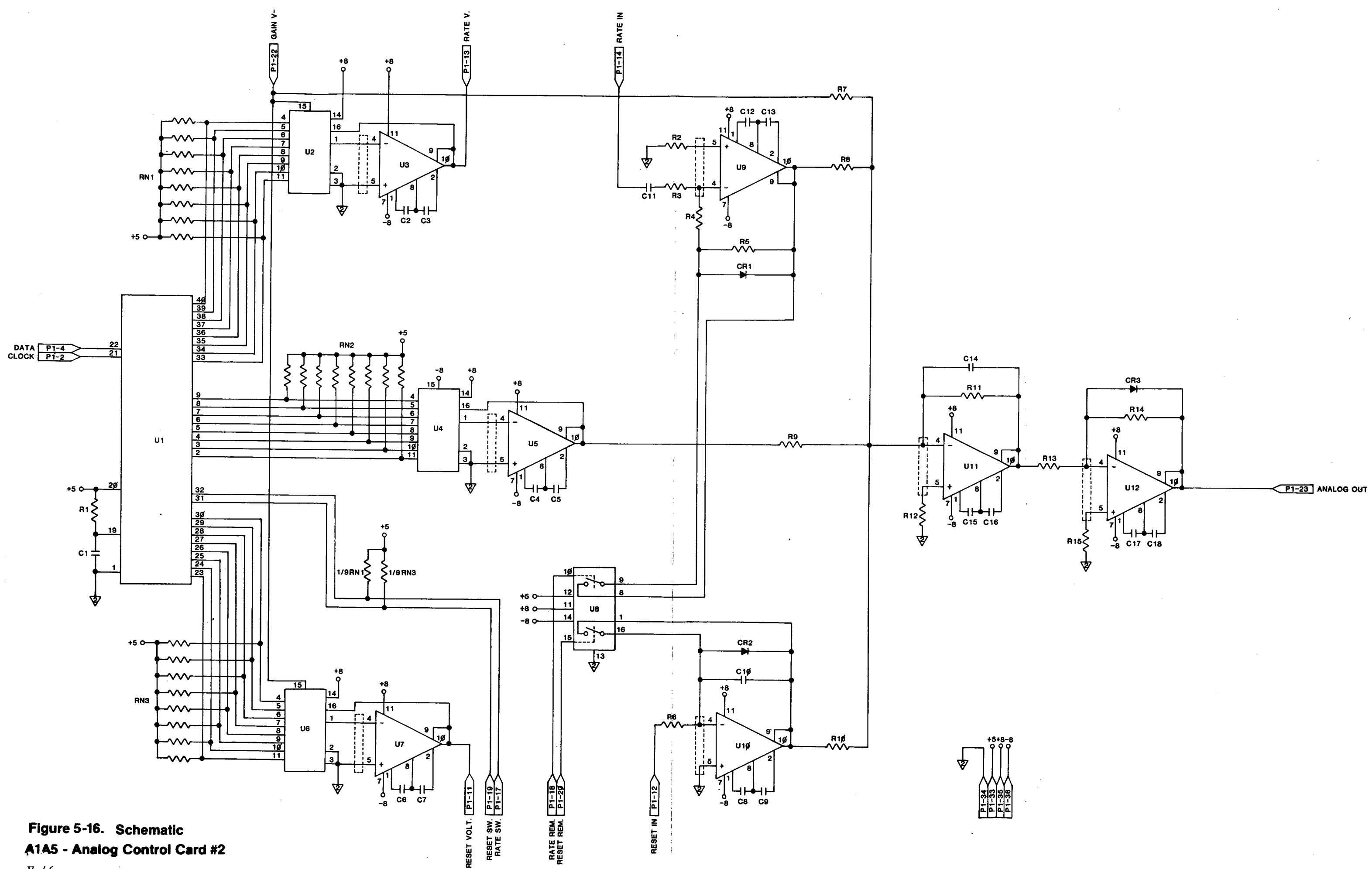


Figure 5-16. Schematic
A1A5 - Analog Control Card #2

Table 5-7. A2A1 - Display Board Assembly

LSCI Part Number 113-123

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A2A1	DRC-82C Display PCB Artwork #: D-219-83-01B	111-043	LSCI	111-043	1
DS1	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	21 *
DS2	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS3	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS4	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS5	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS6	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS7	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS8	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS9	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS10	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS11	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS12	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS13	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS14	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS15	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS16	LED, R, Sample - K	102-111	HP	5082-4494	20 *
DS17	LED, R, Sample - A	102-111	HP	5082-4494	REF
DS18	LED, R, Sample - V	102-111	HP	5082-4494	REF
DS19	LED, R, Sample - M	102-111	HP	5082-4494	REF
DS20	LED, R, Sample - B	102-111	HP	5082-4494	REF
DS21	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS22	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS23	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS24	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS25	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS26	Digit, .3" tall LED Display	102-124	HP	hp 5082-7611	REF
DS27	Bar Graph, 101 element	102-130	HP	HDSP-8820	1 *
DS28	LED, R, Set Point - V	102-111	HP	5082-4494	REF
DS29	LED, R, Set Point - K	102-111	HP	5082-4494	REF
DS30	LED, R, Control - V	102-111	HP	5082-4494	REF
DS31	LED, R, Control - K	102-111	HP	5082-4494	REF
DS32	LED, R, Control - M	102-111	HP	5082-4494	REF
DS33	LED, R, Control - B	102-111	HP	5082-4494	REF
DS34	LED, R, Control - A	102-111	HP	5082-4494	REF
DS35	LED, R, Heater Range - OFF	102-111	HP	5082-4494	REF
DS36	LED, R, Heater Range-1/10000	102-111	HP	5082-4494	REF
DS37	LED, R, Heater Range-1/1000	102-111	HP	5082-4494	REF
DS38	LED, R, Heater Range-1/100	102-111	HP	5082-4494	REF
DS39	LED, R, Heater Range-1/10	102-111	HP	5082-4494	REF
DS40	LED, R, Heater Range - MAX	102-111	HP	5082-4494	REF
DS41	LED, R, LOCAL	102-111	HP	5082-4494	REF
DS42	LED, R, REMOTE	102-111	HP	5082-4494	REF

Table 5-7. DRC-82 Display Board Assembly

LSCI Part Number 113-123, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
J1	Connector, 24 Pin, Male	106-218	AMP	1-87228-2	3
J2	Connector, 24 Pin, Male	106-218	AMP	1-87228-2	REF
J3	Connector, 10 Pin, Male	106-208	AMP	87228-5	1
J4	Connector, 24 Pin, Male	106-218	AMP	1-87228-2	REF
S1	Switch, LOCAL	105-651	ALPS	KEF 10901	28 *
S2	Switch, REMOTE	105-651	ALPS	KEF 10901	REF
S3	Switch, 9	105-651	ALPS	KEF 10901	REF
S4	Switch, 6	105-651	ALPS	KEF 10901	REF
S5	Switch, 3	105-651	ALPS	KEF 10901	REF
S6	Switch, ENTER	105-651	ALPS	KEF 10901	REF
S7	Switch, 8	105-651	ALPS	KEF 10901	REF
S8	Switch, 5	105-651	ALPS	KEF 10901	REF
S9	Switch, 2	105-651	ALPS	KEF 10901	REF
S10	Switch, 0	105-651	ALPS	KEF 10901	REF
S11	Switch, 7	105-651	ALPS	KEF 10901	REF
S12	Switch, 4	105-651	ALPS	KEF 10901	REF
S13	Switch, 1	105-651	ALPS	KEF 10901	REF
S14	Switch, .	105-651	ALPS	KEF 10901	REF
S15	Switch, CLEAR	105-651	ALPS	KEF 10901	REF
S16	Switch, ↑	105-651	ALPS	KEF 10901	REF
S17	Switch, ↓	105-651	ALPS	KEF 10901	REF
S18	Switch, MANUAL HTR. PWR.	105-651	ALPS	KEF 10901	REF
S19	Switch, GAIN	105-651	ALPS	KEF 10901	REF
S20	Switch, RATE	105-651	ALPS	KEF 10901	REF
S21	Switch, RESET	105-651	ALPS	KEF 10901	REF
S22	Switch, SET POINT	105-651	ALPS	KEF 10901	REF
S23	Switch, MAX	105-651	ALPS	KEF 10901	REF
S24	Switch, 1/10	105-651	ALPS	KEF 10901	REF
S25	Switch, 1/100	105-651	ALPS	KEF 10901	REF
S26	Switch, 1/1000	105-651	ALPS	KEF 10901	REF
S27	Switch, 1/10000	105-651	ALPS	KEF 10901	REF
S28	Switch, OFF	105-651	ALPS	KEF 10901	REF
XDS1	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	21
XDS2	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS3	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS4	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS5	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS6	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS7	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS8	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS9	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS10	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS11	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS12	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS13	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF

Table 5-7. A2A1 - Display Board Assembly
 LSCI Part Number 113-123, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
XDS14	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS15	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS21	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS22	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS23	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS24	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS25	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF
XDS26	Socket, DIP, 14 Pin	106-580	ARS	14-511-11	REF

Table 5-8. A2A2 - Display Board Driver Assembly

LSCI Part Number 113-124

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A2A2	DRC-82C Display Board Driver Assembly Artwork: D-220-83-01B	111-046	LSCI	111-046	1
C1	CAP, 1.5MF, 10V, TANT	101-132	SPRG	150D155X9010A2	2
C2	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	2
C3	CAP, 30pf	101-067	CDE	CD15-ED300J	2
C4	CAP, .1MF, 100V, POLY	101-042	PLSY	160.1K100G	3
C5	CAP, .1MF, 100V, POLY	101-042	PLSY	160.1K100G	REF
C6	CAP, .1MF, 100V, POLY	101-042	PLSY	160.1K100G	REF
C7	CAP, 1.5MF, 10V, TANT	101-132	SPRG	150D155X9010A2	REF
C8	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	REF
C9	CAP, 30PF	101-067	CDE	CD15-ED300J	REF
C10	CAP, .03MF, QPAK	101-126	RGRS	UQ40.03	3
C11	CAP, .03MF, QPAK	101-126	RGRS	UQ40.03	REF
C12	CAP, .03MF, QPAK	101-126	RGRS	UQ40.03	REF
JB	Connector, 20 Pin Header	106-244	TBA	609-2022M	1
JC	2 Cond. 28 ga. 4" Long		LSCI		1
J1	Connector, 24 Pin, Socket	106-216	AMP	1-86386-0	3
J2	Connector, 24 Pin, Socket	106-216	AMP	1-86396-0	REF
J3	Connector, 10 Pin, Socket	106-207	AMP	87141-1	1
J4	Connector, 24 Pin, Socket	106-216	AMP	1-86396-0	REF
R1	RES, 1M, 1/4W, 1%, MTF	103-472			1
R2	RES, 4.99 ohm, 1/4W, 1%, MTF	103-200			2
R3	RES, 22.1 ohm, 1/4W, 1%, MTF	103-208			1
R4	RES, 4.99 ohm, 1/4W, 1%, MTF	103-200			REF
R5	RES, 4.7K, 1/4W, 1%, MTF	103-306			2
R6	RES, 4.7K, 1/4W, 1%, MTF	103-306			REF
RN1	Resistor network, DIP, 22 ohm individual	103-181	BOR	4116R-001-220	3
RN2	Resistor Network, DIP, 22 ohm individual	103-181	BOR	4116R-001-330	REF
RN3	Resistor Network, DIP, 22 ohm individual	103-181	BOR	4116R-001-220	REF
Q1	XSTR, PNP	102-072	NAT	2N3906	10*
Q2	XSTR, PNP	102-072	NAT	2N3906	REF
Q3	XSTR, PNP	102-072	NAT	2N3906	REF
Q4	XSTR, PNP	102-072	NAT	2N3906	REF
Q5	XSTR, PNP	102-072	NAT	2N3906	REF
Q6	XSTR, PNP	102-072	NAT	2N3906	REF
Q7	XSTR, PNP	102-072	NAT	2N3906	REF
Q8	XSTR, PNP	102-072	NAT	2N3906	REF
Q9	XSTR, PNP	102-072	NAT	2N3906	REF
Q10	XSTR, PNP	102-072	NAT	2N3906	REF

Table 5-8. A2A2 - Display Board Driver Assembly

LSCI Part Number 113-124, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
U1	IC, Microprocessor	104-510	INT	P8031AH	1*
U2	IC EPROM 64K (PROGRAM)	104-620	INT	D2764-4	1*
U3	IC, 8 bit latch	104-528	INT	P8282	1*
U4	IC, Peripheral Interface	104-526	INT	P8279-5	2*
U5	IC, I/O Expander	104-522	INT	P8243	1*
U6	IC, 4-to-16 decoder	104-277	NAT	DM74LS154	1*
U7	IC, Multiplexer	104-280	NAT	74LS157	1*
U8	IC, 4-bit Counter	104-287	NAT	74LS161	1*
U9	IC, 3-to-8 decoder	104-261	NAT	74LS138	3*
U10	IC, transistor driver	104-160	SPRG	UDN-2585A	6*
U11	IC, transistor driver	104-160	SPRG	UDN-2585A	REF
U12	IC, transistor driver	104-160	SPRG	UDN-2585A	REF
U13	IC, transistor driver	104-160	SPRG	UDN-2585A	REF
U14	IC, Peripheral Interface	104-526	INT	P8279-5	REF
U15	IC, 3-to-8 decoder	104-261	NAT	74LS138	REF
U16	IC, 3-to-8 decoder	104-261	NAT	74LS138	REF
U17	IC, transistor driver	104-160	SPRG	UDN-2585A	REF
U18	IC, transistor driver	104-160	SPRG	UDN-2585A	REF
U19	IC, open collector inverter	104-210	NAT	7406N	4*
U20	IC, open collector inverter	104-210	NAT	7406N	REF
U21	IC, open collector inverter	104-210	NAT	7406N	REF
U22	IC, 4-to-10 decoder driver	104-270	NAT	74145	1*
U23	IC, open collector inverter	104-210	NAT	7406N	REF
U24	IC, Voltage Reference	102-011	MOT	LM7805ACT	1*
XU1	Socket, DIP,40 Pin	106-507	AUG	540-AGIID	3
XU2	Socket, DIP,28 Pin	106-506	AUG	528-AGIID	1
XU3	Socket, DIP,20 Pin	106-504	AUG	520-AGIID	1
XU4	Socket, DIP,40 Pin	106-507	AUG	540-AGIID	REF
XU5	Socket, DIP,24 Pin	106-505	AUG	524-AGIID	2
XU6	Socket, DIP,24 Pin	106-505	AUG	524-AGIID	REF
XU7	Socket, DIP,16 Pin	106-503	AUG	516-AGIID	6
XU8	Socket, DIP,16 Pin	106-503	AUG	516-AGIID	REF
XU9	Socket, DIP,16 Pin	106-503	AUG	516-AGIID	REF
XU14	Socket, DIP,40 Pin	106-507	AUG	540-AGIID	REF
XU15	Socket, DIP,16 Pin	106-503	AUG	516-AGIID	REF
XU16	Socket, DIP,16 Pin	106-503	AUG	516-AGIID	REF
XU22	Socket, DIP,16 Pin	106-503	AUG	516-AGIID	REF
XU24	XSTR Header	112-503	LSCI		1
Y1	Crystal, 5.000 MHz	103-990	MTRON	MP1 5.000 MHz	1

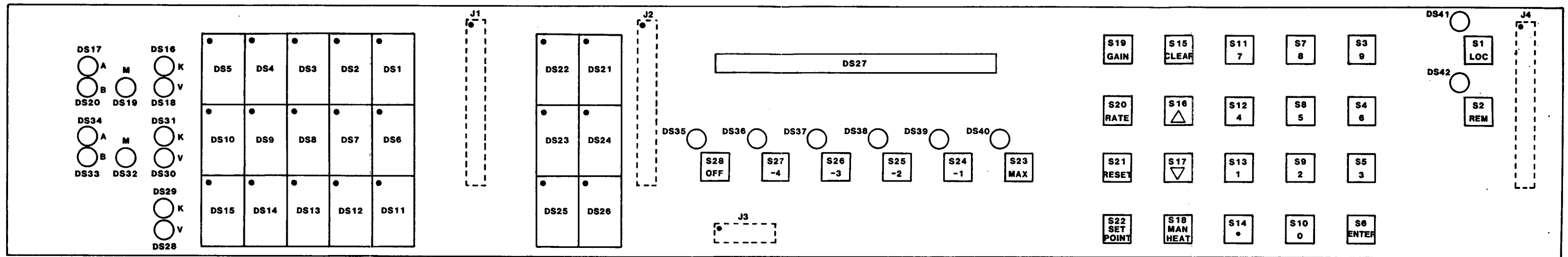


Figure 5-17. A2A1 - Display Board Assembly

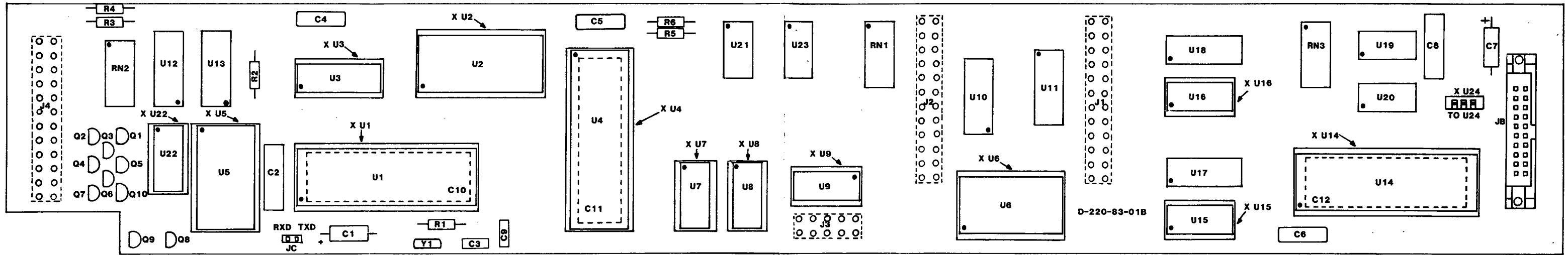


Figure 5-18. A2A2 -
Display Board Driver Assembly

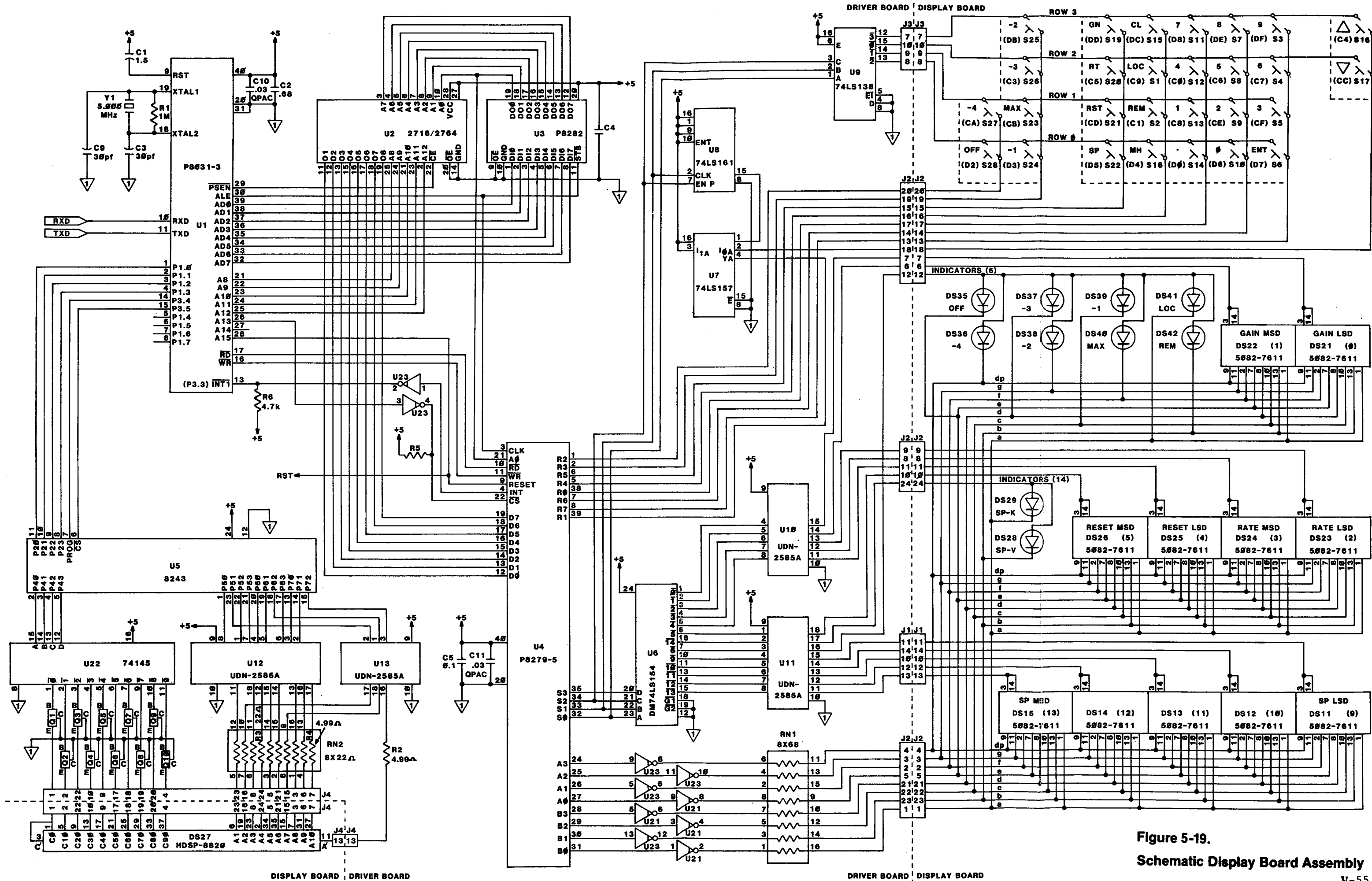


Figure 5-19.
Schematic Display Board Assembly

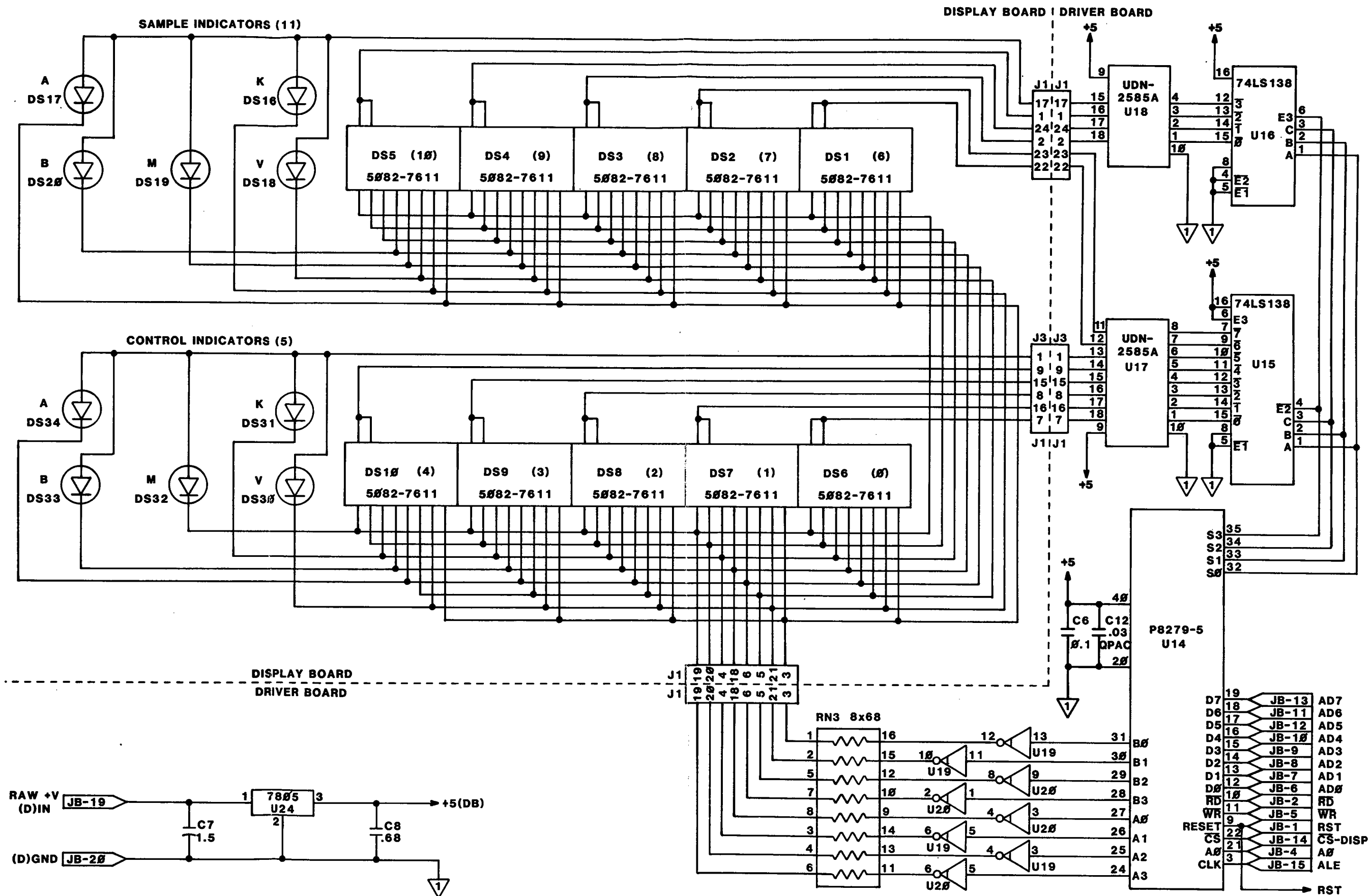


Figure 5-20. Schematic Display Board Assembly

Table 5-9. A3 - Front Panel Assembly

LSCI Part Number 108-039

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A2A1	DRC-82C Display Board Assembly	113-123	LSCI	113-123	1
A2A2	DRC-82C Display Board Driver Assembly	113-124	LSCI	113-124	1
A3A1	DRC-82C Front Sub-Panel Machined per Drawing #: D-217-83-01C	107-096	LSCI	107-096	1
A3A2	DRC-82C Front Panel Overlay	107-098	LSCI	107-098	1
H1	Screws, 4-40 x 3/4" PFHMS				8
H2	Standoffs, 4-40 hex O.D. x 3/8" long		CCRD	634A-5005-19	8
H3	Screws, 4-40 x 1/4" PHMS				8
H4	Fiber Washers, 4-40				17
H5	Nylon Washers, 6-32				8
H6	Standoff, 4-40 x 5/16"		CCRD	634A-5004-19	8
H7	Key Tops - Blue	105-671	LSCI	105-671	10
H8	Key Tops - L. Gray	105-676	LSCI	105-676	18

Table 5-10. AA - Rear Panel Assembly

LSCI Part Number 108-040

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A4A1	DRC-82C rear panel machined per Dwg. #: D-218-83-01C Silk Screened per Artwork #: 1101-83-01	107-097	LSCI	107-097	1
A4A2	Blank Cover Plate	107-019	LSCI	107-019	1
C1	CAP, MYLAR, 1.0MF, 100V	101-032	PLSY	1501K100FC	2
C2	CAP, MYLAR, 1.0MF, 100V	101-032	PLSY	1501K100FC	REF
C3	CAP, CER, .056MF, 100V	101-115	SPRG	225P56397WD3	1
F1	AC line cord plug/fuse holder/line volt. selector	106-025	COR-COM	6J4	1
J1	Connector, 5-pin female A-Input	106-011	AML	126-218	2
J2	Connector, 5-pin female B-Input	106-011	AML	126-218	REF
J3	Connector, 7-pin female monitor outputs	106-013	AML	126-198	1
J6	Connector, Heater + Out Grey Binding Post	106-002	EFJ	111-0113-001	1
J7	Connector, Heater - Out Black Binding Post	106-001	EFJ	111-0103-001	2
J8	Connector, Heater GND Black Binding Post	106-001	EFJ	111-0103-001	REF
H1	Screw, 6-32 x ¼ PFHMS				2
H2	Screw, 6-32 x ½ PPHMS				2
H3	Mica insulator for TO-3	110-023			1
S4	Switch, Control Selector	105-504	C&K	7301-M-Y-Z-Q	1
S5	Switch, Sample Selector	105-502	C&K	7101-M-Y-Z-Q	1
U19	Power Mosfet 100V P-CH	102-095	IR	IRF9130	1*
W1	Wire assembly from A input plug to input card	112-032	LSCI		2
	Connector:	106-140	MOL	2139-09-50-3061	1
	Terminals:	110-150	MOL	2878-08-50-0116	6
W2	Wire assembly from B input plug to input card	112-032			REF
	Connector:	106-140	MOL	2139-09-50-3061	1
	Terminals	110-150	MOL	2878-08-50-0116	6
XU19	Socket for TO-3	106-570	AUG	8080-1G1	1
W3	Wire Assembly from Control Switch S4 to Analog Control Card #1	112-035	LSCI	112-035	

Table 5-11. A5 - Main Transformer Assembly

LSCI Part Number 113-127

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
H1	Transformer Mounting Brackets Dwg. #: A-283-83-01	107-100	LSCI		2
P1	16-PIN TRANSFORMER RECEPTACLE 16-Terminals	106-108	AMP	1480438-0	1
		110-153	AMP	60617-1	16
P2	6-PIN RECEPTACLE 6-Terminals	106-140	MOL	2139-09-50-3061	1
		110-150	MOL	2878-08-50-0116	6
TX1	DRC-82C Main Transformer	109-019	LSCI	109-019	1

Table 5-12. A6 - Output Transformer Assembly
 LSCI Part Number 113-128

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
H1	Transformer Mounting Brackets Dwg #: A-283-83-01	107-100	LSCI		2
P1	12-Pin Transformer Receptacle 12-Terminals	106-106	AMP	1480-287-0	1
		110-153	AMP	60617-1	12
TX2	DRC-82C Output Transformer	109-020	LSCI	109-020	1

Table 5-13. A7 - Enclosure Assembly

LSCI Part Number 108-042

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
H1	#6-32 Fiber Washers				6
H2	Standoffs, #6-32 x 3/16"				6
H3	Screws, 4-40 x 1/4" FHMS				10
H4	Screws, 6-32 x 3/16" PHMS				7
H5	Screws, 6-32 x 3/16" FHMS				8
H6	Screws, 6-32 x 1/4" FHMS				4
H7	Screws, 6-32 x 5/8" FHMS				6
H8	#4-40 Keps Nuts				2
MP1	Front Rail - 17", Top Artwork: B-217-81-01, VAR 2	107-005	LSCI	107-005	2
MP2	Front Rail - 17", Bottom Artwork: B-217-81-01, VAR 2	107-005	LSCI	107-005	REF
MP3	Front Vertical - 3½", Left Artwork: B-215-81-01, VAR 1	107-007	LSCI	107-007	2
MP4	Front Vertical - 3½", Right Artwork: B-215-81-01, VAR 1	107-007	LSCI	107-007	REF
MP5	Back Vertical - 3½", Left Artwork: B-216-81-01, VAR 1	107-009	LSCI	107-009	2
MP6	Back Vertical - 3½", Right Artwork: B-216-81-01, VAR 1	107-009	LSCI	107-009	REF
MP7	Right Bottom Rail Artwork: B-328-84-01	107-001	LSCI	107-001	1
MP8	Right Top Rail Artwork: B-329-84-01	107-002	LSCI	107-002	1
MP9	Left Bottom Rail Artwork: B-330-84-01	107-003	LSCI	107-003	1
MP10	Left Top Rail Artwork: B-331-84-01	107-004	LSCI	107-004	1
MP11	Left Side Panel - 3½" Perforated Artwork: B-341-84-01, VAR 1	107-111	LSCI	107-111	2
MP12	Right Side Panel - 3½" Perforated Artwork: B-341-84-01, VAR 1	107-111	LSCI	107-111	REF

Table 5-14. A8 - Bottom Panel Assembly

LSCI Part Number 108-041

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
H1	Tilt Bail - 14"	110-112	BUC	MP40008-10	1
H2	Tinner Man Clips	110-110			6
H3	Screw, 6 x 32 x 1/2" FHMS				6
H4	Feet, Right Front		BUC		1
H5	Feet, Left Front		BUC		1
H6	Feet, Rear		BUC		2
MP1	Bottom Panel Artwork #: C-176-81-01-A Variation 7	107-103	LSCI	107-103	1

Table 5-15. A9 - Final Assembly

LSCI Part Number 1022

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1	Model DRC-82C Main Board Assembly	113-120	LSCI	113-120	1
A1A2	Microprocessor and Memory Card	113-125	LSCI	113-125	1
A1A3	Analog Input Card	113-126	LSCI	113-126	2
A1A4	Analog Control Card #1	113-121	LSCI	113-121	1
A1A5	Analog Control Card #2	113-122	LSCI	113-122	1
A3	DRC-82C Front Panel Assembly	108-039	LSCI	108-039	1
A4	DRC-82C Rear Panel Assembly	108-040	LSCI	108-040	1
A5	DRC-82C Main Transformer Assembly	109-111	LSCI	109-111	1
A6	DRC-82C Output Transformer Assembly	109-112	LSCI	113-128	1
A7	Enclosure Assembly	108-042	LSCI	108-042	1
A8	Bottom Cover Assembly	108-041	LSCI	108-041	1
B1	Blower, with Mounting Bracket	109-201	MCNL	V60TL-24VAC	1
F1	Fuse: 90-125 VAC, 2A 210-250 VAC, 1A	110-016 110-014	LIT BUS	313-002 MDL 1	1
H1	Nylon Washers 6-32				2
H2	#6 Solder Eyelet Terminal				1
H3	Screw, 4-40 x 1/4" PHMS				1
H4	Screw, 6-32 x 1/4" PHMS				11
H5	Screw, 6-32 x 1/4" FHMS				8
H6	Clips for mounting calibration cover Artwork #: A-288-83-01	110-135	LSCI	110-135	4
H7	Screw, 4-40 x 1/4" FHMS				4
H8	#6-32 Kep Nuts				6

Table 5-15. A9 - Model C-82 Final Assembly

LSCI Part Number 1022, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
MP1	Top Cover Artwork: C-176-81-01A, VAR 8	107-104	LSCI	107-104	1
MP2	Calibration Cover Artwork: D-247-83-01 Silk Screen #: 1102-84-01	107-105	LSCI	107-105	1
MP3	82C Connector Kit	113-131	LSCI	113-131	1
W1	Wiring Assembly for display board Cable: 20 conductor ribbon, 15" Header: 20 pin PCB	112-034	LSCI	112-034	1
		106-421	TBA	609-2030	2

Table 5-16. Cross Reference of Manufacturers

ALCO	Alco Electronic Products, Inc. 1551 Osgood Street N. Andover, MA 01845 (617) 685-4371	BKMN	Beckman Instruments, Inc. Helipot Division 2500 Harbor Blvd. Fullerton, CA 92634 (714) 871-4848
ALPS	Alps Electric U.S.A. 100 N. Centre Ave. Rockville Centre, NY 11570 (516) 766-3636	BOR	Bourns, Inc. 1200 Columbia Avenue Riverside, CA 92507 (714) 781-5050
AML	Amphenol North America 2875 South 25th Avenue Broadview, IL 60153 (312) 261-2020	BRDY	Burndy Corporation Richards Avenue Norwalk, CT 06852 (203) 838-4444
AMP	AMP, Inc. Harrisburg, PA 17105 (717) 564-0101	BUC	Buckeye Stamping Company 555 Marion Road Columbus, OH 43207 (614) 445-8433
ARS	Aries Electronics, Inc. 62A Trenton Avenue P.O. Box 130 Frenchtown, NJ 08825 (201) 996-6841	BUS	Bussman Div./McGraw Edison P.O. Box 14460 St. Louis, MO 63178 (314) 394-2877
AUG	Augat, Inc. 33 Perry Avenue P.O. Box 779 Attleboro, MA 02703 (617) 222-2202	CBN	Cambion 445 Concord Avenue Cambridge, MA 02238 (617) 491-5400
AV	Aavid Engineering, Inc. 30 Cook Ct. P.O. Box 614 Laconia, NH 03246 (603) 524-4443	CCRD	Concord Electronics 30 Great James Street New York, NY 10012 (212) 777-6571
BB	Burr-Brown Int. Airport Industrial Park P.O. Box 11400 Tuscon, AZ 85734 (602) 746-1111	CDE	Cornell-Dubilier 150 Avenue L Newark, NJ 07101
BEL	Belden Electronic Div. Belden Corporation Richmond, IN 47374	CENT	Centralab, Inc. 5855 N. Glen Park Road P.O. Box 2032 Milwaukee, WI 53201 (414) 228-7380
		COR	Corning Glass Works Corning, NY 14803

Table 5-16. Cross Reference of Manufacturers, cont'd.

CORCOM	Corcom, Inc. 1600 Winchester Road Libertyville, IL 60048 (312) 680-7400	INT	Intel Corporation 3065 Bowers Avenue Santa Clara, CA 95051
C&K	C&K Components, Inc. 15 Riverside Avenue Newton, MA 02158 (617) 964-6400	IR	International Rectifier Semiconductor Div. 233 Kansas Street El Segundo, CA 90245 (213) 772-2000
EAC	Electronic Applications Co. 4918 Santa Anita Avenue El Monte, CA 91734 (213) 442-3212	ISL	Intersil, Inc. 10710 N. Tantau Avenue Cupertino, CA 95014 (408) 996-5000
EFJ	E.F. Johnson Company Components Division 299 Tenth Ave., S.W. Waseca, MN 56093 (507) 835-6222	LIT	Littlefuse, Inc. 800 E. Northwest Highway Des Plaines, IL 60016 (312) 824-1188
FLD	Fairchild 464 Ellis Street Mountain View, CA 94042 (415) 962-5011	LSCI	Lake Shore Cryotronics, Inc. 64 East Walnut Street Westerville, OH 43081 (614) 891-2243
GYH	Grayhill, Inc. 561 Hillgrove Ave. LaGrange, IL 60525 (312) 354-1040	MCNL	Micronel U.S. 4716 S. Mission Road Fallbrook, CA 92028 (714) 723-9505
HAR	Harris Semiconductor Products Division Palm Bay Road P.O. Box 883 Melbourne, FL 32901 (305) 724-7000	MEP/EL	Mepco/Electra, Inc. 6071 St. Andrews Road Columbia, SC 29210 (803) 772-2500
HHS	H.H. Smith 812 Snediker Avenue Brooklyn, NY 11207 (212) 272-9400	MOL	Molex, Inc. 2222 Willington Court Lisle, IL 60532 (312) 969-4550
HP	Hewlett-Packard Components Division 640 Page Mill Road Palo Alto, CA 94304	MOT	Motorola Semiconductor Products, Inc. Box 20912 Phoenix, AZ 95036
		MTRON	M-Tron Industries, Inc. 1000 South Douglas Box 630 Yankton, SC 57078 (605) 665-9321

Table 5-16. Cross Reference of Manufacturers, cont'd.

NAT	National Semiconductor Corp. 2900 Semiconductor Drive Santa Clara, CA 95051 (408) 737-5000	SPTX	Supertex, Inc. 1225 Bordeau Drive Sunnyvale, CA 94086 (408) 744-0100
PAN	Panasonic Co. - ECD P.O. Box 1503 Secaucus, NJ 07094 (201) 348-5230	TBA	T&B Ansley Corporation 3208 Humbolt Street Los Angeles, CA 90031
PLSY	Plessey Capacitors, Inc. 5334 Sterling Center Drive Westlake Village, CA 91361 (213) 889-4120	TI	Texas Instruments, Inc. P.O. Box 22512 Dallas, TX 75265
PMI	Precision Monolithics, Inc. 1500 Space Park Drive Santa Clara, CA 95050 (408) 246-9222	TRMLY	Thermalloy, Inc. 2021 W. Valley View Box 340839 Dallas, TX 75234 (214) 243-4321
RGRS	Rogers Corp. Q/PAC Division 5750 E. McKellips Road Mesa, AZ 85205 (602) 830-3370	VISH	Vishay 63 Lincoln Highway Malvern, PA 19355 (215) 644-1300
SAMT	Samtec, Inc. 810 Progress Blvd. New Albany, IN 47150 (812) 944-6733	WKF	EG&G Wakefield Engrg. 60 Audubon Road Wakefield, MA 01880 (617) 245-5900
SEAL	Sealelectro Corp. 225 Hoyt Street Mamaroneck, NY 10543 (914) 698-5600	XICOR	Xicor, Inc. 851 Buckeye Court Malpitas, CA 95035 (408) 946-6920
SIL	Siliconix, Inc. 2201 Laurelwood Road Santa Clara, CA 95054 (408) 988-8000		
SPRG	Sprague Products Co. 551 Marshall Street N. Adams, MA 01247 (413) 664-4481		

APPENDIX A

Standard DRC Voltage-Temperature Characteristics

TEMP (K)	D CURVE		E1 CURVE		DT-470 CURVE 10	
	BP#	PROM VOLTAGE	BP#	PROM VOLTAGE	BP#	PROM VOLTAGE
1.4		2.5984	30	2.6591	29	1.69808
1.5		2.5958		2.6567		1.69674
1.6		2.5932		2.6542		1.69521
1.7		2.5906		2.6518		1.69355
1.8		2.5880		2.6494		1.69177
1.9		2.5854		2.6470		1.68987
2.0	30	2.5828	29	2.6446	28	1.68912
2.2		2.5735		2.6355		1.68352
2.4		2.5643		2.6265		1.67880
2.6		2.5551		2.6175		1.67376
2.8		2.5458		2.6084		1.66845
3.0	29	2.5366	28	2.5994		1.66292
3.2		2.5226		2.5868		1.65721
3.4		2.5086		2.5742		1.65134
3.6		2.4946		2.5616		1.64529
3.8		2.4807		2.5490	27	1.64112
4.0		2.4667	27	2.5364		1.63263
4.2		2.4527		2.5221		1.62602
4.4		2.4387		2.5077		1.61920
4.6		2.4247		2.4934		1.61220
4.8		2.4108		2.4791		1.60506
5.0		2.3968		2.4648		1.59782
5.5		2.3618		2.4290		
6.0		2.3269		2.3932		1.56027
6.5		2.2919		2.3574		1.54097
7.0		2.2570		2.3216		1.52166
7.5		2.2220		2.2858		1.50272
8.0		2.1871		2.2500		1.48443
8.5		2.1521		2.2142		1.46700
9.0	28	2.1172	26	2.1784	26	1.44850
9.5		2.0909		2.1516		1.43488
10.0		2.0646		2.1247		1.42013
11.0		2.0119		2.0708		1.39287
12.0		1.9592		2.0170	25	1.36687
13.0	27	1.9066	25	1.9632		1.34530
14.0		1.8338		1.9011		1.32412
15.0	26	1.7610		1.8390		1.30422
16.0		1.6984		1.7769		1.28527
17.0	25	1.6359		1.7148		1.26702
18.0		1.5646	24	1.6527		1.24928
19.0		1.4932		1.5724		1.23184
20.0		1.4219		1.4922	23	1.21555
21.0	24	1.3505		1.4120		1.19645
22.0		1.3006	23	1.3317		1.17705
23.0	23	1.2507		1.2837		1.15558
24.0		1.2114	22	1.2357	22	1.13598
25.0	22	1.1720	21	1.1877	21	1.12463
26.0	21	1.1486	20	1.1559	20	1.11896
27.0	20	1.1308	19	1.1365	19	1.11517
28.0	19	1.1190	18	1.1239	18	1.11202
29.0	18	1.1116	17	1.1150		1.10945
30.0	17	1.1058	16	1.1080		1.10702
32.0	16	1.0970	15	1.0981		1.10263
34.0	15	1.0902	14	1.0909		1.09864
36.0		1.0850	13	1.0848	16	1.09477
38.0		1.0798		1.0797		1.09131
40.0	14	1.0746	12	1.0746		1.08781
45.0		1.0633		1.0630		
50.0		1.0520		1.0515		1.07053
55.0	13	1.0407		1.0399		

APPENDIX A

Standard DRC Voltage-Temperature Characteristics, cont'd.

TEMP(K)	D CURVE		E1 CURVE		DT-470 CURVE 10	
	BP#	PROM VOLTAGE	BP#	PROM VOLTAGE	BP#	PROM VOLTAGE
60.0		1.0287	11	1.0284	14	1.05277
65.0		1.0166		1.0159		1.04353
70.0	12	1.0046		1.0035		1.03425
75.0		.99172	10	0.9911		1.02482
77.35				0.9849		
80.0		.97890		0.9780		1.01525
85.0		9.6609		0.9649		1.00552
90.0	11	.95327		0.9518		.99565
95.0		.93987		0.9388	12	.98574
100.0		.92647	9	0.9257		.97550
105.0		.91307		0.9122		.96524
110.0		.89966		0.8988		.95487
115.0		.88626		0.8853	11	.94455
120.0		.87286		0.8718		.93383
125.0		.85946		0.8584		.92317
130.0	10	.84606	8	0.8449		.91243
135.0		.83228		0.8311		.90161
140.0		.81850		0.8173	10	.89082
145.0		.80472		0.8035		.87976
150.0		.79094		0.7896		.86873
155.0		.77716		0.7758		.85764
160.0		.76338		0.7620		.84650
165.0		.74961		0.7482	9	.83541
170.0	9	.73582	7	0.7344		.82404
175.0		.72170		0.7202		.81274
180.0		.70757		0.7060		.80138
185.0		.69344		0.6918		.78999
190.0		.67931		0.6777		.77855
195.0		.66518		0.6635	8	.76717
200.0		.65105		0.6493		.75554
205.0		.63693		0.6351		.74398
210.0		.62280		0.6210		.73238
215.0		.60867		0.6068		.72075
220.0	8	.59455	6	0.5926		.70908
225.0		.58080		0.5789		.69737
230.0		.56707		0.5651	7	.68580
235.0		.55334		0.5514		.67387
240.0	7	.53960	5	0.5377		.66208
245.0		.52649		0.5246		.65026
250.0		.51337		0.5115		.63841
255.0		.50026		0.4984		.62654
260.0		.48714		0.4853		.61465
265.0	6	.47403	4	0.4722		.60273
270.0		.46057		0.4588		.59080
275.0		.44711		0.4454		.57886
280.0		.43365		0.4320	6	.56707
285.0	5	.42019	3	0.4186		.55492
290.0		.40613		0.4045		.54294
295.0		.39208		0.3904		.53093
300.0		.37802		0.3763		.51892
305.0	4	.36397	2	0.3622		.50689
310.0		.34940		0.3476		.49484
315.0		.33482		0.3330		.48278
320.0		.32025		0.3184		.47069
325.0		.30568		0.3038		.45858
330.0		.29111	1	0.2893		.44647
335.0		.27654				.43435
340.0		.26197			5	.42238
345.0	3	.24739				.41003
350.0		.23325				.39783
355.0		.21911				.38561
360.0		.20497				.37337
365.0	2	.19083				.36110
370.0		.17774				.34881
375.0		.16464				.33650
380.0	1	.15155				.32416

APPENDIX A

DIN Standard Curve for 100 ohm Platinum Sensors

BP#	TEMP (K)	RES (OHMS)
28	30.0	3.82000
	32.0	4.23481
27	34.0	4.68000
	36.0	5.14601
	38.0	5.65000
25	40.0	6.17000
24	42.0	6.72621
	44.0	7.31000
23	46.0	7.90899
	48.0	8.57000
22	50.0	9.24000
	52.0	9.92364
	54.0	10.66000
21	56.0	11.41000
	58.0	12.17995
20	60.0	12.99000
	65.0	15.01541
	70.0	17.11000
19	75.0	19.22302
	80.0	21.36000
18	85.0	23.52499
	90.0	25.67000
	95.0	27.82000
	100.0	29.95000
17	105.0	32.08087
	110.0	34.16000
16	115.0	36.25000
	120.0	38.34000
	125.0	40.42000
	130.0	42.49000
	135.0	44.57000
15	140.0	46.64758
	145.0	48.69000
	150.0	50.75000
	155.0	52.80000
	160.0	54.84000
15	165.0	56.88000
	170.0	58.92000
	175.0	60.96840
	180.0	62.98000

DIN Standard Curve for 100 ohm Platinum Sensors

BP#	TEMP (K)	RES (OHMS)
	185.0	65.00000
	190.0	67.01000
	195.0	69.02000
	200.0	71.03000
	205.0	73.03000
14	210.0	75.04385
	215.0	77.02000
	220.0	79.00000
	225.0	80.98000
	230.0	82.96000
	235.0	84.94000
	240.0	86.92000
	245.0	88.90000
	250.0	90.88000
	255.0	92.86000
13	260.0	94.83000
	265.0	96.80000
	270.0	98.78433
	275.0	100.72000
	280.0	102.67000
	285.0	104.62000
	290.0	106.57000
	295.0	108.51000
	300.0	110.45000
	305.0	112.39000
12	310.0	114.32000
	315.0	116.27003
	320.0	118.19000
	325.0	120.11000
	330.0	122.03000
	335.0	123.95000
	340.0	125.86000
	345.0	127.78000
	350.0	129.69000
11	355.0	131.61563
	360.0	133.50000
	365.0	135.40000
	370.0	137.31000
	375.0	139.20000
	380.0	141.09000

DIN Standard Curve for 100 ohm Platinum Sensors

BP#	TEMP (K)	RES (OHMS)
10	385.0	142.98000
	390.0	144.87000
	395.0	146.76000
	400.0	148.65215
	405.0	150.51000
	410.0	152.39000
	415.0	154.26000
	420.0	156.14000
	425.0	158.01000
	430.0	159.87000
9	435.0	161.73000
	440.0	163.59000
	445.0	165.46573
	450.0	167.30000
	455.0	169.15000
	460.0	171.00000
	465.0	172.84000
	470.0	174.68000
	475.0	176.52000
	480.0	178.36000
8	485.0	180.19000
	490.0	182.03545
	495.0	183.85000
	500.0	185.67000
	505.0	187.49000
	510.0	189.32000
	515.0	191.13000
	520.0	192.94000
	525.0	194.75000
	530.0	196.56000
7	535.0	198.38649
	540.0	200.17000
	545.0	201.96000
	550.0	203.75000
	555.0	205.54000
	560.0	207.33000
	565.0	209.12000
	570.0	210.91000
	575.0	212.69000
	580.0	214.46000

DIN Standard Curve for 100 ohm Platinum Sensors

BP#	TEMP (K)	RES (OHMS)
6	585.0	216.25553
	590.0	218.01000
	595.0	219.78000
	600.0	221.55000
	605.0	223.31000
5	610.0	225.07000
	615.0	226.83000
	620.0	228.59000
	625.0	230.34000
	630.0	232.10593
	635.0	233.84000
	640.0	235.57000
	645.0	237.31000
	650.0	239.06000
	655.0	240.79000
4	660.0	242.52000
	665.0	244.25000
	670.0	245.97000
	675.0	247.71350
	680.0	249.42000
	685.0	251.14000
	690.0	252.85000
	695.0	254.56000
	700.0	256.27000
	705.0	257.97000
3	710.0	259.68000
	715.0	261.39092
	720.0	263.07000
	725.0	264.77000
	730.0	266.46000
	735.0	268.14000
	740.0	269.83000
	745.0	271.51000
	750.0	273.19000
	755.0	274.87000
2	760.0	276.56633
	765.0	278.22000
	770.0	279.88000
	775.0	281.55000
	780.0	283.21000
1	785.0	284.87000
	790.0	286.53000
	795.0	288.18000
	800.0	289.83000

APPENDIX B

B-1. OPTIONS INSTALLED.

B-2. The Table given on page B-2 summarizes the Options Installed in this instrument. The DRC-81C/82C incorporates three option slots, each of which can accommodate one 8220-Series Option. The Table below lists the various Option Slot/8220-Series Option combinations.

<u>8220-Series Option</u>	<u>Option Slot</u>
8221 Loop interface	3
8222 BCD Interface	1
8223 RS-232C Interface	2
8225 Analog Output	1 or 2 (Position depends on the presence of either the Model 8222 or 8223 Interfaces)

B-3. A Model 8219 Platinum Sensor Option is installed in place of either the Input A or Input B standard Silicon Diode Analog Input card. If only one 8219 is ordered and its Input is not specified when ordered, it is installed in the Input B Position.

B-4. When an option is ordered for field installation, the customer should update the Options Installed Table to keep documentation current. A copy of the current Options Installed Table on file at Lake Shore Cryotronics, Inc. is included when any option is shipped for field installation. Any discrepancy should be brought to the attention of an authorized representative.

B-5. CURVE TABLE INFORMATION.

B-6. The Tables given on page B-4 give the Precision Option Table as well as the Curve Number -vs- Position # Correlation Table.

B-7. The Precision Option Table summarizes the Curve # (00-15 decimal), the Number of Lines (or Voltage/Temperature points) per Curve, an internal starting address in hexadecimal and the 6 character description which is the last six characters of the 18 character information line. Curves 00-03 are the fixed standard curves with curves 04-15 being the DRC-Precision Option or user generated curve locations. The Number of Lines given includes the 0 temperature and 0 voltage points.

APPENDIX B

Table B-1. Options Installed Table

Options Installed In DRC-82C	Serial Number _____
Microprocessor Card Installed:	<input type="checkbox"/> Standard (113-125) <input type="checkbox"/> 053 Update Kit (113-125B)
Option Slot 1:	<input type="checkbox"/> 8225 Analog Output <input type="checkbox"/> Other _____ <input type="checkbox"/> None
Option Slot 2:	<input type="checkbox"/> 8223 RS-232C Interface <input type="checkbox"/> 8225 Analog Output <input type="checkbox"/> Other _____ <input type="checkbox"/> None
Input A:	<input type="checkbox"/> 8210 <input type="checkbox"/> 8211 <input type="checkbox"/> 8218C <input type="checkbox"/> 8219 <input type="checkbox"/> Other _____
Input B:	<input type="checkbox"/> 8210 <input type="checkbox"/> 8211 <input type="checkbox"/> 8218C <input type="checkbox"/> 8219 <input type="checkbox"/> Other _____

B-8. The Curve Table can be considered a data file and can be accessed in one of two ways; either by directly calling up the curve through the SENSOR ID switches or by inputting a Multiple Position. Table B-3 gives the relationship between the switch 4-8 settings of the SENSOR ID and the Curve # selected for directly calling up a curve. For example, if there is a precision option curve # 04 and that curve is to be used with the sensor in Input A, the Sensor A-ID switches 4-8 should be set to XXX00100. If a curve is called for on the SENSOR ID switches and that curve is not present in the unit, the default curve is 00 for Diodes and 03 for inputs that have an 8219 option installed. In addition, if a curve is selected and its temperature coefficient does not match that of the sensor input curve (i.e., a positive temp. co. curve specified for a negative temp. co. input card or vice versa), then the default curve is 00 for a negative temp. co. input card and 03 for an 8219 input card.

B-9. The Multiple Position input can also be used to call up a Curve Table. The Curve Number -vs- Position # Correlation Table shows the Multiple Position combinations and the Curve # associated with that position for the A and B Inputs. When the Multiple Position switch (#4) of the Sensor A or B ID is activated (1 or closed), the instrument first looks to the REMOTE SENSOR ID input connector for a remote input from either the Model 8084 Sensor Scanner or the SW-10A 10-Sensor Selector Switch. If the position is 0 (or the connection is left open), the unit looks at switches 5-8 of the SENSOR ID for a position input. Table B-4 gives the Remote Sensor ID input and the SENSOR ID switches 4-8 combinations for the given remote positions. (Note: The 8084 and SW-10A go up to position 10 or A, only.) The Curve Number -vs- Position # Correlation Table gives the Curve # addressed when Remote Positions A0-AF and B0-BF are input. (Note: This table can be modified using the XAC=N₁N₂* or XBC=N₁N₂* commands as outlined in Section 3-109.)

B-10. When a DRC-Precision Option is generated, two sheets of data are included which outline the data stored in the instrument curve E²PROM. The first sheet contains general information for the sensor; its Model, Serial Number, Calibration Current and Calibration Run Number. This sheet also includes the linearized break point table for the calibrated sensor. Included is the BP# (or Voltage/Temperature line of the curve), TEMP in K, VOLTS in V and the difference between the calibrated temperature and corrected linearized Precision Option temperature. This difference, or Maximum Allowable Error is specified for the DRC-Precision Option and DT-500 Series Silicon Diodes at ± 0.1K or better. The error is typically better than that and is indicated above the table. (Note: Some DRC-Precision Options for sensor types other than DT-500 Series Silicon Diodes have Maximum Allowable Errors above ± 0.1K due to sensitivity differences in the sensor types.) The second sheet summarizes the Voltage -vs- Temperature points that comprise the curve. It should be noted that the 0K and 0V lines are not present in this table. Therefore, a Precision Option curve that indicates 29 Breakpoints actually has 31, including the end points of 0K and 0V.

APPENDIX B

Table B-2. Curve Table Information

Unit _____
 S/N _____

Precision Option Table

<u>Curve #</u>	<u># of Lines</u>	<u>Address</u>	<u>Description</u>
00	31	1D40	DRC-D
01	31	1DF0	DRC-E1
02	31	1EA0	CRV 10
03	31	1F50	DIN-PT
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Curve Number -vs- Position # Correlation Table

<u>Input A</u>		<u>Input B</u>	
<u>Position</u>	<u>Curve #</u>	<u>Position</u>	<u>Curve #</u>
A0	_____	B0	_____
A1	_____	B1	_____
A2	_____	B2	_____
A3	_____	B3	_____
A4	_____	B4	_____
A5	_____	B5	_____
A6	_____	B6	_____
A7	_____	B7	_____
A8	_____	B8	_____
A9	_____	B9	_____
AA (10)	_____	BA (10)	_____
AB (11)	_____	BB (11)	_____
AC (12)	_____	BC (12)	_____
AD (13)	_____	BD (13)	_____
AE (14)	_____	BE (14)	_____
AF (15)	_____	BF (15)	_____

B-11. PRECISION OPTION AND USER GENERATED CURVES

B-12. There are two distinctly different curve formats used in the DRC-82C. The curves to be used with non - 8218C inputs can be either Piecewise-Linear or Lagrangian format while 8218C inputs require a Lagrangian format. The advantage of the Lagrangian format is the tremendous increase in accuracy without a dramatic increase in the number of points required. The standard curves for the diode and platinum sensors given in Appendix A were generated using the Piecewise-Linear method. A Lagrangian curve is similar to the Piecewise-Linear format in that the voltage (or Log R) is in ascending order. The limits are up to 6 volts or 99999 ohms (4.99999 in Log) and Kelvin up to 399.9 (or 799.9 for platinum sensors).

B-13. Generating an optimized curve for use with the unit is a highly involved process. The quality of the precision option depends on the accuracy of the calibration data used to generate it. Data of questionable accuracy is useless, no matter how much care is devoted to preparing it for programming into the temperature controller. LSCI's temperature sensor calibration facility provides measurements which are at least as good as the conservative accuracy specifications published in the data sheet "Low Temperature Calibration Service" (Table II: Accuracy of Lake Shore Calibrations), and are based on carefully maintained temperature and resistance standards periodically calibrated by the National Bureau of Standards or by Great Britain's National Physical Laboratory. Note that LSCI's accuracy specifications are estimated maximum deviations from the IPTS-68 and EPT-76 temperature scales, not just from the working standards used during the calibration.

B-14. The preparation of the calibration data for the precision option begins when the sensor's calibration report is generated. Smoothed values of temperature and resistance (or voltage for diodes) are produced by fitting polynomials to the data, and these values are stored in a computer data file. From this data a set of interpolated values is generated using evenly spaced temperature increments. A subset of these points is selected by a computer program which checks the interpolation error over each interval between selected points, using the same algorithm for computing temperature from resistance (Lagrangian interpolation) that is used by the temperature controller. The final set of breakpoints selected is the minimum number of points which will keep the interpolation error below some pre-selected value (usually 5 millikelvin for germanium or carbon-glass resistance sensors). The sensor identification and breakpoints data are then stored in another computer data file to be transferred to the temperature controller's curve PROM using a different computer program.

B-15. The Lagrangian interpolation method used in the tempera-

APPENDIX B

Table B-3.

Sensor ID Switch (1)					Curve #
4(2)	5	6	7	8	
0	0	0	0	0	00
0	0	0	0	1	01
0	0	0	1	0	02
0	0	0	1	1	03
0	0	1	0	0	04
0	0	1	0	1	05
0	0	1	1	0	06
0	0	1	1	1	07
0	1	0	0	0	08
0	1	0	0	1	09
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15

Notes: (1) Open is indicated as 0 and closed as 1 on Back panel of Unit
 (2) The Multiple Position switch is 0 (open)

Table B-4.

Remote Sensor ID Pins					Remote Position
ID Switch 4	10	8	6	4	
or Sensor ID Switches (1)					
4(2)	5	6	7	8	
1	0	0	0	0	0
1	0	0	0	1	1
1	0	0	1	0	2
1	0	0	1	1	3
1	0	1	0	0	4
1	0	1	0	1	5
1	0	1	1	0	6
1	0	1	1	1	7
1	1	0	0	0	8
1	1	0	0	1	9
1	1	0	1	0	A (3)
1	1	0	1	1	B
1	1	1	0	0	C
1	1	1	0	1	D
1	1	1	1	0	E
1	1	1	1	1	F

Notes: (1) Open is indicated as 0 and closed as 1 on Back panel of Unit
 (2) The Multiple Position Switch is 1 (closed)
 (3) The 8084 or SW-10A go through position 10 (A)

ture controller uses four of the breakpoints to generate a cubic equation for computing temperature from measured resistance. Since this is a different cubic equation in each interval over the sensor's calibration range, this is equivalent to using a single equation of order one less than the number of breakpoints over the entire calibration range.

B-16. An example of a Piecewise-Linear and Lagrangian DRC-Precision Option curve is given at the end of this appendix. Included is the tabular array for the curve and the typical format for the curve to be loaded into the unit using the XC command. In order for the unit to recognize the curve as Lagrangian, the first character of the 18 character information line must be an 'L'.

B-17. When the XC command is used the unit adds the curve to the Precision Option Table and takes the last 6 characters of the 18 character information line as a summary of data. On Precision Options generated by Lake Shore these last 6 characters are typically the device serial numbers. If a curve is entered using XC and a curve already exists by that number, the original file is deleted, the curve data is repacked (or shuffled to have the earliest entry first in the file), and the new curve stored. Do not enter the 0 V and 0 K lines. The unit automatically generates a 0.00000 V, 000.0 K line for positive temperature coefficient sensors and 0.00000 V, 499.9 K line for negative temperature coefficient sensors as the first line. The unit also stores the last line as 6.55360 V, 999.9 K and 6.55360 V, 499.9 K for the two temperature coefficients respectively. The temperature coefficient as well as the determination of the first and last breakpoints is made from the data entered.

XC04,NDT-500-CU D46537,0.37939,300.0,0.43460,280.0,0.48787,260.0,0.5272
4,245.0,0.56777,230.0,0.62368,210.0,0.70854,180.0,0.79201,150.0,0.86017,125.0,0.
92703,100.0,0.97926,080.0,1.00444,070.0,1.02872,060.0,1.05635,048.0,1.06983,042.
0,1.08194,037.0,1.09047,034.0,1.09761,032.0,1.10198,031.0,1.10711,030.0,1.11354,
029.0,1.12183,028.0,1.13343,027.0,1.15081,026.0,1.17722,025.0,1.21452,024.0,1.25
778,023.0,1.31195,022.0,1.62236,017.5,1.74724,015.5,1.88823,013.5,2.11305,009.5,
2.37899,005.6,2.51245,003.7,2.57706,002.4,2.59996,001.6,2.60286,001.4*

Calibration Run No.: 1033

Sensor Type: DT-500-CU

Serial No.: D46537

BP#	Temp. (K)	Voltage
1	300.0	.37939
2	280.0	.43460
3	260.0	.48787
4	245.0	.52724
5	230.0	.56777
6	210.0	.62368
7	180.0	.70854
8	150.0	.79201
9	125.0	.86017
10	100.0	.92703
11	80.0	.97926
12	70.0	1.00444
13	60.0	1.02872
14	48.0	1.05635
15	42.0	1.06983
16	37.0	1.08194
17	34.0	1.09047
18	32.0	1.09761
19	31.0	1.10198
20	30.0	1.10711
21	29.0	1.11354
22	28.0	1.12183
23	27.0	1.13343
24	26.0	1.15081
25	25.0	1.17722
26	24.0	1.21452
27	23.0	1.25778
28	22.0	1.31195
29	17.5	1.62236
30	15.5	1.74724
31	13.5	1.88823
32	9.5	2.11305
33	5.6	2.37899
34	3.7	2.51245
35	2.4	2.57706
36	1.6	2.59996
37	1.4	2.60286
-1	0.0	0.00000

Breakpoints for DT-500-CU Device - Serial No. D46537

BP No.	Temp.(K)	Voltage(decimal)	(2/3)Voltage(decimal)
37	1.4	2.60286	1.73524
36	1.6	2.59996	1.73331
35	2.4	2.57706	1.71804
34	3.7	2.51245	1.67496
33	5.6	2.37899	1.58599
32	9.5	2.11305	1.40870
31	13.5	1.88823	1.25882
30	15.5	1.74724	1.16483
29	17.5	1.62236	1.08157
28	22.0	1.31195	.87463
27	23.0	1.25778	.83852
26	24.0	1.21452	.80968
25	25.0	1.17722	.78481
24	26.0	1.15081	.76720
23	27.0	1.13343	.75562
22	28.0	1.12183	.74788
21	29.0	1.11354	.74236
20	30.0	1.10711	.73807
19	31.0	1.10198	.73465
18	32.0	1.09761	.73174
17	34.0	1.09047	.72698
16	37.0	1.08194	.72129
15	42.0	1.06983	.71322
14	48.0	1.05635	.70423
13	60.0	1.02872	.68581
12	70.0	1.00444	.66963
11	80.0	.97926	.65284
10	100.0	.92703	.61802
9	125.0	.86017	.57344
8	150.0	.79201	.52801
7	180.0	.70854	.47236
6	210.0	.62368	.41579
5	230.0	.56777	.37852
4	245.0	.52724	.35150
3	260.0	.48787	.32525
2	280.0	.43460	.28973
1	300.0	.37939	.25293

Breakpoint Information for DT-500-CU Device - Serial No. D46537
 From Calibration Run Number 1033

Upper Temperature Limit and Maximum Allowable Error:
 300.0 Kelvin ± .050

BP#	Temp. (K)	Voltage	T(Cal)-T(PROM)	
37	1.4	2.60286	.006	
	1.5	2.60119	-.012	
36	1.6	2.59996	-.037	
	1.7	2.59698	-.005	
	1.8	2.59456	.013	
	1.9	2.59193	.020	
	2.0	2.58908	.019	
	2.1	2.58599	.011	
	2.2	2.58267	-.003	
	2.3	2.57912	-.022	
	35	2.4	2.57706	-.044
		2.5	2.57132	-.019
2.6		2.56709	-.001	
2.7		2.56265	.011	
2.8		2.55802	.018	
2.9		2.55322	.021	
3.0		2.54826	.020	
3.1		2.54315	.017	
3.2		2.53790	.011	
3.3		2.53251	.003	
34	3.4	2.52700	-.006	
	3.5	2.52135	-.018	
	3.6	2.51557	-.031	
	3.7	2.51245	-.047	
	3.8	2.50351	-.031	
	3.9	2.49729	-.018	
	4.0	2.49099	-.006	
	4.2	2.47823	.014	
	4.4	2.46506	.026	
	4.6	2.45164	.035	
33	4.8	2.43795	.039	
	5.0	2.42411	.042	
	5.2	2.41013	.042	
	5.4	2.39600	.040	
	5.6	2.37899	.038	
	5.8	2.36736	.028	
	6.0	2.35292	.017	
	6.5	2.31688	-.010	
	7.0	2.28123	-.032	
	7.5	2.24620	-.046	
32	8.0	2.21194	-.049	
	8.5	2.17851	-.041	
	9.0	2.14609	-.016	
	9.5	2.11305	.031	
	10.0	2.08513	.003	

Breakpoint Information for DT-500-CU Device - Serial No. D46537
 From Calibration Run Number 1033

Upper Temperature Limit and Maximum Allowable Error:
 300.0 Kelvin ± .050

BP#	Temp. (K)	Voltage	T(Cal)-T(PROM)
	10.5	2.05603	-.014
	11.0	2.02735	-.024
	11.5	1.99968	-.017
	12.0	1.97245	-.001
	12.5	1.94437	-.001
	13.0	1.91556	-.013
31	13.5	1.88823	-.044
	14.0	1.85375	.012
	14.5	1.82057	.041
	15.0	1.78560	.043
30	15.5	1.74724	.035
	16.0	1.71480	-.018
	16.5	1.68260	-.035
	17.0	1.65167	-.031
29	17.5	1.62236	-.026
	18.0	1.58913	.020
	18.5	1.55574	.034
	19.0	1.51985	.013
	19.5	1.48329	-.015
	20.0	1.44794	-.028
	21.0	1.37875	-.031
28	22.0	1.31195	-0.000
27	23.0	1.25778	-0.000
26	24.0	1.21452	-0.000
25	25.0	1.17722	-0.000
24	26.0	1.15081	-0.000
23	27.0	1.13343	-0.000
22	28.0	1.12183	-0.000
21	29.0	1.11354	0.000
20	30.0	1.10711	-0.000
19	31.0	1.10198	0.000
18	32.0	1.09761	.019
	33.0	1.09389	-.045
17	34.0	1.09047	.028
	35.0	1.08753	-.034
	36.0	1.08471	-.025
16	37.0	1.08194	.041
	38.0	1.07948	-.012
	39.0	1.07701	-.034
	40.0	1.07459	-.032
15	42.0	1.06983	.025
	44.0	1.06529	-.019
	46.0	1.06075	-.038
14	48.0	1.05635	-.047
	50.0	1.05173	-.008

Breakpoint Information for DT-500-CU Device - Serial No. D46537
 From Calibration Run Number 1033

Upper Temperature Limit and Maximum Allowable Error:
 300.0 Kelvin ± .050

BP#	Temp. (K)	Voltage	T(Cal)-T(PROM)
	52.0	1.04719	.023
	54.0	1.04263	.041
	56.0	1.03802	.040
	58.0	1.03337	.018
13	60.0	1.02872	-.024
	65.0	1.01669	.046
12	70.0	1.00444	-.008
	75.0	.99189	.016
	77.4	.98593	-.001
11	80.0	.97926	-.039
	85.0	.96626	.022
	90.0	.95324	.036
	95.0	.94012	.014
10	100.0	.92703	-.036
	105.0	.91367	.006
	110.0	.90036	.028
	115.0	.88699	.030
	120.0	.87357	.011
9	125.0	.86017	-.028
	130.0	.84656	.008
	135.0	.83297	.024
	140.0	.81933	.019
	145.0	.80563	-.004
8	150.0	.79201	-.044
	155.0	.77810	-0.000
	160.0	.76426	.026
	165.0	.75038	.035
	170.0	.73644	.027
	175.0	.72246	.002
7	180.0	.70854	-.036
	185.0	.69439	-.003
	190.0	.68031	.018
	195.0	.66619	.026
	200.0	.65205	.027
	205.0	.63790	.027
6	210.0	.62368	.032
	215.0	.60967	-.012
	220.0	.59563	-.035
	225.0	.58168	-.025
5	230.0	.56777	.030
	235.0	.55418	-.030
	240.0	.54067	-.031
4	245.0	.52724	.024
	250.0	.51407	-.019
	255.0	.50090	-.035

Breakpoint Information for DT-500-CU Device - Serial No. D46537
From Calibration Run Number 1033

Upper Temperature Limit and Maximum Allowable Error:
300.0 Kelvin ± .050

BP#	Temp. (K)	Voltage	T(Cal)-T(PROM)
3	260.0	.48787	-.041
	265.0	.47459	.016
	270.0	.46135	.043
	275.0	.44799	.028
2	280.0	.43460	-.037
	285.0	.42087	.025
	290.0	.40709	.035
	295.0	.39318	-.003
1	300.0	.37939	-.021

Calibration Run No.: 1081
Sensor Type: CGR-1-1000 Serial No.: C5876

BP#	Temp. (K)	Resistance	Loq10(R)
1	325.0	9.7191067	.98763
2	320.0	9.7713819	.98996
3	295.0	10.049915	1.00216
4	270.0	10.363893	1.01552
5	240.0	10.802311	1.03352
6	215.0	11.235448	1.05059
7	185.0	11.870787	1.07448
8	155.0	12.702875	1.10390
9	140.0	13.232163	1.12163
10	130.0	13.643073	1.13491
11	120.0	14.113477	1.14963
12	115.0	14.376698	1.15766
13	110.0	14.662796	1.16622
14	105.0	14.974619	1.17536
15	100.0	15.312691	1.18505
16	98.0	15.457792	1.18915
17	84.0	16.653407	1.22150
18	76.0	17.527317	1.24372
19	68.0	18.604913	1.26963
20	62.0	19.597832	1.29221
21	58.0	20.376721	1.30913
22	54.0	21.279752	1.32797
23	52.0	21.787255	1.33820
24	48.0	22.929404	1.36039
25	47.0	23.247538	1.36638
26	42.0	25.098176	1.39964
27	36.0	28.089702	1.44855
28	32.0	30.815930	1.48878
29	25.0	38.182979	1.58187
30	24.0	39.679646	1.59857
31	20.5	46.436569	1.66686
32	17.5	55.220311	1.74210
33	15.0	66.504218	1.82285
34	12.5	84.930405	1.92906
35	9.6	128.10481	2.10757
36	8.2	170.03974	2.23055
37	6.8	248.68346	2.39565
38	5.0	525.78750	2.72081
39	4.3	810.69536	2.90886
40	3.5	1588.3191	3.20094
41	2.9	3233.9195	3.50973
42	2.3	8950.0837	3.95183
43	1.8	32006.757	4.50524
44	1.4	150282.68	5.17691

XC04,LCGR-1-1000 C5876,0.98763,325.0,0.98996,320.0,1.00216,295.0,1.01552,270.0,
1.03352,240.0,1.05059,215.0,1.07448,185.0,1.10390,155.0,1.12163,140.0,1.13491,13
0.0,1.14963,120.0,1.15766,115.0,1.16622,110.0,1.17536,105.0,1.18505,100.0,1.1891
5,098.0,1.22150,084.0,1.24372,076.0,1.26963,068.0,1.29221,062.0,1.30913,058.0,1.
32797,054.0,1.33820,052.0,1.36039,048.0,1.36638,047.0,1.39964,042.0,1.44855,036.
0,1.48878,032.0,1.58187,025.0,1.59857,024.0,1.66686,020.5,1.74210,017.5,1.82285,
015.0,1.92906,012.5,2.10757,009.6,2.23055,008.2,2.39565,006.8,2.72081,005.0,2.90
886,004.3,3.20094,003.5,3.50973,002.9,3.95183,002.3,4.50524,001.8,5.17691,001.4*

Temperature for Resistance Decades :

Resistance	Temp. (K)
10	299.28
100	11.19
1000	4.02
10000	2.25
100000	1.49

Breakpoints for CGR-1-1000 Device - Serial No. C5876

BP No.	Temp.(K)	Res.(dec.)	LOG10(R)
44	1.4	150282.680	5.17691
43	1.8	32006.757	4.50524
42	2.3	8950.084	3.95183
41	2.9	3233.920	3.50973
40	3.5	1588.319	3.20094
39	4.3	810.695	2.90886
38	5.0	525.788	2.72081
37	6.8	248.683	2.39565
36	8.2	170.040	2.23055
35	9.6	128.105	2.10757
34	12.5	84.930	1.92906
33	15.0	66.504	1.82285
32	17.5	55.220	1.74210
31	20.5	46.437	1.66686
30	24.0	39.680	1.59857
29	25.0	38.183	1.58187
28	32.0	30.816	1.48878
27	36.0	28.090	1.44855
26	42.0	25.098	1.39964
25	47.0	23.248	1.36638
24	48.0	22.929	1.36039
23	52.0	21.787	1.33820
22	54.0	21.280	1.32797
21	58.0	20.377	1.30913
20	62.0	19.598	1.29221
19	68.0	18.605	1.26963
18	76.0	17.527	1.24372
17	84.0	16.653	1.22150
16	98.0	15.458	1.18915
15	100.0	15.313	1.18505
14	105.0	14.975	1.17536
13	110.0	14.663	1.16622
12	115.0	14.377	1.15766
11	120.0	14.113	1.14963
10	130.0	13.643	1.13491
9	140.0	13.232	1.12163
8	155.0	12.703	1.10390
7	185.0	11.871	1.07448
6	215.0	11.235	1.05059
5	240.0	10.802	1.03352
4	270.0	10.364	1.01552
3	295.0	10.050	1.00216
2	320.0	9.771	.98996
1	325.0	9.719	.98763

Breakpoint Information for CGR-1-1000 Device - Serial No. C5876
 From Calibration Run Number 1081

Temperature Error is .009K

BP#	Temp. (K)	Res. (Ω)	T(Cal)-T(PROM)
44	1.4	150282.68	-0.000
	1.5	96632.017	-.004
	1.6	64572.270	-.003
	1.7	44718.342	-.002
43	1.8	32006.757	0.000
	1.9	23611.073	.001
	2.0	17902.330	.002
	2.1	13913.132	.001
	2.2	11052.576	.001
42	2.3	8950.0837	0.000
	2.4	7311.2977	.002
	2.5	6060.8467	.003
	2.6	5092.2520	.002
	2.7	4331.0234	.002
	2.8	3724.2733	.001
41	2.9	3233.9195	0.000
	3.0	2820.8322	.001
	3.1	2480.2376	.002
	3.2	2197.0621	.002
	3.3	1959.6992	.001
40	3.4	1759.1365	.001
	3.5	1588.3191	-0.000
	3.6	1438.6070	.001
	3.7	1309.3102	.001
	3.8	1197.0642	.001
	3.9	1099.1205	.001
	4.0	1013.2224	.001
39	4.1	937.50655	0.000
	4.2	870.42716	-0.000
	4.3	810.69536	0.000
	4.4	756.15648	.001
	4.5	707.26350	.001
	4.6	663.30529	.001
	4.7	623.67078	.001
	4.8	587.83322	.001
38	4.9	555.33715	.001
	5.0	525.78750	0.000
	5.2	472.68268	.003
	5.4	427.86313	.006
	5.6	389.78383	.008
	5.8	357.21903	.008
	6.0	329.18891	.007
	6.2	304.90441	.006
	6.4	283.72534	.005
	6.6	265.12856	.002

Breakpoint Information for CGR-1-1000 Device - Serial No. C5876
 From Calibration Run Number 1081

Temperature Error is .009K

BP#	Temp. (K)	Res. (Ω)	T(Cal)-T(PROM)	
37	6.8	248.68346	-0.000	
	7.0	233.49733	.003	
	7.2	219.95351	.004	
	7.4	207.82674	.004	
	7.6	196.92509	.003	
	7.8	187.08432	.002	
	8.0	178.16320	.001	
36	8.2	170.03974	0.000	
	8.4	162.44811	.001	
	8.6	155.48889	.003	
	8.8	149.09583	.003	
	9.0	143.21027	.003	
	9.2	137.78006	.002	
	9.4	132.75873	.001	
35	9.6	128.10481	0.000	
	9.8	123.67480	.002	
	10.0	119.54009	.004	
	10.5	110.34041	.008	
	11.0	102.51445	.009	
	11.5	95.803200	.008	
	12.0	89.998315	.004	
34	12.5	84.930405	0.000	
	13.0	80.340104	.003	
	13.5	76.275912	.004	
	14.0	72.658500	.004	
	14.5	69.420482	.002	
	33	15.0	66.504218	-0.000
		15.5	63.816595	.001
16.0		61.371779	.003	
16.5		59.140711	.002	
17.0		57.097780	.001	
32		17.5	55.220311	0.000
		18.0	53.469749	.001
	18.5	51.849970	.001	
	19.0	50.347964	.001	
	19.5	48.951988	0.000	
	20.0	47.651409	-0.000	
	31	20.5	46.436569	0.000
21.0		45.287787	0.000	
21.5		44.209431	.002	
22.0		43.195499	.002	
22.5		42.240464	.001	
23.0		41.339229	0.000	
23.5		40.487079	0.000	
30	24.0	39.679646	0.000	

Breakpoint Information for CGR-1-1000 Device - Serial No. C5876
 From Calibration Run Number 1081

Temperature Error is .009K

BP#	Temp. (K)	Res. (Ω)	T(Cal)-T(PROM)
	24.5	38.911673	0.000
29	25.0	38.182979	0.000
	26.0	36.825752	0.000
	27.0	35.591655	0.000
	28.0	34.466281	.001
	29.0	33.436846	-0.000
	30.0	32.491950	-0.000
	31.0	31.621378	-.001
28	32.0	30.815930	0.000
	33.0	30.059449	.001
	34.0	29.356395	.005
	35.0	28.701440	.004
27	36.0	28.089702	0.000
	37.0	27.512747	-0.000
	38.0	26.970858	.001
	39.0	26.461093	.002
	40.0	25.980721	.001
	41.0	25.527205	0.000
26	42.0	25.098176	0.000
	43.0	24.688920	.005
	44.0	24.300649	.008
	45.0	23.931900	.008
	46.0	23.581296	.004
25	47.0	23.247538	0.000
24	48.0	22.929404	0.000
	49.0	22.625423	-.005
	50.0	22.334452	-.009
23	52.0	21.787255	0.000
22	54.0	21.279752	0.000
	56.0	20.810914	-.003
21	58.0	20.376721	0.000
	60.0	19.973528	.002
20	62.0	19.597832	0.000
	64.0	19.245609	-0.000
	66.0	18.915298	-0.000
19	68.0	18.604913	0.000
	70.0	18.312070	.001
	72.0	18.035760	.002
	74.0	17.774606	.001
18	76.0	17.527317	0.000
	78.0	17.292050	.001
	80.0	17.068540	.002
	82.0	16.855930	.001
17	84.0	16.653407	0.000
	86.0	16.459636	-.001

Breakpoint Information for CGR-1-1000 Device - Serial No. C5876
 From Calibration Run Number 1081

Temperature Error is .009K

BP#	Temp. (K)	Res. (Ω)	T(Cal)-T(PROM)
	88.0	16.274460	-.002
	90.0	16.097291	-.005
	92.0	15.927565	-.006
	94.0	15.764746	-.008
	96.0	15.608320	-.005
16	98.0	15.457792	0.000
15	100.0	15.312691	0.000
14	105.0	14.974619	0.000
13	110.0	14.662796	0.000
12	115.0	14.376698	0.000
11	120.0	14.113477	0.000
	125.0	13.869738	-0.000
10	130.0	13.643073	-0.000
	135.0	13.430926	.002
9	140.0	13.232163	0.000
	145.0	13.045106	.001
	150.0	12.868984	.001
8	155.0	12.702875	0.000
	160.0	12.545443	-.003
	165.0	12.396341	-.005
	170.0	12.254923	-.006
	175.0	12.120576	-.005
	180.0	11.992716	-.003
7	185.0	11.870787	-0.000
	190.0	11.753464	.001
	195.0	11.641180	.001
	200.0	11.533576	.001
	205.0	11.430305	.001
6	210.0	11.331036	.001
	215.0	11.235448	0.000
	220.0	11.142745	.002
	225.0	11.053264	.003
	230.0	10.966818	.003
	235.0	10.883226	.002
5	240.0	10.802311	0.000
	245.0	10.723681	0.000
	250.0	10.647427	0.000
	255.0	10.573433	0.000
	260.0	10.501585	0.000
	265.0	10.431774	-0.000
4	270.0	10.363893	0.000
	275.0	10.297779	-.003
	280.0	10.233409	-.004
	285.0	10.170697	-.004
	290.0	10.109559	-.003

Breakpoint Information for CGR-1-1000 Device - Serial No. C5876
From Calibration Run Number 1081

Temperature Error is .009K

BP#	Temp. (K)	Res. (Ω)	T(Cal)-T(PROM)
3	295.0	10.049915	0.000
	300.0	9.9916808	-.003
	305.0	9.9347839	-.004
	310.0	9.8791501	-.003
	315.0	9.8247064	-.002
2	320.0	9.7713819	0.000
1	325.0	9.7191067	0.000

APPENDIX C

Model 8219 Platinum Sensor Option

C-1. INTRODUCTION.

C-2. This Appendix contains general and specific information concerning the Model 8219 Platinum Sensor Option. Included is a description, specifications, installation, operation and maintenance information.

C-3. DESCRIPTION.

C-4. The Model 8219 Platinum Sensor Option is designed to be installed in a DRC-81C/82C to convert either Input A or Input B (or both with two options) to accommodate platinum RTD sensors. The standard 8219 option is used with Lake Shore PT-100 Series Nominal 100 ohm Platinum RTD's which conform to DIN 43760 tolerances $\pm 0.1K$, have an interchangeability of 0.1% at 0°C and temperature coefficient (0-100°C) of 0.00385/°C. Special 8219 options can be ordered for nominal 1000 ohm Platinum RTD's (8219-P2) or nominal 27 ohm Rhodium-Iron RF-800-4 sensors (8219-R1).

C-5. SPECIFICATIONS.

C-6. Specifications for the Model 8219 Platinum Sensor Option are given in Table C-1.

C-7. INSTALLATION.

C-8. The 8219 can be installed in the DRC-81C/82C in place of either the Input A or Input B Analog Input Card (or both with two options). Use the following procedure for the installation of the 8219 Platinum Sensor Option. (Note: when an option is ordered for field installation, the customer should update the Options Installed Table in Appendix B to keep documentation current. If only one 8219 is ordered and its Input is not specified when ordered, it is installed in the Input B position.)

1. With the power off, remove the three top panel screws and slide panel off. Note on the calibration cover the position of the Analog Input Card the 8219 PCB will replace.
2. Remove the four screws that secure the calibration cover to its clips and remove cover. (Note: The cover rests on fibre washers on the clips, when removing the cover care must be taken to avoid losing the washers into the unit.)

3. Gently unplug the Analog Input Card that is being replaced. Care should be taken not to stretch the wiring harness that connects the card to the instrument back panel.
4. Disconnect the wiring harness by lifting the locking tab on the Input Card connector and gently pulling on the body of the wiring harness mating connector.
5. Connect the wiring harness mating connector to the 8219 making sure that the wiring harness locking tab is seated over the extended edge of the wiring harness mating connector.
6. Plug the 8219 PCB into the Input Card Slot with the component side to the left of the unit as viewed from the front. Make sure the card is thoroughly seated. Verify that the wiring harness is in place correctly by noting that the "A" or "B" on the harness connector is facing up (if it is not, review the harness installation again).*
7. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clip washers and starting the screws. Carefully move any misaligned card to its proper position and tighten cover screws.

C-9. OPERATION.

C-10. The 8219 Platinum Sensor Option supplies the excitation Current to the RTD. The returning sensor voltage is amplified by a factor of -10 (negative 10). The resulting negative signal is converted to a digital quantity with a resolution of better than 100_{μ}V and sent to the microprocessor. The amplified voltage is also routed to the Control Sensor selection switch. There is a jumper on the Input Card defined as JMP2. If this jumper is in place, it indicates to the microprocessor that the input is a positive temperature coefficient sensor (increasing voltage/resistance with increasing temperature). If the jumper is not in place, the input is indicated as a negative temperature coefficient sensor (increasing voltage/resistance with decreasing temperature). This jumper is in place on the 8219 Option PCB so that, if the Control Input is selected that the 8219 occupies, the resulting input voltage can be converted to temperature properly and the polarity of the set point voltage can be output correctly. The Set Point voltage is negative for a negative temp. co. sensor and positive for a positive temp. co. sensor.

* If the 8219 is to replace an 8218C (carbon glass resistor card), then a 1.0MF cap must be added across pin A and B of the input connector. The capacitor will already be there if the 8219 is replacing an 8210 (diode input card).

Table C-1. Model 8219 Specifications

Temperature Range

- 8219, 8219-P2 - 30 - 800K
- 8219-R1 - 1.4 - 800K

Sensor (order separately)

- 8219 - PT-101, PT-102, PT-103 or any other 100-ohm, 0.00385/°C Sensor
- 8219-P2 - PT-1001 or any other 1000-ohm, 0.00385/°C Sensor
- 8219-R1 - RF-800-4 27-ohm Rhodium-Iron Sensor

Sensor Excitation

- 8219 - 1 milliampere ($\pm 0.005\%$)
- 8219-P2 - 100 microamperes ($\pm 0.005\%$)
- 8219-R1 - 3 milliampere ($\pm 0.005\%$)

Sensor Response Curve

- 8219 - Standard response curve (Curve #03) based on 0.1% interchangeability at 0°C and temperature coefficient (0-100°C) of 0.00385/°C. DRC-Precision Option can increase accuracy to better than $\pm 0.1^\circ\text{K}$ over the calibration range specified (Calibration of sensor must be ordered separately)
- 8219-P2 - DRC-Precision Option and calibration of 1000-ohm sensor required.
- 8219-R1 - DRC-Precision Option and calibration of 27-ohm sensor required.

C-11. The Sensor voltage present at the Monitor Plug will be negative 10 times the actual sensor voltage (the sensor voltage is the resistance times the current). See Table 2-2 for the Monitor Plug Connections. (For the 82C, if the Set Point is to be input in voltage for a Control Input with an 8219 Option installed, the voltage must be 0.01 times the desired resistance point for the standard 8219, 0.001 for the 8219-P2 and 0.03 for the 8219-R1. The polarity of the Set Point is taken care of by the microprocessor automatically.)

C-12. CALIBRATION.

C-13. The 8219 has been calibrated to specification prior to shipment. If recalibration is needed, refer to the following procedure. The following equipment is used to calibrate the 8219 Platinum Sensor Option:

1. Digital Voltmeter (DVM) - $4\frac{1}{2}$ digit resolution or better, including a current scale.
2. Precision Standard Resistor - 10K, 1K or 100 ohms with a tolerance of $\pm 0.01\%$ or better. See procedure for resistor required.
3. Precision Voltage Standard - 100 μ V out of 3V resolution or better.

The unit should be allowed a one-hour warm-up time to achieve rated specs. Use the following procedure to calibrate the 8219 Platinum Sensor Option:

1. Remove the three top panel screws and slide panel off.
2. Connect a precision resistor across pins A and B of the Input Connector that has the 8219 Option installed. A $\pm 0.01\%$ or better tolerance resistor is required. The suggested values for: 8219 (1mA current) is 1K ohms; 8219-P2 (100 μ A current) is 10K; and 8219-R1 (3mA current) is 100 ohms. Adjust the trimpot marked I for the appropriate Channel Input Card until the voltage across the resistor is equal to the current times the resistance \pm the tolerance of the resistor.
3. The balance of the calibration requires the removal of the calibration cover. Remove the four screws that secure the calibration cover to its clips and remove cover (Note: the cover rests on fibre washers on the clips, when removing the cover care must be taken to avoid losing the washers into the unit).

4. Calibrate the Input -10 Amplifier. Connect the ground lead of the voltmeter to the Ground pin of the Monitor Plug for the appropriate input card. Put the positive lead to the top of C8 on the 8219 PCB. Connect the precision voltage standard across pins D and E of the Input Connector and set the standard to 0.0000V. Adjust the Amplifier Zero adjust, R8, to achieve a voltage of 0.0000V out. Set the standard to 0.2500 volts in and adjust the Amplifier Span adjust, R11, until the voltage reads -2.5000 volts.
5. Calibrate the Monitor Output. Move the DVM positive lead to the Monitor Plug Voltage Output pin. With the standard still set at 0.2500 volts in, adjust the Monitor Voltage adjust, R11, until the voltage reads -2.5000 volts.
6. Calibrate the A/D converter. For the 82C, put the Sample Display into voltage mode and set the Sample switch to the 8219 input. Set the standard to 0.1500 volts and adjust the A/D trimpot, R29, until the display reads 1.5000 volts. To check linearity, verify that with inputs of 0.2500 and 0.0500 volts the display reads 2.5000 and 0.5000 volts respectively.

For the 81C, with a standard 8219, select a middle range temperature point for input. A voltage of 0.15051 corresponds to 405K for the standard curve (Curve #03). Adjust the A/D trimpot, R29, until the display reads 405.0K. To check linearity, input a high and low temperature point; 0.00924 corresponds to 50.0K and 0.28818 to 795.0K for the standard curve (Curve #03).

Note: The temperature/voltage points for an 8219, 8219-P2 or 8219-R1 with the DRC-Precision Option will differ from those given in procedure 6. Refer to the Breakpoint Information Table for the values to use.

C-14. USER GENERATED CURVE INFORMATION FOR THE 8219.

C-15. Before the user can input a curve to DRC-81C/82C for use with the 8219 Platinum Sensor Option using the XCN₁N₂ command (as outlined in Section 3-111), the curve data must be put in a usable form for the unit. The curve data is in table form with voltage -vs- temperature in ascended voltage order. Therefore, the resistance of the sensor to be used with the 8219 must be converted to voltage. Listed in Table C-2 are the multipliers for the 8219 configurations. The voltage and temperature for the 8219 are in Volts up to 3.00000 and K up to 799.9

Table C-2. Curve Multipliers for the 8219

8219 Version	Resistance Range (ohms)	Excitation Current	Multiplier (R ohms)x(Multiplier) = V _{PROM}
Standard 8219	0-300	1mA	.01
8219-P2	0-3000	100 μ A	.001
8219-R1	0-100	3mA	.03

C-16. REPLACEABLE PARTS.

C-17. Below is a list of Tables and Figures for the Model 8219 Platinum Sensor Option schematic, replaceable parts list and illustrated component layout. Refer to Section 5 of this manual for ordering information.

Parts List	- Model 8219 Platinum Sensor Option Board Assembly	Table C-3
Component Layout	- Model 8219 Platinum Sensor Option Board Assembly	Figure C-1
Schematic	- Model 8219 Platinum Sensor Option Board Assembly	Figure C-2

Table C-3. Model 8219 Platinum Sensor Input Card

LSCI Part Number 113-132

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1A3	Analog input card P.C. Board Artwork #: C-261-83-01D	111-044	LSCI	111-044	1
C1	CAP, MICA, 150PF, 500V	101-085	CDE	CD15CD151G03	1
C2	CAP, POLY, .0015MF, 100V	101-001	CDE	WMF1D15	1
C3	CAP, POLY, .33MF, 100V	101-025	PLSY	150.33K100FC	1
C4	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	4
C5	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	REF
C6	CAP, MICA, 330PF, 500V	101-094	CDE	CD15CD331G03	1
C7	CAP, TANT, 1.5MF, 10V	101-132	SPRG	150D155X9010A2	1
C8	CAP, POLY, 1.0MF, 100V	101-032	PLSY	150.1K100FC	REF
C9	CAP, MYLAR, 50PF, 500V	101-073	CDE	CD15ED500G03	1
C10	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	3
C11	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C12	CAP, POLY, .68MF, 100V	101-046	PLSY	160.68J100G	1
C13	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C14	CAP, MYLAR, 30PF, 500V	101-067	CDE	CD15ED300J03	1
C15	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	REF
CR1	DIODE, SIL, G.P.	102-062	FLD	IN459A	2*
CR2	DIODE, SIL, G.P.	102-062	FLD	IN459A	REF
JMP1	Not Present		LSCI		1
JMP2	1/2" Wire Jumper		LSCI		1
P2	6 Post Locking Conn.	106-142	MOL	2420-09-75-1061	1
R1	RES, MTF, 10K, 1%, 1/2W	103-358			2
R2	RES, MTF, 1.54K, 1%, 1/2W	103-272			1
R3	RES, MTF, 3.74K, 1%, 1/2W	103-296			2
R4	POT, 5K	103-049	BOR	3059Y-1-502	2
R5	SEE TABLE 'A'				1
R6	RES, MTF, 442Ω, 1%, 1/2W	103-237			1
R7	RES, MTF, 10K, 1%, 1/2W	103-358			REF
R8	POT, 10K	103-010	BOR		1
R9	POT, 50Ω	103-003	BOR		1
R10	RES, MTF, 1K, 1%, 1/2W	103-265			2
R11	POT, 20K	103-051			1
R12	RES, MTF, 150K, 1%, 1/2W	103-431			1
R13	RES, MTF, 64.9Ω, 1%, 1/2W	103-214			1
R14	RES, MTF, 196Ω, 1%, 1/2W	103-225			1
R15	RES, MTF, 49.9K, 1%, 1/2W	103-397			1
R16	RES, MTF, 301K, 1%, 1/2W	103-448			1
R17	RES, MTF, 392Ω, 1%, 1/2W	103-234			3
<u>TABLE A</u>					
	<u>Model No.</u>	<u>R5 in OHMS</u>			
	8219	4.99K		103-308	
	8219-P2	49.9K		103-397	
	8219-R1	1.62K		103-274	

Table C-3. Model 8219 Platinum Sensor Input Card
 LSCI Part Number 113-132, cont'd.

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
R18	RES, MTF, 392Ω, 1%, 1/4W	103-234			REF
R19	RES, MTF, 4.75K, 1%, 1/4W	103-306			4
R20	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R21	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R22	RES, MTF, 392Ω, 1%, 1/4W	103-234			REF
R23	RES, MTF, 1.18K, 1%, 1/4W	103-267			1
R24	RES, MTF, 4.75K, 1%, 1/4W	103-306			REF
R25	RES, MTF, 100K, 1%, 1/4W	103-420			1
R26	RES, MTF, 3.74K, 1%, 1/4W	103-296			REF
R27	RES, MTF, 2K, 1%, 1/4W	103-278			2
R28	RES, MTF, 40.2K, 1%, 1/4W	103-388			1
R29	POT, 5K	103-049	BOR	3059Y-1-502	REF
R30	RES, MTF, 2K, 1%, 1/4W	103-278			REF
R31	RES, MTF, 1K, 1%, 1/4W	103-265			REF
R32	RES, MTF, 100K, 1%, 1/4W				
U1	LIN, REF	102-043	NAT	LM399H	1*
U2	IC, LIN, OP AMP	104-005	NAT	LM308N	1*
U3	FET, P-CH ENG.	102-074	SIL	3N163	1*
U4	LIN, INST. AMP.	104-041	AD	AD524CD	1*
U5	IC, LIN, OP AMP	104-001	PMI	OP07EP	1*
U6	IC, INVERTER	104-207	NAT	74LS04	2*
U7	IC, INVERTER	104-207	NAT	74LS04	REF
U8	IC, A/D REF	104-460	ISL	ICL8068ACPD	1*
U9	IC, A/D CONVERTER	104-461	ISL	ICL7104-16CPL	1*
U10	IC, P-S SHIFT REG.	104-099	NAT	CD4021BCN	2*
U11	IC, P-S SHIFT REG.	104-099	NAT	CD4021BCN	REF
U12	IC, OPTO-COUPLER	104-350	HP	HCPL-2530	1*
U13	IC, OPTO-COUPLER	104-352	HP	6N135	1*
U14	IC, TIMER	104-051	ISL	ICM7555IPA	1*
XU2	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	5
XU4	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	3
XU5	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU6	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	3
XU7	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	REF
XU8	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	REF
XU9	SOCKET, IC, 40 PIN DIP	106-507	AUG	540-AGIID	1
XU10	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	REF
XU11	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	REF
XU12	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU13	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU14	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF

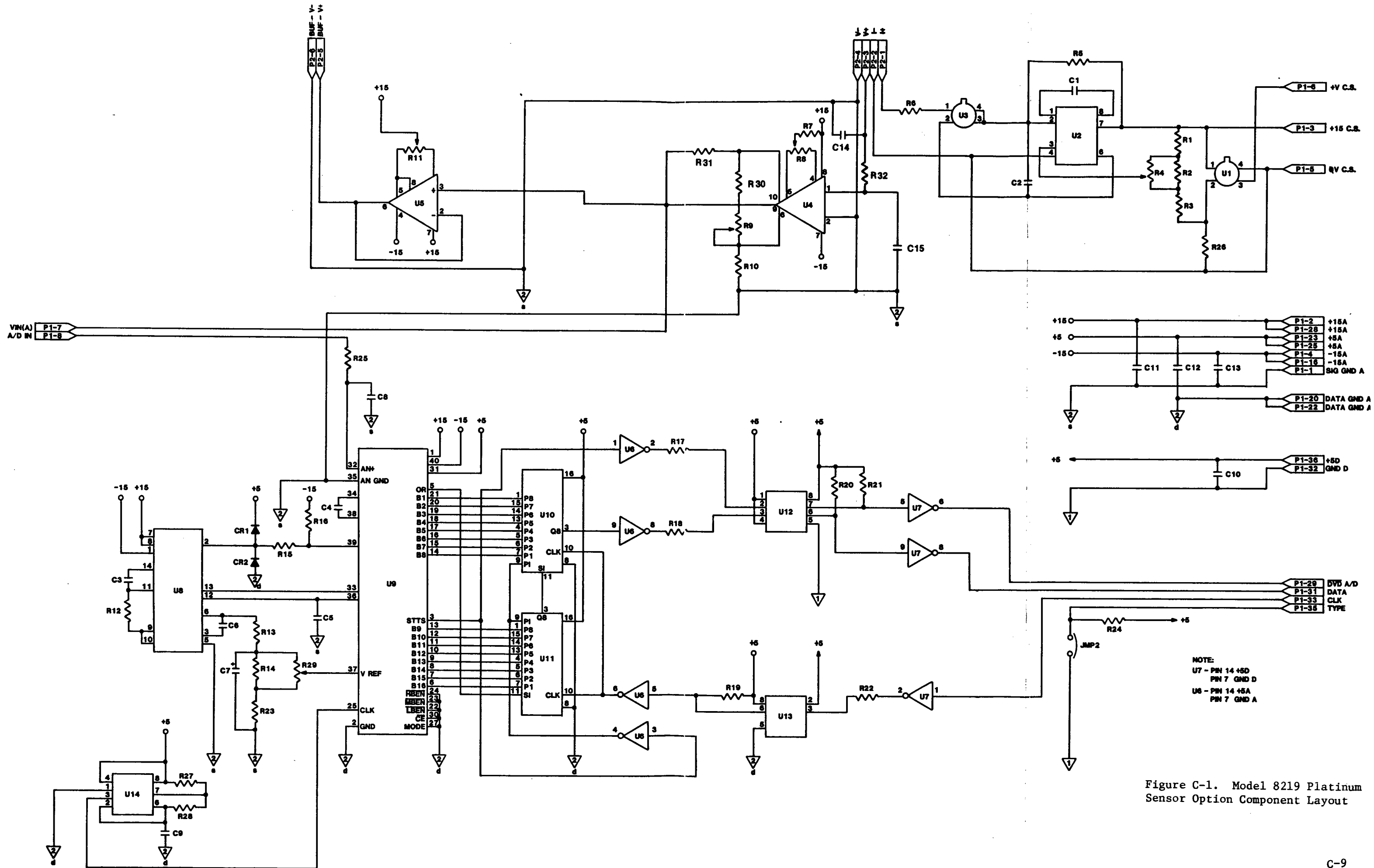


Figure C-1. Model 8219 Platinum Sensor Option Component Layout

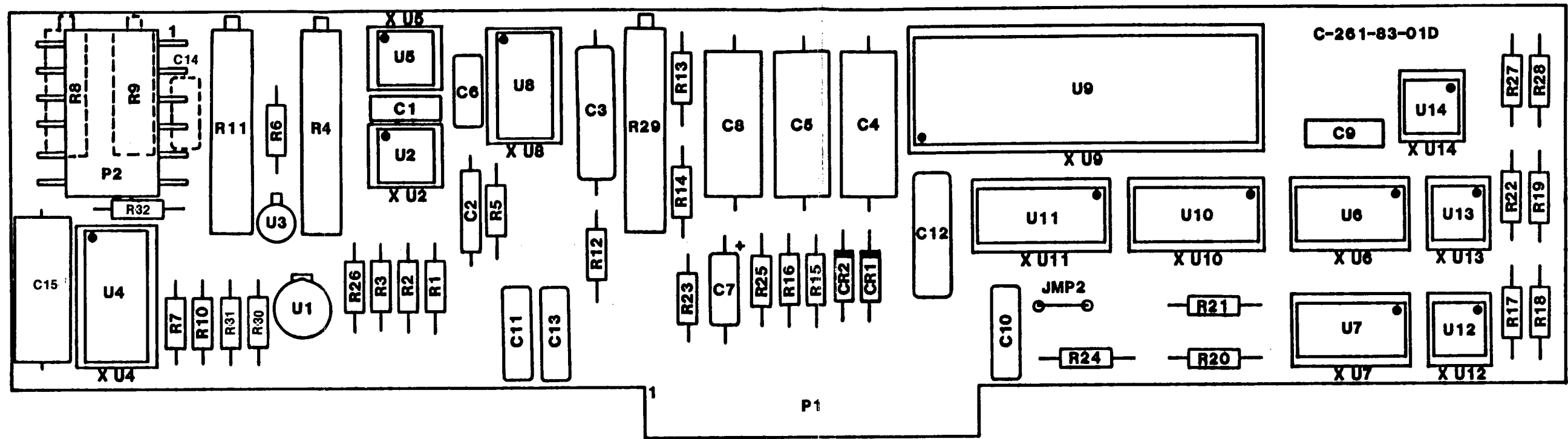


Figure C-2. Model 8219 Platinum
Sensor Option Schematic

APPENDIX F

MODEL 8223 RS-232C INTERFACE

F-1. INTRODUCTION.

F-2. This Appendix contains general and specific information concerning the Model 8223 RS-232C Interface. Included is a description, specifications, installation, operation and maintenance information.

F-3. DESCRIPTION.

F-4. The Model 8223 RS-232C Interface is designed to be installed in a DRC-81C/82C and provide an interface with an external RS-232C instrument such as a computer, modem or CRT. The interface operates in a half duplex mode (it can only transmit and receive information in one direction at a time) and data transmission is asynchronous (each character is bracketed by start and stop bits that separate and synchronize the transmission and receipt of data). The baud rate is switch selectable at 300 or 1200 baud and the interface maintains EIA voltage levels for data transmission.

F-5. Figure F-1 gives a transmission format which shows the data bits framed by the start and stop synchronization bits. The data is transmitted using two voltage levels which represent the two binary states of the digit. A logic 0 (or SPACE) is +3 to +12 VDC. A logic 1 (or MARK) is -3 to -5 VDC. When data is not being transmitted, the line is held low (MARK state). When the transmitting device is ready to send data, it takes the line to the high (SPACE) state for the time of one bit. This transition is called the start bit. The remaining data is then transmitted. If a parity bit is used, it follows the character. The parity bit is determined by the number of 1 bits in the character. Refer to Table F-1 for parity determination.

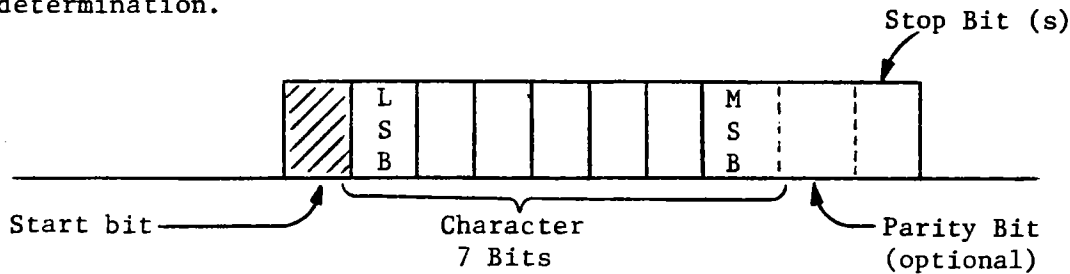


Figure F-1. Word Structure

Table F-1. Parity Determination

<u>Number of "1" s in character</u>	<u>Parity Specified</u>	<u>Parity Bit</u>
Odd	Odd	0
Even	Odd	1
Odd	Even	1
Even	Even	0

F-6. The Model 8223 RS-232C Interface has a 25 pin D style connector located on the rear panel. Pin assignments are shown in Table F-2.

Table F-2. Connector Pin Assignments for RS-232C

<u>Pin #</u>	<u>Description</u>	<u>RS-232C Signal</u>
1	Protective Ground	AA
2	Transmitted Data	BA
3	Received Data	BB
4	Request to Send	CA
5	Clear to Send	CB
6	Data Set Ready	CC
7	Signal Ground	AB
8	Received Line Signal Detector	CF
20	Data Terminal Ready	CD

F-7. The RS-232C signals are used in the following manner:

Protective Ground (AA) - conductor is taken to case (earth) ground potential and is common with the signal ground (AB)

Transmitted Data (BA) - transmits data using the EIA voltage levels (+12V and -5V)

Received Data (BB) - accepts data using EIA voltage levels.

Request to Send (CA) - indicates to the host computer or terminal that the Interface is ready to transmit data. The Interface transmits data on line BA when the "ON" state is maintained on CC, CB and CF, while a low level on these lines inhibits transmission by the Interface.

Clear to Send (CB) - indicates to the Interface that data transmission is allowed. Internally pulled up to maintain "ON" state when left disconnected.

Data Set Ready (CC) - indicates to the Interface that the host computer or terminal is not in a test mode and that power is ON.

Signal Ground (AB) - this line is the common signal connection for the interface

Received Line Signal Detector (CF) - this line is held positive ("ON") when the Interface is receiving signals from the host computer. When held low ("OFF") the BB line is clamped to inhibit data reception. Internally pulled up to maintain "ON" state when left disconnected.

Data Terminal Ready (CD) - asserted by the Interface whenever DRC-82C power is "ON" to indicate that the Interface is ready to receive and transmit data.

F-8. The Model 8223 has a field selectable baud rate using DIP switch package S1 on the Interface PCB (refer to Figure F-7). The baud rate is selected by closing the switch position for the desired rate and making sure all other positions are open. Table F-3. gives the baud rate selection table.

Table F-3. Baud Rate Switch S1

<u>DIP Switch Number</u>	<u>Baud Rate</u>
6	300
8	1200

F-9. The word structure is determined by switch settings for character length, parity and stop bits using DIP switch package S2 on the Interface PCB (Refer to Figure F-7). Refer to Table F-4 for settings where "0" is OPEN and "1" is closed.

Table F-4. Word Structure Switch S2

<u>DIP Switch Number / Settings</u>		<u>Choices</u>
<u>1</u>	<u>2</u>	<u>Stop Bits</u>
0	1	1 Bit
1	1	2 Bits
	<u>3</u>	<u>Parity Generation/Check</u>
	1	Even
	0	Odd
	<u>4</u>	<u>Parity Enable</u>
	1	Enable
	0	Disable
<u>5</u>	<u>6</u>	<u>Character Length</u>
1	0	7 bits

Note: Any settings other than those shown will cause faulty operation of the 8223 interface.

F-10. SPECIFICATIONS.

F-11. Specifications for the Model 8223 RS-232C Interface are given in Table F-5.

Table F-5. Model 8223 RS-232C Interface Specifications

Timing Format	- Asynchronous
Transmission Mode	- Half Duplex
Baud Rate (Bits per second)	- Switch Selectable, 300 or 1200 (Factory set to 300)
Bits per Character	- 7 (not including start, stop or parity bits)
Parity Enable	- Switch selectable, Enabled or Disabled (Factory set Enabled)
Parity Select	- Switch selectable, Odd or Even (Factory set Odd)
Number of Stop Bits	- Switch selectable, 1 or 2 (Factory set to 1)
Data Interface Levels	- Transmits and receives using EIA voltage levels (+12V and -5)

F-12. INSTALLATION.

F-13. The 8223 is installed in the DRC-81C/82C Option Slot 2. If an 8225 Analog Output is installed it must be moved to Option Slot 1 (refer to Appendix G for 8225 Installation). Use the following procedure for the installation of the 8223 RS-232C Interface PCB Assembly. (Note: when an option is ordered for field installation, the Customer should update the Options Installed Table in Appendix B to keep documentation current.)

1. Configure the baud rate and word structure switches as outlined in Section F-3.
2. With the power off, remove the three top panel screws and slide panel off. Note on the calibration cover the position of Option Slot 2 which the 8223 PCB will occupy.
3. Remove the four screws that secure the calibration cover to its clips and remove cover (Note: the cover rests on fibre washers on the clips; when removing the cover, care must be taken to avoid losing the washers into the unit).
4. Remove the screws that attach the blank cover plate to the interface opening on the back panel and remove plate.
5. Remove jumper JMP6 on the microprocessor board. JMP6 is either a wire jumper (which must be cut) or a red plug on jumper (which must be removed). Note: If the 8223 PCB is removed from the unit for any reason, this jumper must be replaced for proper operation.
6. Plug the internal interface cable supplied onto the 8223 PCB with the locking tab configured properly. Plug the 8223 PCB into Option Slot 2 with the component side to the left of the unit as viewed from the front. Make sure the card is thoroughly seated.
7. Thread the interface cable along the inside edge of the rear panel so that it won't interfere with the installation of the calibration cover or top cover.
8. Position the 25-pin Interface connector and cover plate in the interface opening on the back panel and secure in place using the screws removed earlier.
9. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clip washers and starting the screws. Carefully move any mis-aligned card to its proper position and tighten cover screws. The addition of a new card may cause a slight bow in the cover which will go away as the foam is compressed.

F-14. OPERATION.

F-15. The Model 8223 RS-232C Interface has a 64 character FIFO buffer (not including the End of Line or EOL characters) for input commands. The interface inputs characters until it sees the EOL sequence. After the sequence is input the command string is processed. The interface requires a carriage-return (CR)/line-feed (LF) or line-feed (LF) as its input EOL terminators and transmits a carriage-return (CR)/line-feed (LF) as its output EOL terminators.

F-16. Operation of the interface link is initiated by the computer. The computer will transmit either a Program Code or an Output Request to the 8223 interface. The unit will respond to the Output Request with the appropriate response or with the response and an error message (if an error was detected). The interface responds to Program Code Commands by storing the variables input.

F-17. The Programming Codes given in Table 3-8 are input only and do not result in a response from the interface. The Codes TN_1 and ZN_1 will be accepted and updated even though they have no relevance to the interface (the EOL terminator sequence is always (CF)(LF) and there is no EOI status). The MN_1 command can be considered the "OFF LINE" (Local) and "ON LINE" (Remote or Remote with Local Lockout) states. When "OFF LINE" (Local) parameters such as Sample Sensor and SENSOR ID (as well as Set Point, Gain, Rate and Reset for the 81C) are updated from the hardware settings while "ON LINE" these parameters can be updated from the computer only.

F-18. The Output Statement commands given in Table 3-9 will result in the requested data being output immediately following the reception of the EOL sequence. If more than one Output Statement command is given, the last one received will be acknowledged. Programming Codes and Output Statements can be sent in the same command string. For example, the command string:

S24.5P40I20D25R2H50

would result in the Set Point being updated to 24.5, the Gain to 40, the Reset to 20, the Rate to 25, the Heater Range on 10^{-3} and Manual Heater of 50. No Output Statement was given so no response will be output by the interface. The command string:

S24.5P40I20D25R2H50W0

will result in the W0 contents being output by the interface. (Refer to Section 3-85 for a detailed discussion of the Output Statement commands).

F-19. Table 3-11 gives the Program Curve Command summary. The XDT, XDA and XDN_1N_2 commands are Output Statement style commands which result in a response from the interface. The balance of the commands are Programming Code style commands which do not result in a response from the interface. Care should be taken with the XCN_1N_2 command not to overrun the 64 character buffer of the 8223 interface. Also, any X()() command which results in a modification of E²PROM memory must be given approximately 10 mSec per character due to the write cycle timing limitation of the E²PROM. The characters are input based on the characters per second of the Baud rate but are updated at the internal speed required by the hardware following the EOL sequence. As in the IEEE operation, if a hardware problem is detected in modifying one of the E²PROM locations, an Err01 error will be displayed in the Sample Display and instrument operation is halted. Consult a factory representative if this error occurs.

F-20. There are 3 errors that could be detected by the 8223 interface as defined in Table F-6. Detection of an error does not effect the operation of the interface. The software that interprets the data tries to match the character input to the possible command inputs and processes the command. The error is also transmitted by the interface the next time it is asked for a response. The error is transmitted in addition to the Output Statement data output. For example, if a framing error were detected in the command string:

P50W1

the interface might respond with:

Err12 2,A2B,B40,00,30,25,4,00,047(CR)(LF)

If the error were detected in the transmission of the "P", the gain change would be ignored; if it was in the "50", one or two numerics may have been generated. If the error were detected in the "W", the interface may not respond, in which case it would need to see another Output Statement command. If the error was in the "1", the interface may or may not have responded with W1 data, it may have defaulted to W0. Although errors rarely occur, it is suggested that any commands sent to the DRC-82C be echoed back by sending the appropriate Output Statement command and inputting the stored parameters. Any error that is detected is cleared following the first transmission after the error.

Table F-6. Interface Error Codes.

Error Number	Error/Possible Cause
Err10	Parity Error - may be caused by signal line transients or incorrectly specified parity.
Err11	Overrun Error - caused by the DRC-82C main processor not reading the input character before the next one becomes available. The overrun character(s) are lost.
Err12	Framing Error - may be caused by signal line transients or incorrectly specified stop bits or character length.
Err13	Input Buffer Overrun - caused by more than 64 characters being input to the FIFO buffer. Any characters received after the 64th character are discarded.

F-21. INTERFACING EXAMPLES.

F-22. Example 1. HP-86B Computer, Half Duplex, w/o Handshake

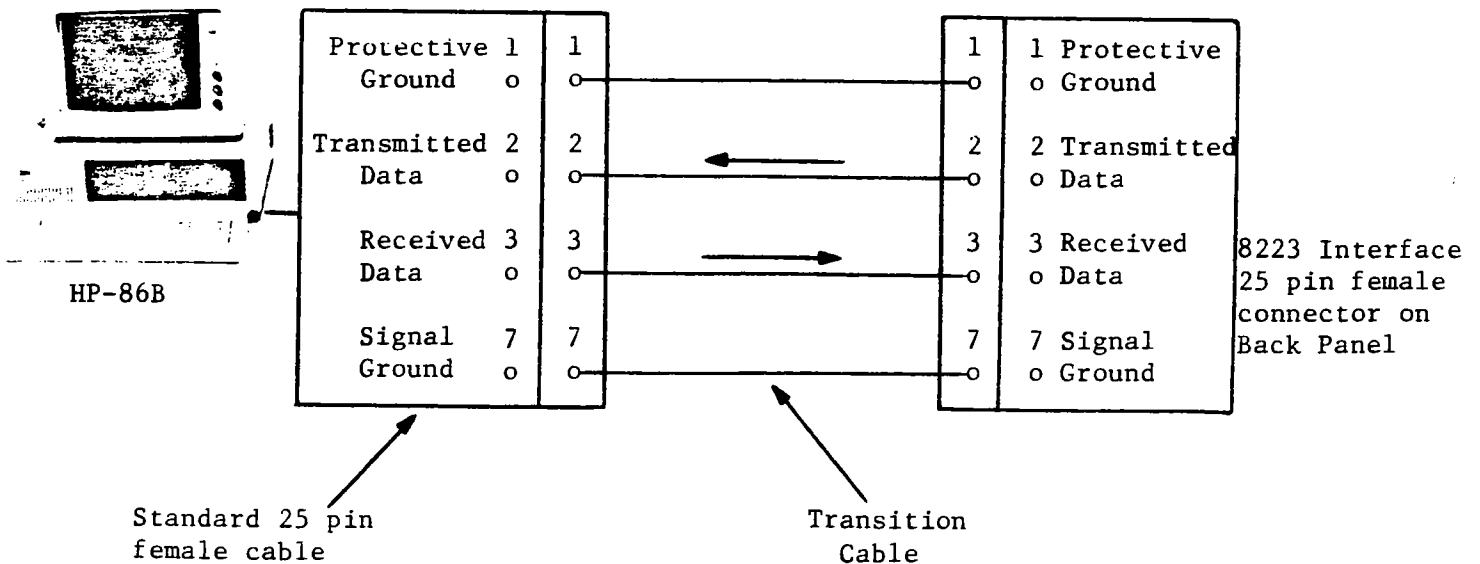
F-23. The HP82939A Serial Interface for the HP-86B is preset at the factory for the following default values:

1. Interface select code = 10
2. Baud rate = 300 Baud
3. Autohandshake = Off
4. Character Length = 7 bits
5. Parity = Odd
6. Stop bits = 1
7. Cable Option = Standard (25 pin female)

Since the HP default Baud rate, character length, parity and stop bit configuration are the same as those of the 8223 Interface when shipped, none of the switches on the 8223 board need to be changed.

F-24. When connecting the HP-86B Serial Interface to the 8223 Interface a transition cable needs to be made to connect the female connector of the HP to the female connector of the 8223 interface. Figure F-2 shows the adapter cable that must be made. The arrows indicate the source and direction of signal flow.

Figure F-2. Half Duplex W/O Handshake Connection to HP-86B



F-25. The following program will input a command from the keyboard and output it to the controller. The program will then input the specified DRC-82C response, display it and return for another command.

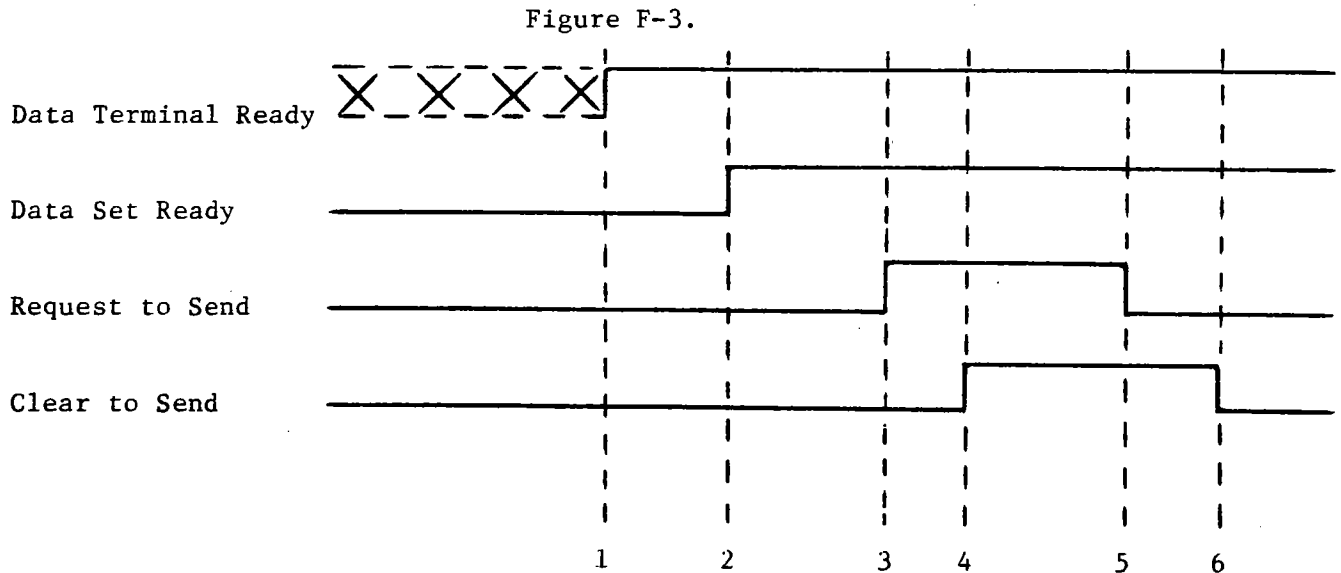
```

10 REM HALF DUPLEX W/O HANDSHAKE I/O TEST (RS232 TEST1)
20 DIM A$(64),B$(3000) ! A$ IS OUTPUT TO THE UNIT,B$ IS INPUT
30 INPUT A$ ! MAKE SURE TO GIVE AN OUTPUT STATEMENT COMMAND
40 OUTPUT 10 ;A$ ! OUTPUT THE COMMAND
50 ENTER 10 ; B$ ! INPUT THE DATA FROM THE DRC INSTRUMENT
60 DISP B$      ! DISPLAY IT
70 GOTO 30      ! RETURN FOR MORE
80 END

```

F-26. Example 2. HP-86B Computer, Half Duplex, with Handshake.

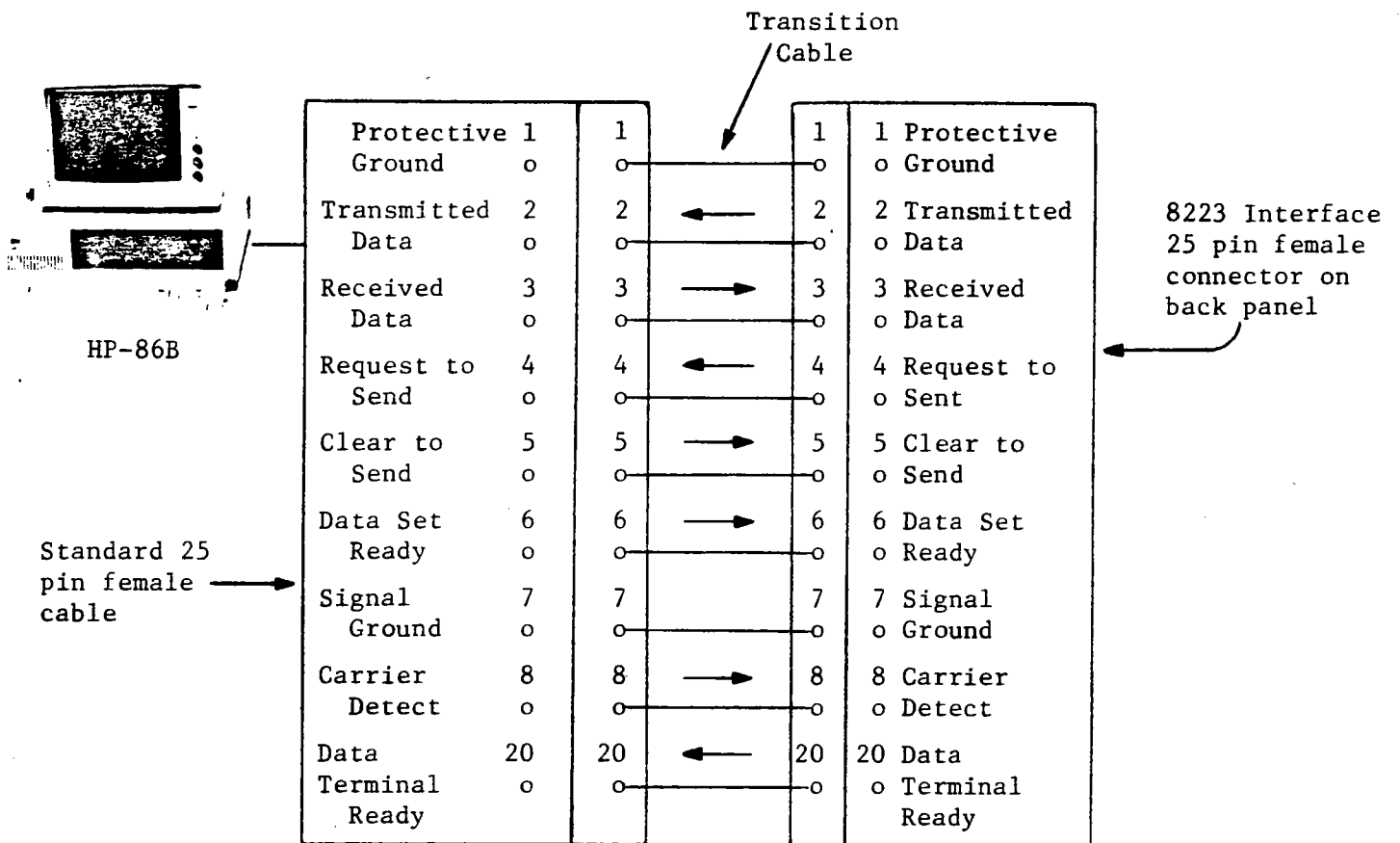
F-27. Situations arise in which it is desirable to use a handshake in serial communications. Figure F-3. shows a typical handshake sequence for half duplex data transfers.



The sending device sets the Data Terminal Ready (1) and monitors the Data Set Ready response. When the receiving unit is "ON" it asserts Data Set Ready (2). The Sending Device asserts the Request to Send line (3) indicating it has data to transmit and monitors the Clear to Send line. The receiving unit asserts the Clear to Send (4) indicating it is ready to receive the data. When the sending device detects the Clear to Send active it transmits its data. Following transmission of the data, the sending device de-activates its Request to Send (5) which signals to the receiving device that the transmission is complete. The receiving device then de-activates its Clear to Send line (6).

F-28. Figure F-4. shows the adapter cable for Half Duplex w/Handshake communications with an HP-86B Serial Interface. The arrows indicate the source and direction of signal flow.

Figure F-4. Half Duplex, with Handshake Connector to HP-86B



F-29. The Auto Handshake capability of the HP-86B Serial Interface must be enabled. The addition of the program line:

```
15 CONTROL 10,2;7 ! ENABLE DSR,DCD,CTS
```

to the program given in Section F-25. enables the HP to receive and transmit in a handshake mode.

F-30. Example 3. General Serial Interface Interconnection.

F-31. The HP-86B Serial Interface Standard cable configuration already takes care of some of the interface interconnection problems to route signals to their proper pins. Figure F-5. and F-6. give more general interconnection configurations for Half Duplex with and without Handshake.

Figure F-5. General Serial Interface Interconnection for Half Duplex with Handshake

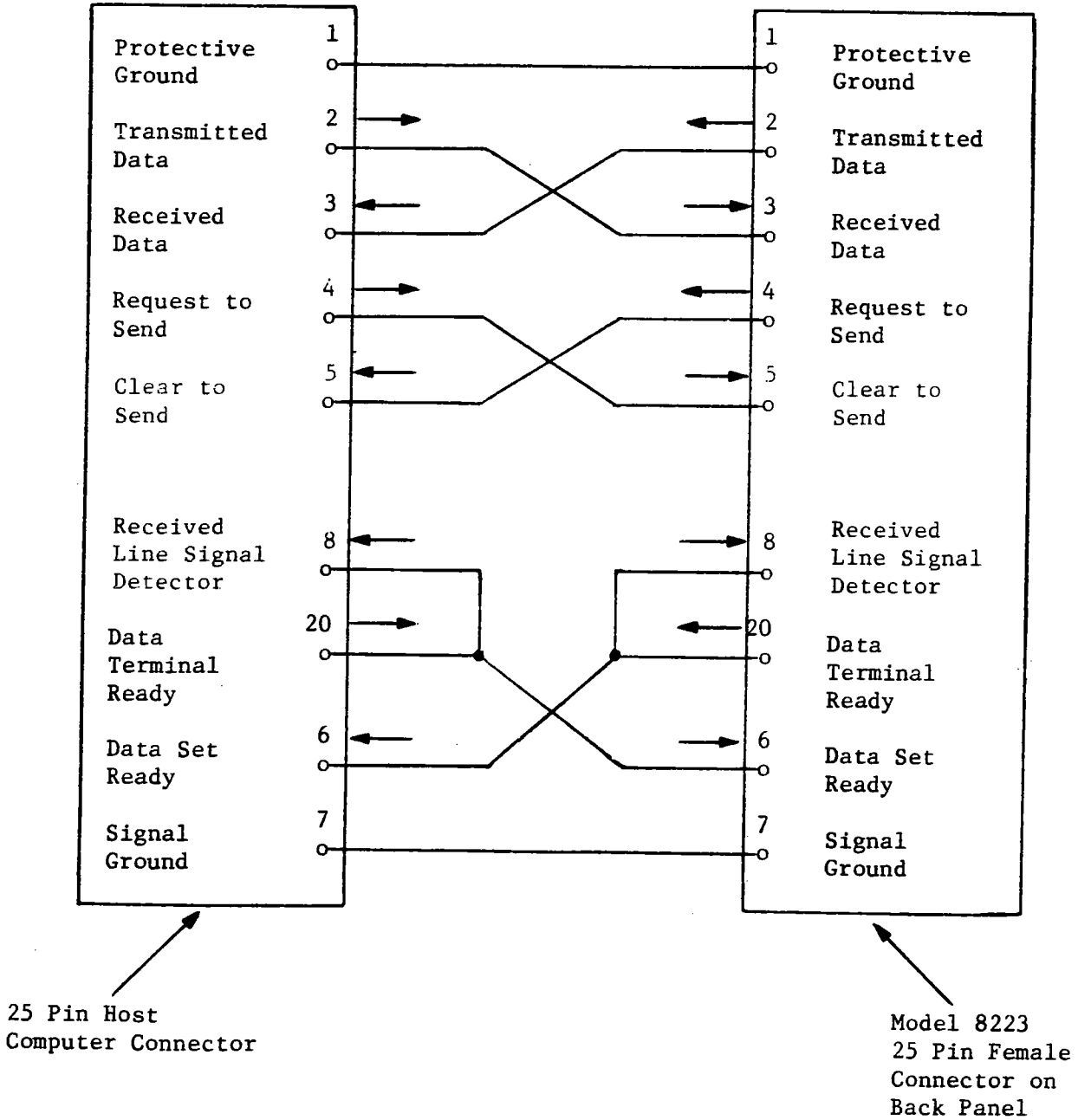
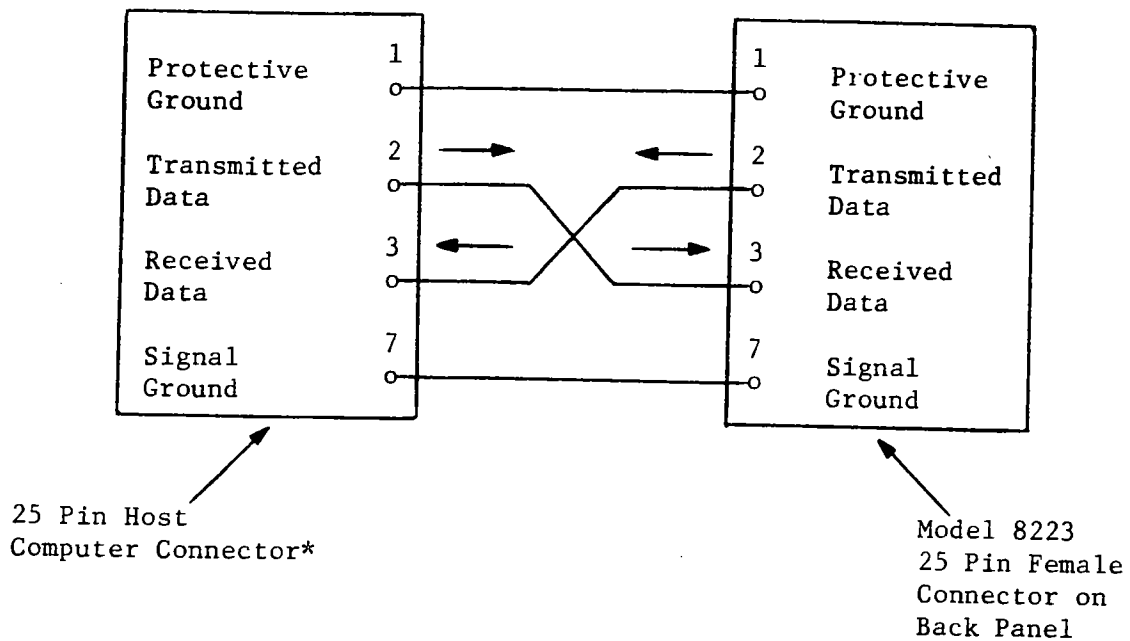


Figure F-6. General Serial Interface Interconnection for Half Duplex W/O Handshake



*Note: It may be necessary to jumper pins 5, 6, 8 and 20 to disable the handshake functions of the Host. This is not required for the 8223 Interface.

F-32. REPLACEABLE PARTS.

F-33. Below is a list of Tables and Figures for the Model 8223 RS-232C Interface schematic, replaceable parts list and illustrated component layout. Refer to Section 5 of this manual for ordering information.

Parts List	- Model 8223 RS-232C Interface Board Assembly	Table F-7
Component Layout	- Model 8223 RS-232C Interface Board Assembly	Figure F-7
Schematic	- Model 8223 RS-232C Interface Board Assembly	Figure F-8

Table F-7.

Parts List - Model 8223 RS-232C Interface Board Assembly
LSCI Part #1000-036

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1	Model 8223 RS-232C Option Board Artwork #: C290-84-01A	111-051	LSCI	111-051	1
C1	CAP,POLY, .68MF, 100V	101-046	PLSY	160.68J100G	3
C2	CAP,TAN, 1.5MF, 20V	101-132	SPRG	150D155X0020A2	3
C3	CAP,TAN, 1.5MF, 20V	101-132	SPRG	150D155X0020A2	REF
C4	CAP,POLY, .68MF, 100V	101-046	PLSY	160.68J100G	REF
C5	CAP,POLY, .68MF, 100V	101-046	PLSY	160.68J100G	REF
C6	CAP,TAN, 1.5MF, 20V	101-132	SPRG	150D155X0020A2	REF
C7	CAP,POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	3
C8	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	7
C9	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	REF
C10	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	REF
C11	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	REF
C12	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	REF
C13	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	REF
C14	CAP,CER, 330PF, 500V	101-094	CDE	CD15FD331J03	REF
C15	CAP,POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C16	CAP,POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
CR1	DIODE, LOW POWER RECTIFIER	102-001	MOT	1N4006	2*
CR2	DIODE, LOW POWER RECTIFIER	102-001	MOT	1N4006	REF
H1	Mounting Plate Dwg. #: A-298-84-01	107-114	LSCI	107-114	1
H2	Screw Lock Assembly for J1	106-254	TRW	D-20418-2	1
H3	Hood for J3 (mate to J1)	106-255	TRW	DB-51226-1	1*
J1	Connector, 25 Pin D-Style Cinch Receptacle	106-252	TRW	DB-25S	1
J2	Connector, 16 Pin Header Socket	106-414	TBAN	609-1630	1
J3	Connector, 25 Pin D-Style Cinch Plut (mate to J1)	106-253	TRW	DB-25P	1*
P2	Connector, 16 Pin PCB Male HDR, RA	106-412	TBAN	609-1602M	1
Q1	Xstr, Gen PRPS NPN	102-071		2N5225	1*
R1	RES,MTF,3.24K,1%, $\frac{1}{4}$ W	103-291			2
R2	RES,MTF,3.24K,1%, $\frac{1}{4}$ W	103-291			REF
R3	RES,CC,15M, $\frac{1}{4}$ W	103-533			1
RN1	Resistor Network, 4.7K, 7-1 COM	103-102	BOR	4308R-101-472	1

Table F-7., cont'd.

Parts List - Model 8223 RS-232C Interface Board Assembly
LSCI Part #1000-036

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
S1	Switch, 8 Pole DIP	105-408	BYH	76SB08	1
S2	Switch, 6 Pole DIP	105-406	GYH	76SB06	1
U1	IC, Baud Generator	104-053	MOT	MC14411	1*
U2	IC, LIN. REG, +12	102-018	MOT	78L12	1*
U3	IC, 8 Bit Multiplexer	104-310	NAT	DM81LS95AN	1*
U4	IC, Quad 2 Input NOR Gates	104-203		74LS02	1*
U5	IC, UART	104-523	INT	P8251A	1*
U6	IC, Transceiver	104-720	MOT	MC1488L	1*
U7	IC, Transceiver	104-721	MOT	MC1489NL	1*
W1	16 Conductor, 9" length of color-coded ribbon cable		LSCI		1
XU1	Socket, IC, 24 Pin DIP	106-505	AUG	524-AGIID	1
XU3	Socket, IC, 20 Pin DIP	106-504	AUG	820-AGIID	1
XU4	Socket, IC, 14 Pin DIP	106-502	AUG	514-AGIID	3
XU5	Socket, IC, 28 Pin DIP	106-506	AUG	528-AGIID	1
XU6	Socket, IC, 14 Pin DIP	106-502	Aug	514-AGIID	REF
XU7	Socket, IC, 14 Pin DIP	106-502	AUG	514-AGIID	REF
Y1	Crystal, 1.8432 M Hz	103-991	MTRON	MP-2-1.8432 M Hz	1*

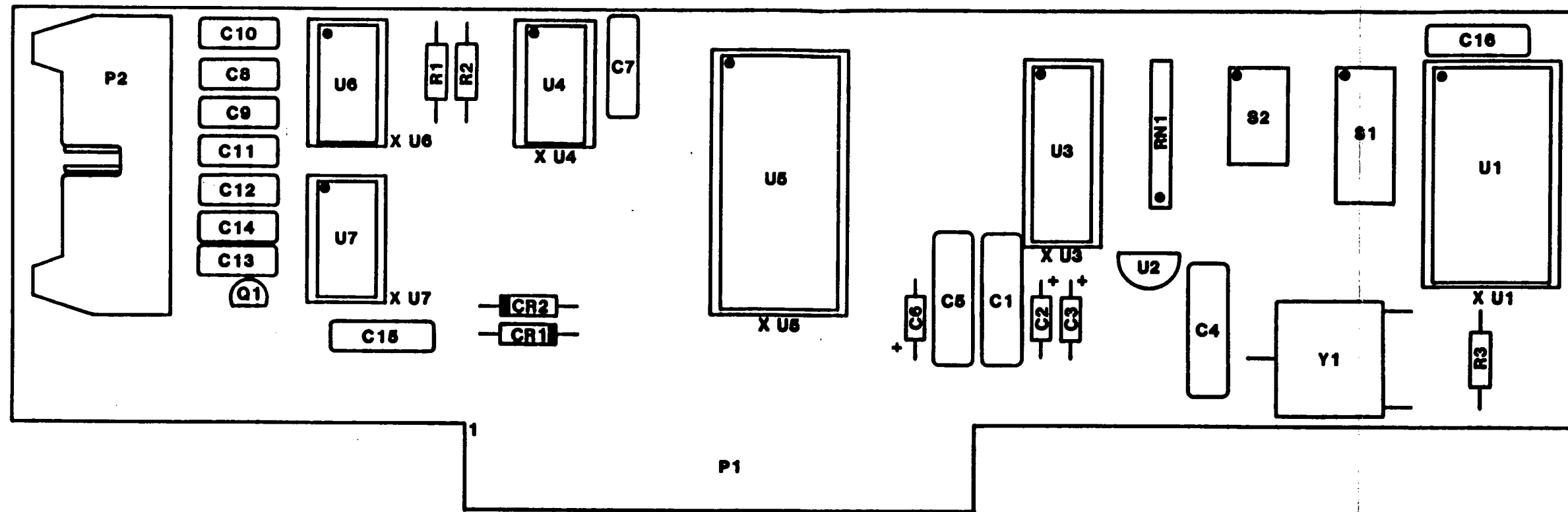


Figure F-7. Model 8223 RS-232C Interface Component Layout

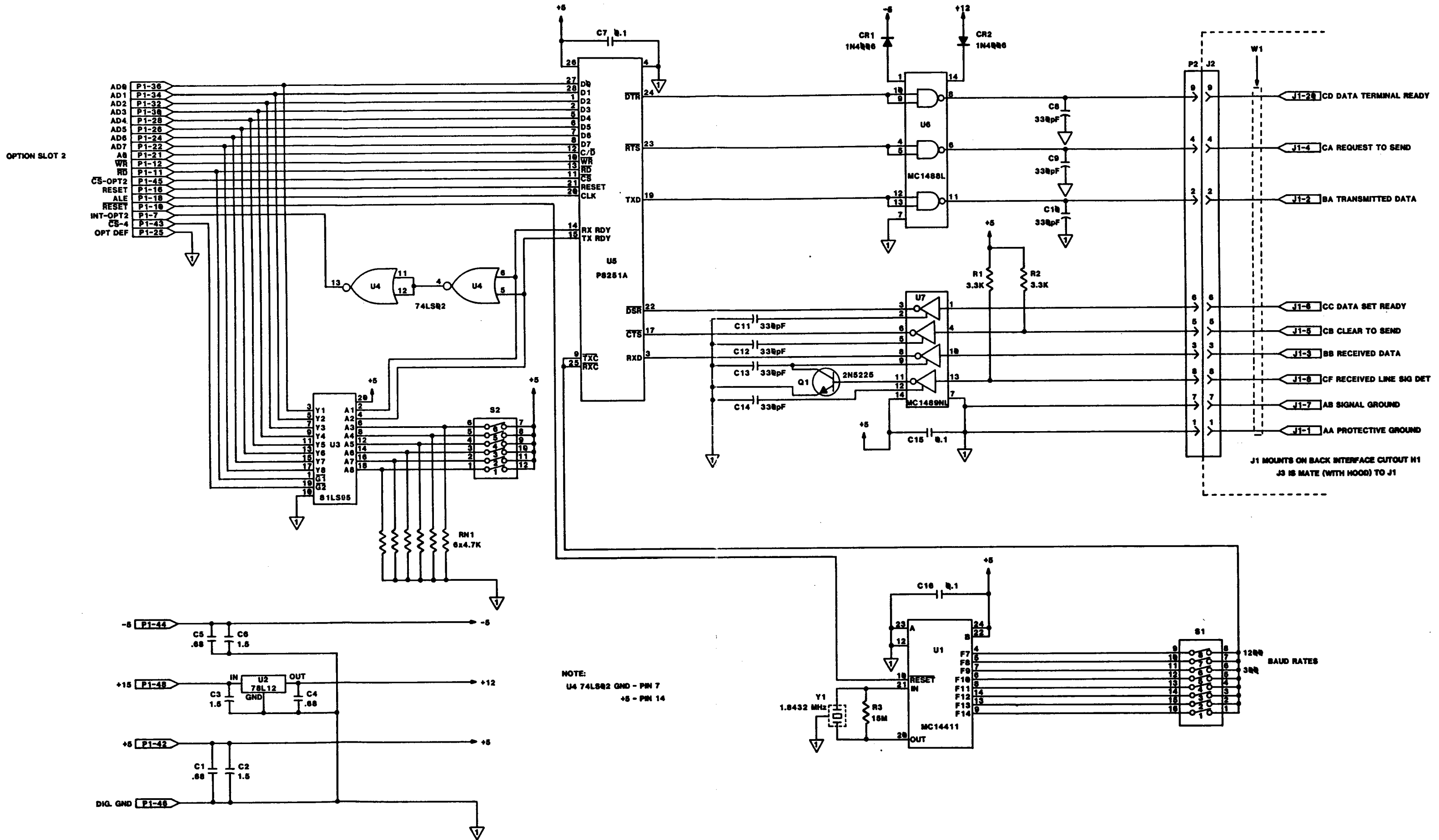


Figure F-8. Model 8223 RS-232C Interface Schematic

APPENDIX G

MODEL 8225 ANALOG OUTPUT

G-1. INTRODUCTION.

G-2. This Appendix contains general and specific information concerning the Model 8225 Analog Output. Included is a description, specifications, installation, operation and maintenance information.

G-3. DESCRIPTION.

G-4. The Model 8225 Analog Output is designed to be installed in a DRC-81C/82C and provide an analog output proportional to Kelvin temperature (or voltage in the case of the 82C) of the Sample or Control Sensor (jumper selectable) for the purpose of recording, either with a strip chart recorder or other similar device, the sensor temperature (or voltage).

G-5. Interface connections to the unit are made by way of a rear panel connector labeled MONITORS (refer to Figure 3.2 for location). The mating connector is supplied as an accessory to the instrument (refer to Table 2.2 for Monitor Plug Connections).

G-6. SPECIFICATIONS.

G-7. Specifications for the Model 8225 Analog Output are given in Section 1 of this manual.

G-8. INSTALLATION.

G-9. The 8225 can be installed in the DRC-81C/82C Option Slot 1 (if a Model 8222 BCD Interface is not present) or Option Slot 2 (if a Model 8223 RS232 Interface is not present). The 8225 Analog Output may be installed if either the 8222 or 8223 are installed but not if both are installed. Use the following procedure for the installation of the 8225 Analog Output PCB Assembly. (Note: when an option is ordered for field installation, the Customer should update the Options Installed Table in Appendix B to keep documentation current.)

1. Configure the red jumper on the 8225 PCB for either CONTROL or SAMPLE (the PCB is shipped with the jumper in the SAMPLE position).
2. With the power off, remove the three top panel screws and slide panel off. Note on the calibration cover the position of the Option Slot the 8225 PCB will occupy.

3. Remove the four screws that secure the calibration cover to its clips and remove cover (Note: the cover rests on fibre washers on the clips; when removing the cover care must be taken to avoid losing the washers into the unit.)
4. Plug the 8225 PCB into the Option Slot with the component side to the left of the unit as viewed from the front. Make sure the card is thoroughly seated.
5. Thread the black and white wires along the rear of the unit and solder the white wire to MONITOR - Pin C and black to MONITOR - Pin D.
6. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side to side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clip washers and starting the screws. Carefully move any mis-aligned card to its proper position and tighten cover screws. The addition of a new card may cause a slight bow in the cover which will go away as the foam is compressed.

G-10. OPERATION.

G-11. The 8225 outputs 10mV/°K of the selected temperature. In other words, 100.0°K on the SAMPLE display corresponds to a 1.000V output. The output is rounded to the nearest tenth of a degree. For a display of 23.42°K the output would be 0.234V and a display of 23.47°K would result in an output of 0.235V.

G-12. CALIBRATION.

G-13. The Model 8225 has been calibrated to specification prior to shipment. If recalibration is needed, refer to the following procedure. The following equipment is used to calibrate the 8225 Analog Output:

1. Digital Voltmeter (DVM) 4½ digit resolution or better, including a current scale.
2. Precision Standard Resistor - 100K ohm with a tolerance of ± 0.01% or better to simulate the input sensor.
or
3. Precision Voltage Standard - 100 µV out of 3V resolution or better.

The unit should be allowed a one-hour warm-up time to achieve rated specs.

Use the following procedure to calibrate the 8225 Analog Output:

1. Remove the three top panel screws and slide panel off.
2. Connect a DVM across the Analog Output MONITOR Pins C and D. Set the DVM to auto range.
3. With the unit on, use either load resistors or a voltage standard to simulate the input sensor. Go to a low temperature and adjust the trimpot labeled Z (for zero) on the calibration cover until the voltmeter reading corresponds to 10mV/K. Then go to a high temperature and adjust the trimpot labeled S (for Span).
4. Repeat step 3 until there is no Zero or Span adjustment required.
5. Install top panel.

G-14. REPLACEABLE PARTS.

G-15. Below is a list of Tables and Figures for the Model 8225 Analog Output schematic, replaceable parts list and illustrated component layout. Refer to Section 5 of this manual for ordering information.

Parts List	- Model 8225 Analog Output Board Assembly	Table G-1
Component Layout	- Model 8225 Analog Output Board Assembly	Figure G-1
Schematic	- Model 8225 Analog Output Board Assembly	Figure G-2

TABLE G-1

Parts List - Model 8225 Analog Output Board Assembly
LSCI Part #1000-034

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1	L/A OPTION CARD P.C. BOARD ARTWORK #: B-312-83-01A	111-050	LSCI	111-050	1
C1	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	3
C2	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	REF
C3	CAP, .1MF, 100V, POLY	101-042	PLSY	160.1K100G	1
C4	CAP, .68MF, 100V, POLY	101-046	PLSY	160.68J100G	REF
H1	3 PIN TERMINAL	110-201	SMTC	SS-132-G-9	3/20
H2	JUMP JAX	106-131	SEL	026-4810-00-C-252	1
R1	POT, 100K	103-005	BOR	3059Y-1-104	2
R2	POT, 100K	103-005	BOR	3059Y-1-104	REF
R3	RES, MTF, 301K, $\frac{1}{4}$ W, 1%	103-448			1
R4	RES, MTF, 174K, $\frac{1}{4}$ W, 1%	103-435			2
R5	RES, MTF, 174K, $\frac{1}{4}$ W, 1%	103-435			REF
R6	RES, MTF, 2K, $\frac{1}{4}$ W, 1%	103-278			1
U1	IC, PRG. PERIPH. INTER.	104-524	INT	P8255A-5	1*
U2	IC, 4 DIGIT DAC	104-425	BB	DAC71-CCD-V	1*
U3	IC, OP AMP	104-001	PMI	OPO7EP	1*
XU1	SOCKET, IC, 40 PIN, DIP	106-507	AUG	540-AGIID	1
XU2	SOCKET, IC, 24 PIN, DIP	106-505	AUG	524-AGIID	1
XU3	SOCKET, IC, 8 PIN, DIP	106-501	AUG	508-AGIID	1
W1	7" LONG TWISTED PAIR OF BLACK & SHITE WIRES		LSCI		1

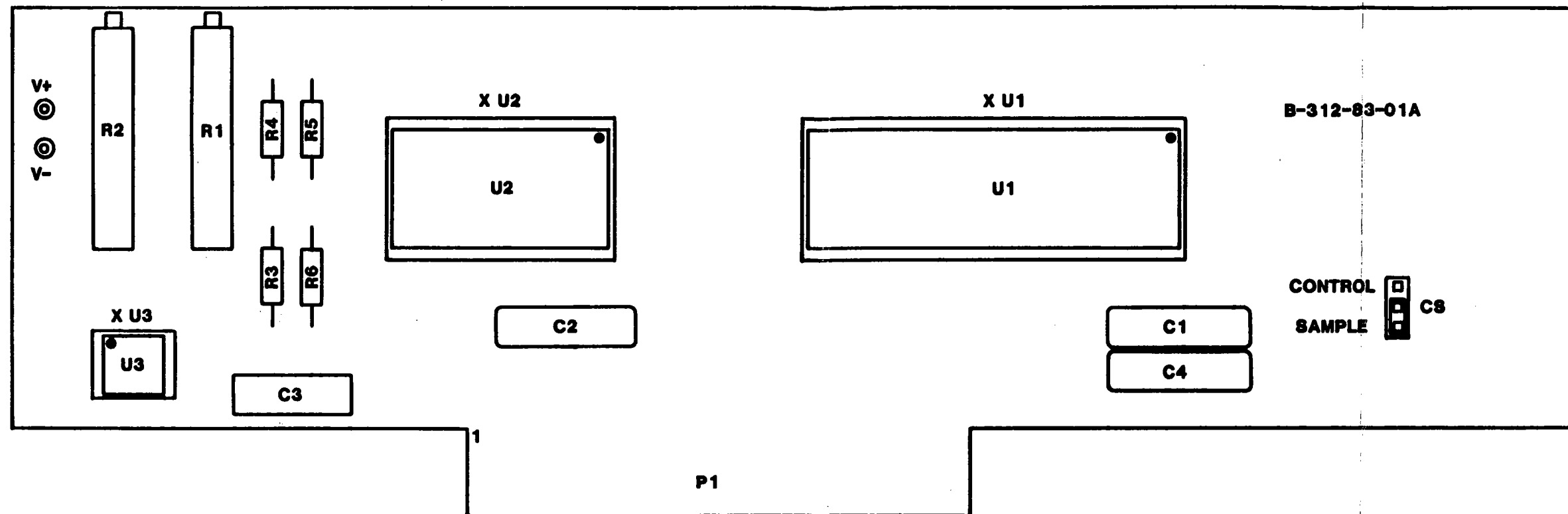


Figure G-1. Model 8225 Analog Output Component Layout

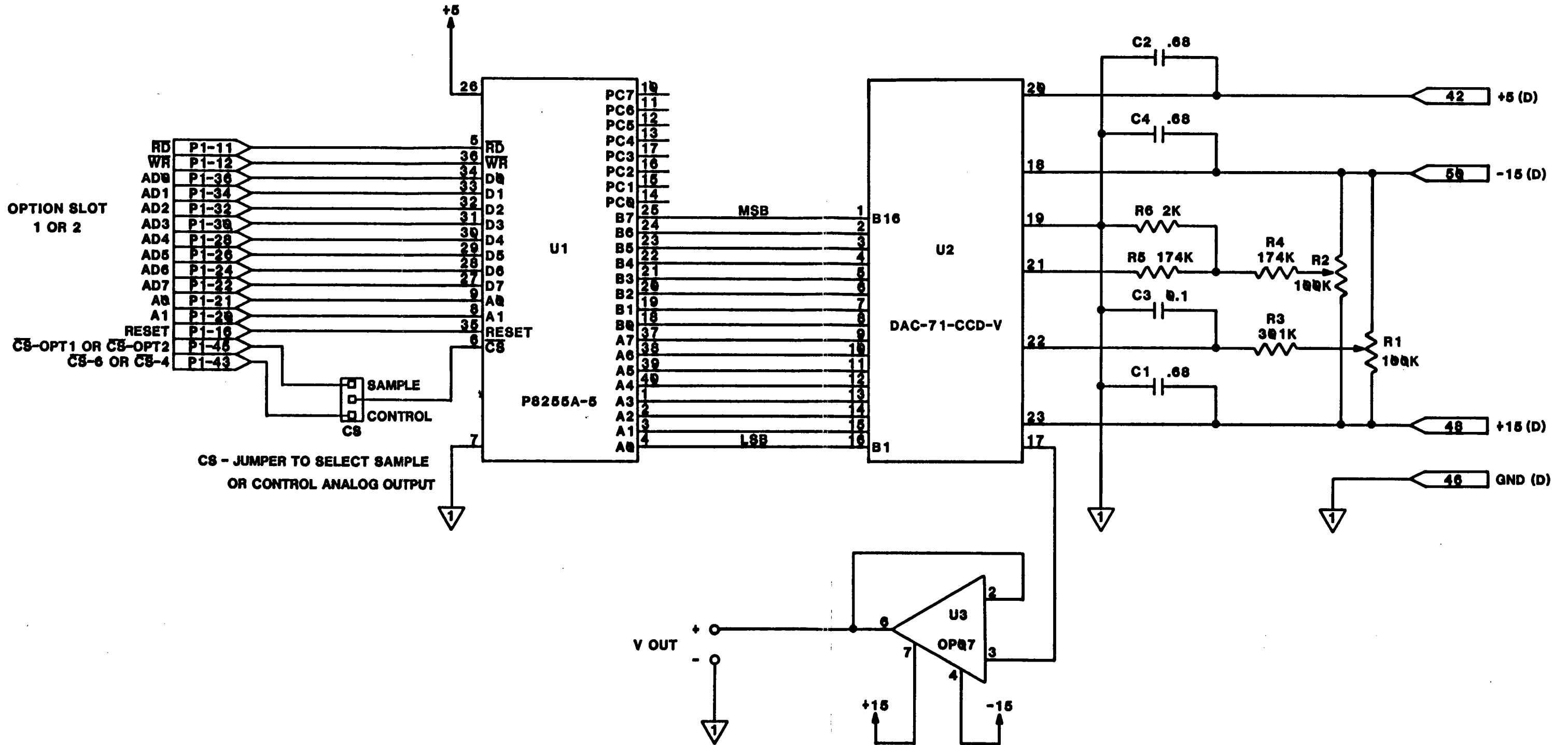


Figure G-2. Model 8225 Analog Output Schematic

APPENDIX J

Model 8211 Diode Input Card (6V)

J-1. INTRODUCTION.

J-2. This Appendix contains general and specific information concerning the Model 8211 Diode Input Card (6V). Included is a description, specifications, installation, operation and maintenance information.

J-3. DESCRIPTION.

J-4. The Model 8211 Diode Input Card (6V) is designed to be installed in a DRC-81C/82C to convert either Input A or Input B (or both with two options) to accommodate sensors with a voltage output of up to 6.5535 volts. The 8211 is used with Lake Shore TG-120 series sensors and requires a calibrated sensor and DRC-Precision Option to be direct reading in temperature.

J-5. SPECIFICATIONS.

J-6. Specifications for the Model 8211 are given in Table J-1.

J-7. INSTALLATION OF 8211 DIODE INPUT CARD (6V).

J-8. The 8211 can be installed in the DRC-81C/82C in place of either the Input A or Input B Analog Input Card (or both with two options).

TABLE J-1. Model 8211 Specifications

Temperature Range:	1.4 to 330 K with TG-120 Series Sensors
Sensor (order separately):	TG-120 Series GaAs sensors or other sensors having a voltage response up to 6.5535 volts
Sensor Excitation:	Constant Current, 10 microamperes \pm 0.005%
Sensor Response Curve:	DRC-Precision Option and calibration of sensor required for the unit to be direct reading in temperature
Input Voltage Range:	0 to 6.5535 Volts, 16 bit conversion yields a resolution of 100 μ V/Bit (Note: The increase in range of the input to 6V changes the resolution from \sim 43 μ V for the 8210 (3V) input card to 100 μ V for the 8211 (6V))

Use the following procedure for the installation of the 8211 Diode Input Card (6V). (Note: When an option is ordered for field installation, the customer should update the Options Installed Table in Appendix B to keep documentation current. If only one 8211 is ordered and its Input is not specified when ordered, it is installed in the Input A position).

1. With the power OFF, remove the three top panel screws and slide panel off. Note on the calibration cover the position of the Analog Input Card the 8211 will occupy.
2. Remove the four screws that secure the calibration cover to its clips and remove cover.
3. Gently unplug the Analog Input Card that is being replaced. Care should be taken not to stretch the wiring harness that connects the card to the instrument back panel.
4. Disconnect the wiring harness by lifting the locking tab on the Input Card connector and gently pulling on the body of the wiring harness mating connector.
5. Connect the wiring harness mating connector to the 8211 making sure that the wiring harness locking tab is seated over the extended edge of the wiring harness mating connector.
6. Plug the 8211 PCB into the Input Card Slot with the component side to the left of the unit as viewed from the front. Make sure the card is thoroughly seated. Verify that the wiring harness is in place correctly by noting that the "A" or "B" on the harness connector is facing up (if it is not, review the harness installation again).
7. Configure the internal 6 DIP switch package S8 on the main PCB to reflect the instrument input card configuration. The following table defines the switch settings where 0 indicates the switch is OPEN (OFF) and 1 indicates the switch is CLOSED (ON). (If the 8211 is to be used with an 8218C/053 Update Kit or any 82C with serial number greater than 13156, do not use the following table to configure S8. Refer to the configuration table in Section M for the proper switch settings.)

<u>Configuration</u>	<u>Switch</u>		
	<u>4</u>	<u>5</u>	<u>6</u>
Default to standard 8210/8219 Determination (*)	0	0	0
A-8211, B-(*)	0	0	1
B-8211, A-(*)	0	1	0
A-8211, B-8211	0	1	1
A-8211, B-8218	1	0	0
A-8218, B-(*)	1	0	1
A-(*) , B-8218	1	1	0

(Note: The 8218 Resistance Sensor Input Option is ordered separately.)

8. Gently unplug the Analog Control Card #1. Remove R6 and change R10 to 14.7 K (supplied). This changes the set point full scale voltage range from $\pm 3.0000V$ to $\pm 6.5535V$. (Note: This change will require a calibration of the set point voltage. See Section J-11. CALIBRATION of this Appendix). Before calibrating the setpoint close switch 2 of S8. This tells the instrument that a 6V input card has been installed.

9. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clip washers and starting the screws. Carefully move any misaligned card to its proper position and tighten cover screws.

J-9. INSTALLATION OF 82KT-6V PARTS KIT.

J-10. An 8211 Diode Input Card (6V) is a standard 8210 Diode Input Card (3V) with an 82KT-6V parts kit installed. Use the following procedure for the installation of the 82KT-6V into an 8210 Diode Input Card (3V):

1. Perform procedures 1-4 of Section J-8.
2. Remove U8 from its socket on the 8210 Diode Input Card and install it in XU1 of the 82KT-6V pcb (see Figure J-1).
3. Plug the 82KT-6V pcb into socket XU8 of the 8210 Diode Input Card.
4. Perform procedures 5-9 of Section J-8.

J-11. OPERATION.

J-12. The Model 8211 Diode Input Card (6V) supplies the 10 microampere excitation current to the sensor. The resulting sensor voltage is digitized by a 16 bit A/D converter with a resolution of 100 μ V/Bit and a full scale input voltage of 6.5535V. The digitized value is converted to a serial string and transferred to the main microprocessor using optical isolation. The sensor voltage is also buffered and transferred to the Monitor Plug and Control switch for further processing.

J-13. CALIBRATION.

J-14. If recalibration of the 8211 is needed, refer to the following procedure. The following equipment is used to calibrate the 8211 Diode Input Card (6V):

1. Digital Voltmeter (DVM) - $4\frac{1}{2}$ digit resolution or better.
2. Precision Standard Resistor - 100 K with a tolerance of $\pm 0.01\%$ or better.
3. Precision Voltage Standard - 100 μ V out of 10V resolution or better.

The unit should be allowed a one-hour warm-up time to achieve rated specifications. Use the following procedure to calibrate the 8211 Diode Input Card (6V):

1. Remove the three top panel screws and slide panel off.
2. Connect the precision resistor across pins A and B of the Input Connector that has the 8211 Option installed. Adjust the trimpot marked I on the calibration cover for the appropriate Input Card until the voltage across the resistor is 1.0000V \pm 100 μ V.
3. Calibrate the Monitor Output. Connect the DVM positive lead to the Monitor Plug Voltage Output pin. With the precision resistor still in place, or with the Voltage Standard across the sensor Voltage input pins to simulate a 1.0000V input, adjust the trimpot marked B on the calibration cover until the DVM reads 1.0000V.
4. Calibrate the A/D Converter. For the 82C, put the Sample Display into voltage mode and set the Sample switch to the 8211 input. Set the standard to 3.0000V and adjust the trimpot marked A/D until the display reads 3.0000 volts. To check linearity, verify that with inputs of 5.0000V and 1.0000V display properly within $\pm 100 \mu$ V.

For the 81C, refer to the Breakpoint Information Table of the DRC-Precision Option and select a middle range temperature near 3.0000V. Adjust the A/D trimpot until the display reads the proper temperature within ± 0.1 K. Verify linearity by inputting a high and low temperature point.

5. The balance of the calibration requires the removal of the the calibration cover. Remove the four screws that secure the calibration cover to its clips and remove cover.
6. Calibrate the Set Point D/A Converter. For the 82C, change the Control Input to the 8211 input and the Control Units to volts by turning "ON" (1) switch 1 of the appropriate sensor ID. Connect the DVM across the set point voltage test points near the front edge of the Analog Control Card #1 pcb. The V+ test point is closest to the front of the unit and the GND is closest to the rear of the unit. Enter a set point of 0.0000V. Adjust the trimpot marked SETPOINT Z on the calibration cover until the DVM reads 0.0000V. Enter a set point of 5.0000V and adjust the trimpot marked SETPOINT S until the DVM reads - 5.0000V. Repeat the 0.0000V and 5.0000V entries until there is no variation.

For the 81C, connect the DVM across the set point voltage test points similar to the 82C. Enter a set point around 300 K. Refer to the Breakpoint Information table of the DRC-Precision Option and adjust trimpot marked SETPOINT Z until the DVM reads the correct voltage. Enter a low set point, i.e., 30 K. Adjust the trimpot marked SETPOINT S until the DVM reads the proper voltage. Repeat the high and low temperature adjustments until there is no variation.

7. Replace calibration cover and top panel.

J-15. USER GENERATED CURVE INFORMATION FOR THE 8211.

J-16. The format for data to be stored using the XCN_1N_2 command (as outlined in Section 3) is the same as for a standard curve. The curve data is in table form with voltages and temperatures in ascending voltage order. The voltages and temperatures for the 8211 are in volts up to 6.5535 and K up to 399.9.

J-17. REPLACEABLE PARTS.

J-18. Below is a list of Tables and Figures for the Model 8211 Diode Input Card (6V) schematic, replaceable parts list and illustrated component layout. Refer to Section 5 of this manual for ordering information.

Parts List	- Model 8211 Diode Input Card (6V) Board Assembly (consisting of the 8210 Diode Input card (3V) and 82KT-6V Parts Kit lists)	Table J-2
Component Layout	- Model 8211 Diode Input Card (6V) Board Assembly (showing an 8210 Diode Input Card (3V) with an 82KT-6V pcb superimposed)	Figure J-1
Schematic	- Model 8210 Diode Input Card (3V) Board Assembly	Figure J-2
Schematic	- 82KT-6V Board Assembly	Figure J-3

TABLE J-2. Model 8211 Diode Input Card (6V)
(Model 8210 Diode Input Card (3V)
Board Assembly)

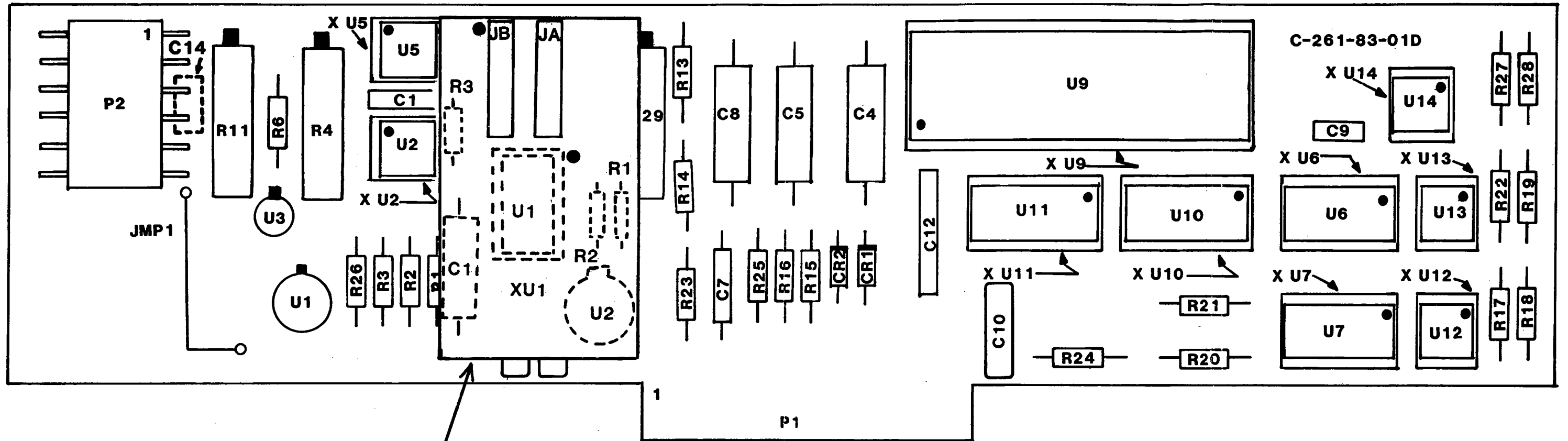
ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1A3	Analog input card P.C. Board Artwork #: C-261-83-01D	111-044	LSCI	111-044	1
C1	CAP, MICA, 150PF, 500V	101-085	CDE	CD15CD151G03	1
C2	CAP, POLY, .0015MF, 100V	101-001	CDE	WMF1D15	1
C3	CAP, POLY, .33MF, 100V	101-025	PLSY	150.33K100FC	1
C4	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	3
C5	CAP, POLY, 1.0MF, 100V	101-032	PLSY	1501K100FC	REF
C6	CAP, MICA, 330PF, 500V	101-094	CDE	CD15CD331G03	1
C7	CAP, TANT, 1.5MF, 10V	101-132	SPRG	150D155X9010A2	1
C8	CAP, POLY, 1.0MF, 100V	101-032	PLSY	150.1K100FC	REF
C9	CAP, MYLAR, 50PF, 500V	101-073	CDE	CD15ED500G03	1
C10	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	3
C11	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C12	CAP, POLY, .68MF, 100V	101-046	PLSY	160.68J100G	1
C13	CAP, POLY, 0.1MF, 100V	101-042	PLSY	160.1K100G	REF
C14	CAP, MYLAR, 30PF, 500V	101-067	CDE	CD15ED300J03	1
CR1	DIODE, SIL, G.P.	102-062	FLD	IN459A	2*
CR2	DIODE, SIL, G.P.	102-062	FLD	IN459A	REF
JMP1	1/2" Wire Jumper, SIL		LSCI		1
JMP2	NOT PRESENT				
P2	6 Post Locking Conn.	106-142	MOL	2420-09-75-1061	1
R1	RES, MTF, 10K, 1%, 1/2W	103-358			1
R2	RES, MTF, 1.54K, 1%, 1/2W	103-272			1
R3	RES, MTF, 3.74K, 1%, 1/2W	103-296			2
R4	POT, 5K	103-049	BOR	3059Y-1-502	2
R5	RES, MTF, 499K, 1%, 1/2W	103-461			1
R6	RES, MTF, 442Ω, 1%, 1/2W	103-237			1
R7	Not Present				
R8	Not Present				
R9	Not Present				
R10	Not Present				
R11	POT, 20K	103-051			1
R12	RES, MTF, 150K, 1%, 1/2W	103-431			1
R13	RES, MTF, 64.9Ω, 1%, 1/2W	103-214			1
R14	RES, MTF, 196Ω, 1%, 1/2W	103-225			1
R15	RES, MTF, 49.9K, 1%, 1/2W	103-397			1
R16	RES, MTF, 301K, 1%, 1/2W	103-448			1
R17	RES, MTF, 392Ω, 1%, 1/2W	103-234			3

TABLE J-2. Model 8211 Diode Input Card (6V)
 (Model 8210 Diode Input Card (3V)
 Board Assembly, cont'd.)

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
R18	RES, MTF, 392Ω, 1%, 1/2W	103-234			REF
R19	RES, MTF, 4.75K, 1%, 1/2W	103-306			4
R20	RES, MTF, 4.75K, 1%, 1/2W	103-306			REF
R21	RES, MTF, 4.75K, 1%, 1/2W	103-306			REF
R22	RES, MTF, 392Ω, 1%, 1/2W	103-234			REF
R23	RES, MTF, 1.18K, 1%, 1/2W	103-267			1
R24	RES, MTF, 4.75K, 1%, 1/2W	103-306			REF
R25	RES, MTF, 100K, 1%, 1/2W	103-420			1
R26	RES, MTF, 3.74K, 1%, 1/2W	103-296			REF
R27	RES, MTF, 2K, 1%, 1/2W	103-278			1
R28	RES, MTF, 40.2K, 1%, 1/2W	103-388			1
R29	POT, 5K	103-049	BOR	3059Y-1-502	REF
U1	LIN, REF	102-043	NAT	LM399H	1 *
U2	IC, LIN, OP AMP	104-005	NAT	LM308N	1 *
U3	FET, P-CH ENH.	102-074	SIL	3N163	1 *
U4	Not Present				
U5	IC, LIN, OP AMP	104-001	PMI	OP07EP	1 *
U6	IC, INVERTER	104-207	NAT	74LS04	2 *
U7	IC, INVERTER	104-207	NAT	74LS04	REF
U8	IC, A/D REF	104-460	ISL	ICL8068ACPD	1 *
U9	IC, A/D CONVERTER	104-461	ISL	ICL7104-16CPL	1 *
U10	IC, P-S SHIFT REG.	104-099	NAT	CD4021BCN	2 *
U11	IC, P-S SHIFT REG.	104-099	NAT	CD4021BCN	REF
U12	IC, OPTO-COUPLER	104-350	HP	HCPL-2530	1 *
U13	IC, OPTO-COUPLER	104-352	HP	6N135	1 *
U14	IC, TIMER	104-051	ISL	ICM7555IPA	1 *
XU2	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	5
XU4	Not Present				
XU5	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU6	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	3
XU7	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	REF
XU8	SOCKET, IC, 14 PIN DIP	106-502	AUG	514-AGIID	REF
XU9	SOCKET, IC, 40 PIN DIP	106-507	AUG	540-AGIID	1
XU10	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	2
XU11	SOCKET, IC, 16 PIN DIP	106-503	AUG	516-AGIID	REF
XU12	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU13	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF
XU14	SOCKET, IC, 8 PIN DIP	106-501	AUG	508-AGIID	REF

TABLE J-2. Model 8211 Diode Input Card (6V)
(82KT-6V Parts Kit)

ITEM NO.	DESCRIPTION	LSCI STOCK NO.	MFR	MFR PART NO.	TOT QTY
A1	Mod. Board Assembly Artwork #: A-310-85-01A	111-052	LSCI	111-052	1
C1	CAP, PP, 0.33MF, 100V	101-025	F-DYNE	MPP11-0.33MF	1
JA, JB	Mod. Board (U1) to Analog Input Card (U8) Interface (2) 7 Pin Socket Strips	106-595	SAMT	BBS-107-G-B	2
R1	RES, MTF, 3.74K, 1%, 1/4W	103-296			1
R2	RES, MTF, 649 ohm, 1%, 1/4W	103-247			1
R3	RES, MTF, 300K, 1%, 1/4W	103-448			1
R4	RES, MTF, 14.7K, 1%, 1/4W (Replaces R10 on Analog CC#1)	103-362			1
U2	IC, Reference	102-043	NAT	LM399H	1
XU1	Socket, IC, 14 Pin DIP	106-502	AUG	514-AGIID	1



82KT-6V PARTS KIT PCB ASSEMBLY

FIGURE J-1. Model 8211 Diode Input Card (6V) Board Assembly

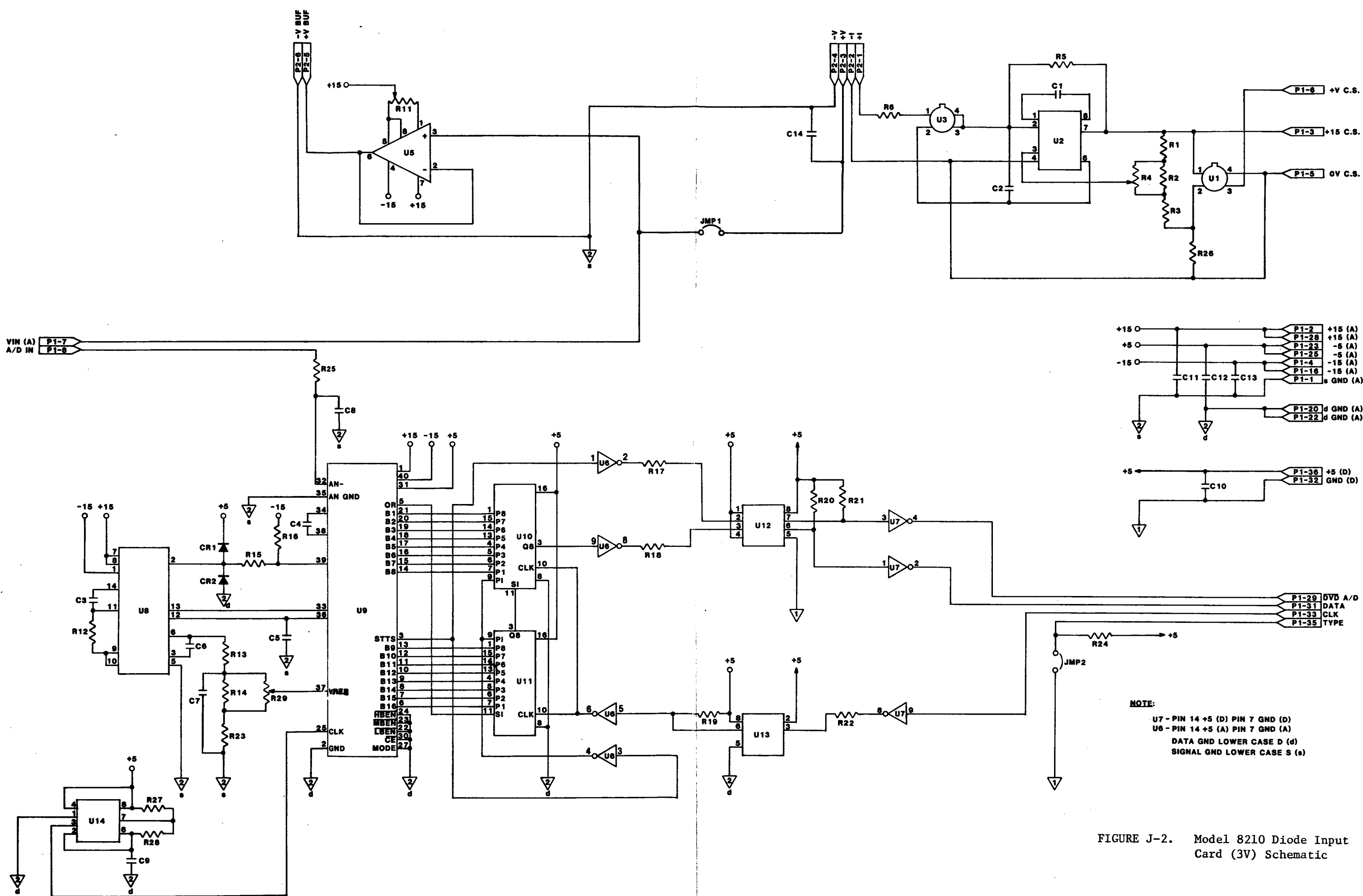


FIGURE J-2. Model 8210 Diode Input Card (3V) Schematic

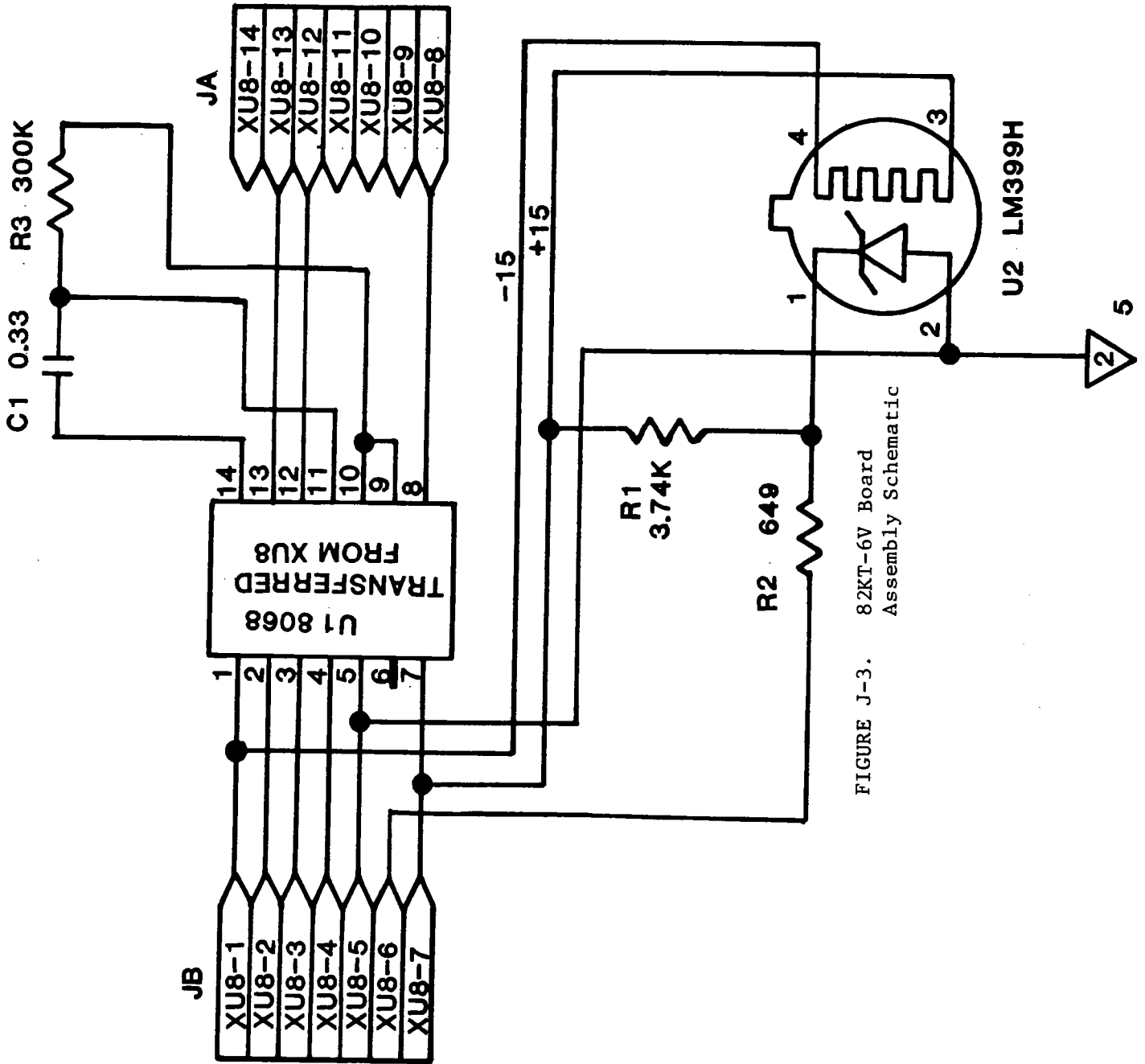


FIGURE J-3. 82KT-6V Board Assembly Schematic

**DIFFERENCES BETWEEN M82C.OBJ 9-1-87
AND THE PREVIOUS MODEL 82C SOFTWARE**

1. The operation of the 8218C Resistance Input Card has changed dramatically. There is a new manual section that outlines the 8218C operation. Units in the field would require a Model 054 Program PROM Update as well as a documentation update. The manual section is now headed MODEL 8218C RESISTANCE INPUT CARD instead of APPENDIX M.

MODEL 054

PROGRAM PROM UPDATE FOR THE DRC-82C AND
8218C RESISTANCE INPUT CARD

DESCRIPTION

The 054 Program PROM Update is for the DRC-82C and 8218C Resistance Input Card. The update incorporates the following changes in the operation of the DRC-82C with 8218C Input Cards installed:

1. The DRC-82C will allow control resistances less than 10 ohms (resistances to 0.00 ohms can be entered, but accuracy and stability suffer greatly below 1 ohm).
2. Accuracy of the control resistance reading when not at the set point has been improved. The 8218C Input Card forces between 8 and 13 millivolts across the sensor while controlling.
3. If thermal correction is active, the thermal is retained while the control point is changing or until the control point has stabilized enough to update the thermal value. This allows for ramping of the set point to include thermal correction.
4. The overall speed of the update of the DRC-82C has been increased.

INSTALLATION

The following procedure outlines the installation of the Model 054 Update. The materials supplied are:

- 1 DRC-82C Updated Software Program PROM (labeled M82C.OBJ)
- 2 8218C Updated Software Program PROM (labeled M9318C.OBJ)

Install the Model 054 Update as follows:

WARNING

To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before removing cover.

1. Set the POWER switch to OFF and disconnect the power cord from the DRC-82C. Remove the three top panel screws and slide the panel off. Note from the calibration cover the position of the Microprocessor Card and the A and B Channel Input Cards.
2. Remove the four screws that secure the calibration cover to its clips and remove cover.
3. The DRC-82C Program PROM is the 2nd device from the front of the DRC-82C on the Microprocessor Card. Carefully replace the old DRC-82C Program PROM with the new Program PROM (the sticker on the top of the device should read M82C.OBJ, with the notch indicating pin 1 to the top). Extreme care must be taken with the serial communications lines between the Microprocessor Card and the Display Driver Board.
4. The 8218C Program PROM is plugged into the microprocessor on the A and/or B 8218C Input Card. The microprocessor is located in the top right corner of the card closest to the front of the DRC-82C. Carefully replace the old 8218C Program PROMS with the new Program PROMS (the sticker on top of the device should read M9318C.OBJ, with the notch indicating pin 1 to the top). Due to the tight space between cards, it may be necessary to unplug the Input Card to change the PROM. Two PROMS have been included even though there may only be one 8218C installed in the unit.
5. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clips and starting the screws. Carefully move any misaligned card to its proper position and tighten the cover screws.
6. Return the old PROMS and any spare PROMS to Lake Shore or a factory representative.

MODEL 8218C RESISTANCE INPUT CARD

8218C-1. INTRODUCTION

8218C-2. This section contains information pertaining to the Model 8218C Resistance Input Card. Included is a description, specifications, installation, operation and maintenance information.

8218C-3. DESCRIPTION

8218C-4. The Model 8218C Resistance Input Card is designed to be installed in a DRC-82C to convert either Input A or Input B (or both with two cards) to accommodate sensors where the voltage level must be kept at levels on the order of 10 millivolts and where a thermal voltage may exist. The 8218C can be used with germanium, carbon glass or carbon resistors or any other negative temperature coefficient resistors and will read in ohms from a full scale reading of 10 ohms with 1 milliohm resolution to a full scale reading of 100,000 ohms with 1 ohm resolution. To read temperature accurately, a calibrated sensor and an 8000 Series Precision Option is required. Refer to Section 8218C-9 for a detailed description of the operation of the 8218C.

8218C-5. SPECIFICATIONS

8218C-6. Specifications for the Model 8218C Resistance Input Card are given in Table 8218C-1 of this Section.

8218C-7. INSTALLATION

8218C-8. The 8218C can be installed in a DRC-82C as either Input A or Input B (or both with two cards). The 8218C is installed prior to shipment if ordered with a DRC-82C. If only one 8218C is ordered and its input is not specified when ordered, it is usually installed in Input A. Use the following procedure for the installation of the 8218C Resistance Input Card. (Note: when a card is ordered for field installation, the Options Installed Table, Table B-1, in Appendix B should be updated to keep documentation current. If the 8218C is to be installed in a DRC-82C that does not have an 8218C Input Card in it already, a Model 053 Upgrade Kit may need to be installed for the 8218C to operate properly. DRC-82Cs with serial number 13155 and higher have an 053 Upgrade installed whether or not an 8218C was ordered with the unit. For units with serial number 13154 and lower that do not already have an 8218C installed, contact a factory representative to obtain an 053 Upgrade Kit. Installation of the Model 053 Upgrade Kit is covered later in this Section.)

**Table 8218C-1. Specifications,
Model 8218C Resistance Input Card**

Input Range: Less than 1 ohm to 100,000 ohms with a resolution of 1 part in 10,000 and an accuracy of 0.05% of reading for resistances from 10 to 10,000 ohms and 0.25% of range for resistances less than 10 ohms and from 10,000 to 100,000 ohms.

Sensor Excitation: Current range is from 0.1 microampere to 1 milliamperere. The current is varied automatically to maintain the voltage across the sensor at 10 millivolts. Current polarity is periodically reversed to allow for automatic digital correction for thermal EMFs in the sensor connections and leads.

Temperature Range: Depends on sensor type used. Sensor resistance scales from 1 to 100,000 ohms can be accommodated.

Sensors (Ordered Separately): Card optimized for CGR Series Carbon Glass or GR Series Germanium Resistance Thermometers. Other negative temperature coefficient resistors (such as thermistors) can also be used.

Sensor Response Curve: The DRC-82C displays resistance in ohms directly. A calibrated sensor and an 8001 Precision Option curve generated using Lake Shore's proprietary Polynomial Interpolation Algorithm are required for the unit to display temperature accurately.

Input Resistance: Greater than 10^9 ohms (sensor voltage measurement).

Maximum Sensor Power Dissipation: Depends on sensor resistance. Voltage applied is typically 10 millivolts, power is $100/R$ in microwatts.

Display Resolution: 5 digits. Displays 0.000 to 99999. ohms. Resultant temperature accuracy is a function of sensor characteristic and is the product of the input accuracy (in percent) times $R (dT/dR)$ plus any transfer inaccuracy introduced by the sensor response curve.

Temperature Control Signal: Card generates an analog voltage output signal which is related to the sensor temperature. The instrument generates a similarly related set point voltage based on the set point resistance or temperature selected. Real-time analog comparison of these two voltages provides the required control signal.

WARNING

To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before removing cover.

1. Set the POWER switch to OFF and disconnect the power cord from the unit. Remove the three top panel screws and slide the panel off. Note from the calibration cover the position of the Input Card the 8218C will occupy.
2. Remove the four screws that secure the calibration cover to its clips and remove the cover.
3. Unplug the Input Card which is to be replaced. Disconnect the wiring harness mating connector by lifting the locking tab on the Input Card and gently pulling on the body of the wiring harness mating connector.
4. Connect the wiring harness mating connector to the 8218C Input Card making sure that the wiring harness locking tab is seated over the extended edge of the wiring harness mating connector. Plug the 8218C into the Input Card Slot with the component side facing to the left of the unit as viewed from the front. Make sure the card is thoroughly seated. Verify that the wiring harness is in place correctly by noting that the "A" or "B" on the harness connector is facing up (if it is not, review the harness installation again).
5. If a 1.0 microfarad capacitor is attached across pins A and B of the input connector the 8218C now occupies, detach the wires from the cap noting the wires original positions. Remove the cap and re-attach the wires to their original positions on pins A and B of the input connector. Note: if an 8210/8211 Diode Input Card or 8219 Platinum Input Card is to be used in the same Input Card Slot again, the 1.0 microfarad cap must be re-installed between pins A and B of the input connector.
6. Configure Internal ID 6 DIP switch package S8 on the Main Board to reflect the current Input Card configuration. The following table defines the switch

settings where 0 indicates the switch is OPEN (OFF) and 1 indicates the switch is CLOSED (ON).

Configuration		Switch			
Input A	Input B	3	4	5	6
8210/8219	8210/8219	0	0	0	0
8211	8210/8219	0	0	0	1
8210/8219	8211	0	0	1	0
8211	8211	0	0	1	1
Reserved for Set Point Cal		0	1	1	1
8210/8219	8218C	1	0	0	0
8218C	8210/8219	1	0	0	1
8211	8218C	1	0	1	0
8218C	8211	1	0	1	1
8218C	8218C	1	1	0	1
Reserved for Set Point Cal		1	1	1	1

7. Install the calibration cover and top panel. The calibration cover has foam strips that restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots are accessible through the cover. This is accomplished by placing the cover on top of the cover clips and starting the screws. Carefully move any misaligned card to its proper position and tighten the cover screws.

8218C-9. OPERATION

8218C-10. The 8218C is a highly complex, microprocessor controlled Input Card. It's resistance measuring technique is distinctly different from the way a DMM would measure resistance. Most DMMs force a large enough signal across the device being measured to make any thermal offset negligible. Using this method in a cryogenic environment could add a significant amount of power, in the form of sensor self heating, to the test system. The 8218C Input Card limits the amount of power added to the system by limiting the voltage across the sensor to about 10 millivolts. The 8218C can also reverse the current polarity in order to correct for thermal EMFs in the sensor connections and leads.

8218C-11. The 8218C current source has four ranges: 0.1 to 1 microamperes (Range 1), 1 to 10 microamperes (Range 2), 10 to 100 microamperes (Range 3) and 100 to 1000 microamperes (Range 4). Each range has 64 independent current values. The ranges overlap each other (for example, Range 1 - Value 60 is equivalent to

Range 2 - Value 6) so that a smooth transition from range to range can be made. The current value, as well as direction, is controlled by a 16 bit bipolar D/A converter. This current resolution is required to maintain as close to 10 millivolts across the sensor as possible. The on-card microprocessor stores calibration constants for each of the four ranges at the end point values of 6 and 60 for both the positive and negative directions (a total of 16 current calibration constants in all).

8218C-12. The resulting sensor voltage is converted from a differential to single ended signal and amplified by a factor of 100. The amplified signal is digitized by a microprocessor controlled 15 bit A/D converter. The microprocessor also has calibration constants stored for the gain and offset of the input amplifier. As a result of the A/D resolution and calibration constant manipulation of the sensor signal, the sensor signal can be digitized with a resolution of 1 part in 10,000 over most of the resistance range the 8218C covers. There is also a sample-and-hold network on the card so that when the sensor signal is reversed for thermal correction while controlling, the correct polarity of the control signal is maintained.

8218C-13. Operation as the Sample Input

8218C-14. When the input the 8218C occupies is selected as the Sample Input (Sample only - not Control), the card tries to determine the resistance and force the voltage across the sensor to 10 millivolts as quickly as possible. Once a forward current range and value have been reached to force the 10 millivolt signal, the current is reversed and the thermal value determined. As long as the voltage across the sensor does not change more than 0.5% of reading from one reading to the next, the forward and reverse readings are taken each time the input card is asked for an update (approximately once a second) and a new thermal value is determined. If the voltage changes more than 0.5% of reading, the card stops reversing the current and uses the thermal value previously determined until the sensor signal stabilizes.

8218C-15. Operation as the Control Input

8218C-16. When the input the 8218C occupies is selected as the Control Input (Control only, or Sample and Control) the operation of the card changes. Since the card has to contend with forcing a signal across the sensor that would either turn on or off the heater power, it can no longer force the sensor signal to 10 millivolts as quickly as possible. When a set point is entered, the instrument calculates the optimum current range and value to

maintain as close to 10 millivolts across the sensor as possible (when the control point is reached) and transmits them to the 8218C. The range and value are determined from the current and voltage constants stored and the set point resistance. It then determines what the equivalent forward voltage value would be for that point and makes it the set point voltage. If the thermal correction is active (switch 3 of the SENSOR ID is CLOSED (ON)) and there has been a valid thermal value determined, it is included in the calculation. If no valid thermal has been determined, or the thermal correction is inactive (switch 3 of the SENSOR ID is OPEN (OFF)), the thermal value used in the set point voltage calculation is forced to 0.

8218C-17. When the new set point current range and value have been transmitted to the 8218C, the Input Card determines whether the actual sensor resistance is above or below the set point resistance. If the actual resistance is less than the set point resistance, an over-temperature condition exists and the heater power should be off. The 8218C changes the current it applies to the sensor in order to maintain between 8 and 10 millivolts across it until the set point current range and value have been reached. In this way, the heater remains off until the actual sensor resistance approaches the set point resistance. Once the set point current value has been reached, the 8218C allows the sensor voltage to go as high as 13 millivolts. If the sensor voltage (and the equivalent resistance) continues to increase (an under-temperature condition exists), the 8218C changes the current to maintain between 11 and 13 millivolts across the sensor to try to force the heater power to come on. Even though this operation takes the sensor voltage away from the optimum 10 millivolt signal until it reaches the control point, the resulting error in the resistance determination is small. If the new set point results in an under-temperature condition, the opposite operation is performed.

8218C-18. If the thermal correction is active, the 82C monitors the sensor resistance until it is within 0.5% of the set point resistance. Once it is, the 82C signals the 8218C card to reverse the sensor current and update the thermal value. The 8218C card and the 82C use this new thermal to determine the resistance and correct the set point. The thermal value is updated every 120 instrument update cycles (about 2 minutes) after the initial update. When the set point is changed, the previous thermal value is used until the correction criteria is met and the thermal updated again.

8218C-19. CALIBRATION SCHEDULE AND EQUIPMENT

8218C-20. The design of the 8218C Resistance Input Card is such that re-calibration should not be required more often than every six to twelve months in order to keep the card within its accuracy specification. However, if re-calibration is required, the following equipment is needed to re-calibrate the card:

1. Digital Voltmeter (DVM) - 5 1/2 digit resolution or better.
2. Five (5) Precision Standard Resistors which are accurate in value to at least 0.005%. Their values must be:
 - a. 10 ohms
 - b. 100 ohms
 - c. 1,000 ohms
 - d. 10,000 ohms
 - e. 100,000 ohms
3. Precision Voltage Standard - capable of outputting a plus and minus 10 millivolt signal to within +/- 1 microvolt.

8218C-21. Since very often these values will not be available to the user of this instrument, Lake Shore Cryotronics, Inc. offers a service to re-calibrate these cards. Contact a factory representative for information concerning re-calibration. Note that the card believes that the correct resistance and voltage is applied during calibration, therefore the accuracy of the calibration depends on the accuracy of the standards used.

8218C-22. CALIBRATION

8218C-23. The 82C should be allowed a one hour warm-up time to achieve rated specifications. References are made in the calibration procedure to eight calibration switches, CAL 8 thru CAL 1. There are two hardware configurations of the calibration switches for the 8218C. Refer to Table 8218C-2 for the hardware switch definitions of CAL 8 thru CAL 1. Use the following procedure to calibrate the 8218C Resistance Input Card.

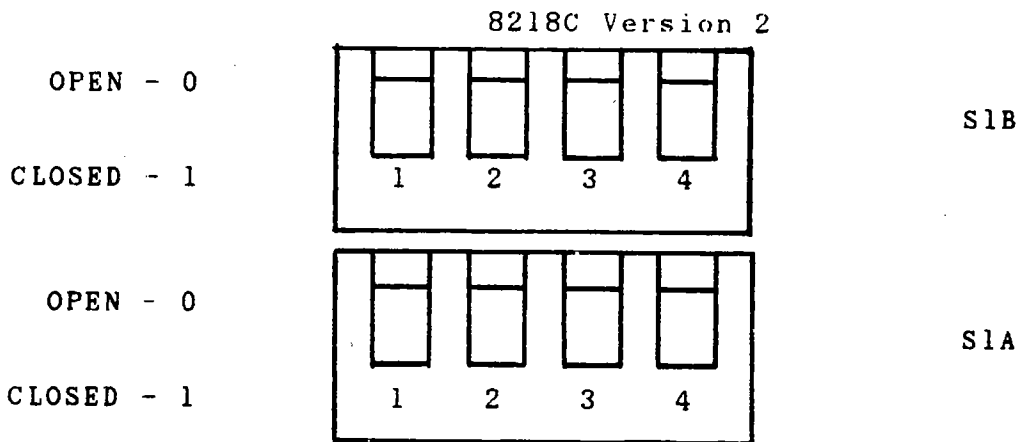
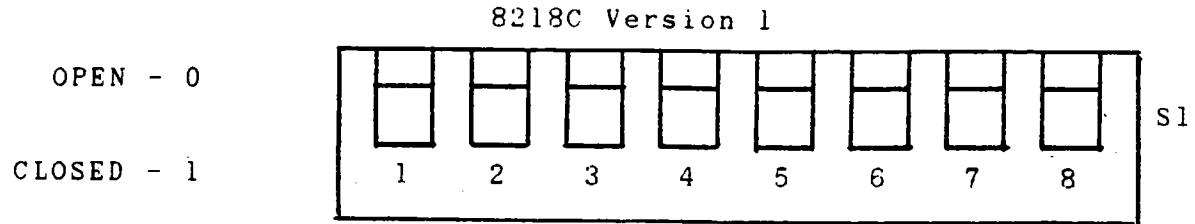
1. Remove the three top panel screws and slide the panel off.
2. Remove the calibration cover from the unit by removing four screws which secure the cover to its clips.

3. Configure the input that contains the 8218C as the SAMPLE input only and make the units R. Take the Digital Filtering and Thermal Correction DIP switches of the appropriate SENSOR ID (switches 2 and 3) to the OPEN (OFF) position.
4. Connect the 100K ohm precision resistor across the +I and -I pins of the 8218C Resistance Input Card input connector and enable both CAL 8 and CAL 7 of the card. Attach the plus and minus leads of the DVM to TP2 and TP1 respectively of the 8218C PCB and adjust trimpot R26 on the 8218C so that the voltage reads as close to zero as possible. If this voltage is not close to zero, it may effect the sensor current setting. Consequently, this operation should be performed before any current calibrations are performed. Disable CAL 7 and continue. Note that CAL 8 will remain enabled for all calibration operations.
5. Connect the DVM plus and minus leads to the V+ and V- Sensor Output Signal terminals of the MONITORS connector for the input being calibrated. Apply a +10 millivolt signal to the +V and -V Sensor Input terminals. Enable CAL 6 on the card (CAL 8 is still enabled). The DVM should read about 1 volt and the display of the unit should read approximately 10000. Adjust trimpot R17 so that the voltage read on the DVM matches the display of the unit (if the DVM reads 1.0085 make the display read 10085.). If the trimpot is adjusted wait a minimum of 10 readings before disabling CAL 6.
6. Apply a -10 millivolt signal to the input and enable CAL 5. Do not adjust any of the trimpots. Disable CAL 5 after approximately 30 seconds. When the display goes to 0. the unit has completed determining the voltage input calibration constants and has stored them in the 8218C calibration EEPROM.
7. Configure the 100K resistor to simulate the sensor. Enable CAL 4 and monitor the unit's display. The display should indicate the number 106. for approximately 30 seconds and then display 0. indicating the end of the 100K range calibration. Disable CAL 4 and continue.
8. Substitute a 10K resistor for the 100K resistor and re-enable CAL 4. The display will display the number

160. for approximately 30 seconds, then the number 206. for another 30 seconds and when complete, a 0. will be displayed. Disable CAL 4 and continue.
9. Substitute a 1K resistor for the 10K resistor and enable CAL 3. The display will indicate 260. for approximately 30 seconds, then 306. for another 30 seconds and finally a 0. Disable CAL 3 and continue.
 10. Substitute a 100 ohm resistor for the 1K resistor and enable CAL 2. The display will indicate 360. then 406. with each time period being approximately 30 seconds. When the 0. appears, disable CAL 2 and continue.
 11. Finally substitute the 10 ohm resistor for the 100 ohm resistor and enable the last switch, CAL 1. The display will indicate 460. for approximately 30 seconds and then a 0. indicating that the calibration of the card is complete. Disable CAL 1 and then CAL 8.
 12. A special set point calibration is required for an 82C with two 8218C Input Cards. Since the set point voltage is related to the set point resistance, and is determined with the individual card calibration constants, there is no way to enter a set point that results in a pre-determined value for the set point. The Internal ID Switch (S8 on the Main Board) is used in the calibration. Note the position of the Internal ID switches before proceeding. Attach the plus and minus leads of the DVM to TP1 and TP2 respectively of the Analog Control Card #1 PCB. Configure the Internal ID switches 3 thru 6 for a setting of 0111. This forces the unit to output a set point of 0 volts. Adjust the SETPOINT Z trimpot (R4 on Control Card #1, the trimpot closest to the rear of the unit) until the DVM reads as close to zero as possible. Turn ON switch 3 of the Internal ID. This forces the unit to output a set point of -2.7 volts. Adjust the SETPOINT S trimpot (R5 on Control Card #1, the trimpot closest to the front of the unit) until the DVM reads as close to -2.7000 volts as possible. The unit then waits for 5 seconds and checks for the 0111 combination again. This procedure should be done until the 0 and -2.7 readings are as close as possible to the calibration values. Before returning to normal operation, re-configure the Internal ID to its original settings.

13. Replace the calibration cover and then the top cover.

Table 8218C-2. Calibration Switch Definitions



<u>Version 1</u> <u>Switch</u>	<u>Version 2</u> <u>Switch</u>	<u>CAL</u>	<u>Definition (when switch is closed)</u>
S1-8	S1A-4	8	Calibration Enable
S1-7	S1A-3	7	Current Source DAC Zero
S1-6	S1A-2	6	+10mV Input A/D Calibration
S1-5	S1A-1	5	-10mV Input A/D Verify
S1-4	S1B-4	4	10K/100K Input Current Verify
S1-3	S1B-3	3	1K ohm Input Current Verify
S1-2	S1B-2	2	100 ohm Input Current Verify
S1-1	S1B-1	1	10 ohm Input Current Verify

8218C-24. USER GENERATED CURVE INFORMATION FOR THE 8218C

8218C-25. The curves used with the 8218C Input Card are generated using a proprietary Polynomial Interpolation Algorithm developed by Lake Shore. The format for the data to be stored using the XCN₁N₂ command (as outlined in Section 3) is the same as for a standard curve except the resistance is converted to a LOG value (where 10,000 ohms would look like 4.0000). Refer to APPENDIX B for a definition of the curve requirements. The curve data is in resistance order. The resistance and temperatures for the 8218C are in ohms up to 100,000 ohms and in kelvin up to 399.9

8218C-26. REPLACEABLE PARTS

8218C-27. Included in this section is a list of Tables and Figures for Version 1 and Version 2 of the Model 8218C Resistance Input Card schematics, replaceable parts lists, and illustrated component layouts. Refer to Section 5 of this manual for ordering information.

- | | | | |
|------------------|---|--|----------------|
| Parts List | - | Model 8218C Resistance Input Card Board Assembly (Version 1) | Table 8218C-3 |
| Component Layout | - | Model 8218C Resistance Input Card Board Assembly (Version 1) | Figure 8218C-1 |
| Schematic | - | Model 8218C Resistance Input Card (Version 1) | Figure 8218C-2 |
| Parts List | - | Model 8218C Resistance Input Card Board Assembly (Version 2) | Table 8218C-4 |
| Component Layout | - | Model 8218C Resistance Input Card Board Assembly (Version 2) | Figure 8218C-3 |
| Schematic | - | Model 8218C Resistance Input Card (Version 2) | Figure 8218C-4 |

8218C-28. MODEL 053 UPDATE KIT

8218C-29. When an 8218C Resistance Input Card is to be used in a DRC-82C, it must have an 053 Upgrade in order to operate properly. When an 8218C is ordered with the 82C, this update is completed at the factory. If the 8218C is to be installed in the field, and the 82C requires an 053 Update Kit, one is supplied in addition to the 8218C card. The following components are supplied in the Model 053 Update Kit:

- 1 113-125B Microprocessor Card
- 1 Updated Display Driver Board PROM
- 1 0.1 MF cap assembly
- 3 "V/R" Units Labels

Use the following procedure to install the Model 053 Upgrade Kit.

WARNING

To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before removing cover.

1. Set the POWER switch to OFF and disconnect the power cord from the unit. Remove the three bottom panel screws and slide the panel off. On the bottom of the Main Board, solder a wire jumper from U15-Pin 10 to Slot 4-Pin 18 and Slot 5-Pin 18. Replace the bottom panel.
2. Complete installation of the 8218C Input Card as outlined in Section 8218C-7 except leave the calibration cover and top panel off.
3. Install the 0.1 MF cap assembly. Attach one end of the assembly to TP-2 (Analog Ground) on the Main Board and thread the wire along the left of the unit past the output transformer and solder it to the solder connector supported by the same screw that supports the fan.
4. Locate the display board PROM U2 on the Display Driver Board assembly. Carefully replace the old PROM keeping pin 1 to pin 1.
5. Remove the old Microprocessor Card by gently unplugging the card from its slot and disconnect the two serial transfer wires from the T and R pins. Attach the green wire to pin T of the new Microprocessor Card and the yellow wire to pin R.

6. Place the old Microprocessor Card and Display Driver Board PROM into the anti-static bag the new card was shipped in, place them in the original shipping carton, attach the Lake Shore shipping label and return to Lake Shore.
7. Replace the top panel and calibration cover.
8. Apply the "V/R" labels supplied over the "V" on the unit's front panel overlay.

Table S218C-3. Model 8218C Resistance Sensor Input Option (Version 1)

LSCI Part Number 046

ITEM NO	DESCRIPTION	LSCI STOCK NO	MFR	MFR PART NO	TOT QTY
A1A1	MODEL 8217/8218/8218C RESISTANCE SENSOR INPUT OPTION BOARD ARTWORK #:C-343-86-01A	111-055	LSCI	111-055	1
C1	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	6
C2	CAP,CER,30PF,500V	101-067	CDE	CD15ED300J	2
C3	CAP,CER,30PF,500V	101-067	CDE	CD15ED300J	REF
C4	CAP,.03MF,QPAK-40	101-126	PGRS	UQ40.03	1
C5	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	8
C6	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C7	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C8	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C9	CAP,POLY,.1MF,100V	101-042	PLSY	160.1K100G	1
C10	CAP,TANT,1.5MF,10V	101-132	SPRG	150D155X9010A2	1
C11	CAP,PP,.33MF,100V	101-025	FDYNE	MPP-11 .33MFD	1
C12	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	7
C13	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C14	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C15	CAP,POLY,1.0MF,100V	101-032	PLSY	1501k100FC	REF
C16	CAP,POLY,0.1MF,100V	101-021	PLSY	150.1K100FC	1
C17	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C18	CAP,POLY,0.01MF,100V	101-008	SPRG	416P10391	1
C19	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C20	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C21	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C22	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C23	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C24	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C25	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C26	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C27	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C28	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C29	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
H1	POWER BUS,3 LAYER	110-158	RGRS	SR646(M836 SERIES)	1
P2	CONNECTOR 6 POST LOCKING RA HDR	106-142	MOL	2420-09-75-1061	1
R1	RES,MTF,8.25K,1%,1/4W	103-340			1
R2	RES,MTF,1M ,1%,1/4W	103-472			2

Table 8218C-3. Cont'd.

ITEM NO	DESCRIPTION	LSCI STOCK NO	MFR	MFR PART NO	TOT QTY
R3	RES,MTF,4.75K,1%,1/4W	103-306			4
R4	RES,MTF,4.75K,1%,1/4W	103-306			REF
R5	RES,MTF,174K,1%,1/4W	103-435			2
R6	RES,MTF,174K,1%,1/4W	103-435			REF
R7	RES,MTF,10K,1%,1/4W	103-358			5
R8	RES,MTF,10M,1%,1/4W	103-534			1
R9	RES,MTF,1M,1%,1/4W	103-472			REF
R10	RES,MTF,100K,1%,1/4W	103-420			2
R11	RES,MTF,10K,1%,1/4W	103-358			REF
R12	RES,MTF,1K,1%,1/4W	103-265			2
R13	RES,MTF,100,1%,1/4W	103-216			2
R14	RES,MTF,100,1%,1/4W	103-216			REF
R15	RES,MTF,100K,1%,1/4W	103-420			REF
R16	RES,MTF,10K,1%,1/4W	103-358			REF
R17	TRIMPOT,5K	103-080	BOR	3299X-1-502	1
R18	RES,MTF,316,1%,1/4W	103-224			1
R19	RES,MTF,1.37K,1%,1/4W	103-269			1
R20	RES,MTF,80.6K,1%,1/4W	103-413			1
R21	RES,MTF,86.6K,1%,1/4W	103-416			1
R22	RES,MTF,12.4K,1%,1/4W	103-354			1
R23	RES,MTF,1K,1%,1/4W	103-265			REF
R24	RES,MTF,4.75K,1%,1/4W	103-306			REF
R25	RES,MTF,4.75K,1%,1/4W	103-306			REF
R26	TRIMPOT,100K	103-081	BOR	3299X-1-104	1
R31	RES,MTF,10K,1%,1/4W	103-358			REF
R32	RES,MTF,10K,1%,1/4W	103-358			REF
RN-1	RES NET,33K,9-1 COM	103-113	BOR	4310R-101-333	1
RN-2	RES NET,2.2K,4 IND (R27,R28,R28,R30)	103-150	BOR	4308R-102-222	1
S1	CAL ENABLE (8 DIP RA)	105-409	GYH	76PSB08	1
U1	IC,MICROPROCESSOR	104-509	OKI	M80C51VS	1
U2	IC,EEPROM	104-652	XICOR	X2404	1
U3	IC,OP AMP	104-001	PMI	OP07EP	2
U4	IC,OPTOCOUPLER	104-345	HP	HCPL-2731	2
U5	IC,OPTOCOUPLER	104-345	HP	HCPL-2731	REF
U6	IC,D/A CONVERTER	104-419	BB	DAC703BH-5	1
U7	IC,ANALOG SWITCH	104-060	NAT	LF13202	1
U8	IC,OP AMP	104-001	PMI	OP07EP	REF
U9	IC,SWITCHED CAPACITOR	104-078	LT	LTC1043	2

Table 8218C-3. Cont'd.

ITEM NO	DESCRIPTION	LSCI STOCK NO	MFR	MFR PART NO	TOT QTY
U10	IC, SWITCHED CAPACITOR	104-078	LT	LTC1043	REF
U11	IC, A/D CONVERTER	104-465	TDYN	TSC500CPE	1
U12	IC, OP AMP	104-086	TDYN	TSC911ACPA	3
U13	IC, OP AMP	104-086	TDYN	TSC911ACPA	REF
U14	IC, BINARY COUNTER	104-098	NAT	CD4020BCN	1
U15	REGULATOR, -5V	102-020	MOT	79L05	1
U16	IC, OP AMP	104-086	TDYN	TSC911ACPA	REF
U17	IC, EPROM	104-660	INT	27C64-3	1
XU1	SOCKET, 40 PIN DIP	106-507	AUG	540-AG11D	1
XU2	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	8
XU3	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU4	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU5	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU6	SOCKET, 24 PIN DIP	106-505	AUG	524-AG11D	1
XU7	SOCKET, 16 PIN DIP	106-503	AUG	516-AG11D	3
XU8	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU9	SOCKET, 18 PIN DIP	106-509	AUG	518-AG11D	2
XU10	SOCKET, 18 PIN DIP	106-509	AUG	518-AG11D	REF
XU11	SOCKET, 16 PIN DIP	106-503	AUG	516-AG11D	REF
XU12	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU13	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU14	SOCKET, 16 PIN DIP	106-503	AUG	516-AG11D	REF
XU16	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
Y1	CRYSTAL, 5.000M HZ	103-990	MTRON	MP1 5.000M HZ	1

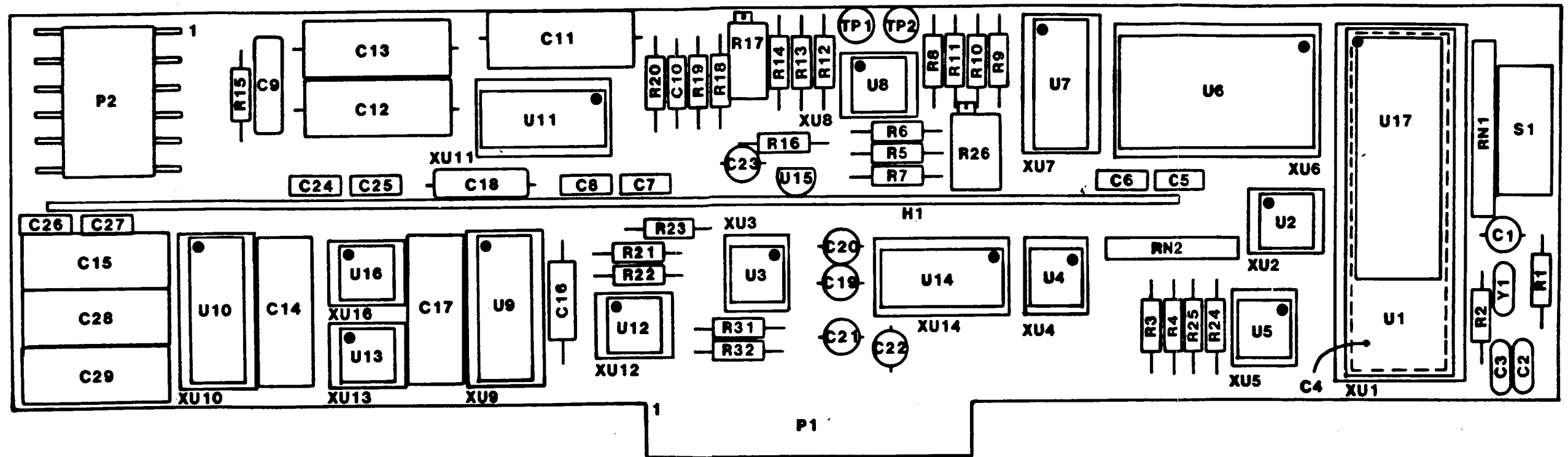


Figure 8218C-1. Model 8218C Resistance
Input Card Component Layout.
(Version 1).

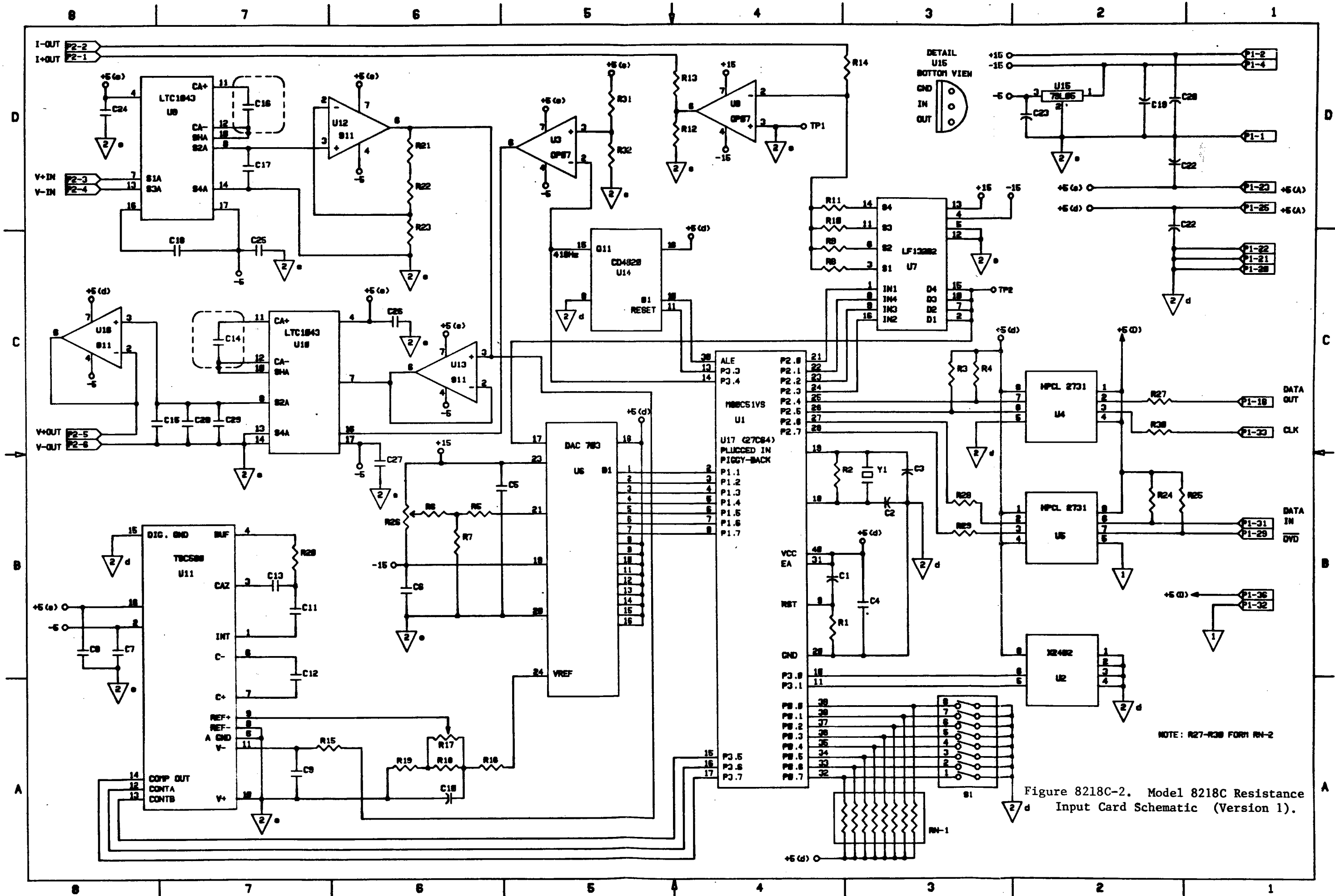


Figure 8218C-2. Model 8218C Resistance Input Card Schematic (Version 1).

Table 8218C-4. Model 8218C Resistance Sensor Input Option (Version 2)

LSCI Part Number 046

ITEM NO	DESCRIPTION	LSCI STOCK NO	MFR	MFR PART NO	TOT QTY
A1A1	MODEL 8217/8218/8218C RESISTANCE SENSOR INPUT OPTION BOARD ARTWORK #:C-343-86-01B	111-055	LSCI	111-055	1
C1	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	6
C2	CAP,CER,30PF,500V	101-067	CDE	CD15ED300J	2
C3	CAP,CER,30PF,500V	101-067	CDE	CD15ED300J	REF
C4	CAP,.03MF,QPAK-40	101-126	PGRS	UQ40.03	1
C5	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	8
C6	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C7	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C8	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C9	CAP,POLY,.1MF,100V	101-042	PLSY	160.1K100G	1
C10	CAP,TANT,1.5MF,10V	101-132	SPRG	150D155X9010A2	1
C11	CAP,PP,.33MF,100V	101-025	FDYNE	MPP-11 .33MFD	1
C12	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	7
C13	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C14	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C15	CAP,POLY,1.0MF,100V	101-032	PLSY	1501k100FC	REF
C16	CAP,POLY,0.1MF,100V	101-021	PLSY	150.1K100FC	1
C17	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C18	CAP,POLY,0.01MF,100V	101-008	SPRG	416P10391	1
C19	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C20	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C21	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C22	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C23	CAP,TANT,10MF,35V	101-137	SPRG	119D106X0035DB1	REF
C24	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C25	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C26	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C27	CAP,CER,.1MF,50V	101-108	SPRG	3CZ5U104X0050C5	REF
C28	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
C29	CAP,POLY,1.0MF,100V	101-032	PLSY	1501K100FC	REF
H1	POWER BUS,3 LAYER	110-158	RGRS	SR646(M836 SERIES)	1
P2	CONNECTOR 6 POST LOCKING RA HDR	106-142	MOL	2420-09-75-1061	1
R1	RES,MTF,8.25K,1%,1/4W	103-340			1
R2	RES,MTF,1M,1%,1/4W	103-472			2

Table 8218C-4. Cont'd.

ITEM NO	DESCRIPTION	LSCI STOCK NO	MFR	MFR PART NO	TOT QTY
R3	RES,MTF,4.75K,1%,1/4W	103-306			4
R4	RES,MTF,4.75K,1%,1/4W	103-306			REF
R5	RES,MTF,174K,1%,1/4W	103-435			2
R6	RES,MTF,174K,1%,1/4W	103-435			REF
R7	RES,MTF,10K,1%,1/4W	103-358			5
R8	RES,MTF,10M,1%,1/4W	103-534			1
R9	RES,MTF,1M,1%,1/4W	103-472			REF
R10	RES,MTF,100K,1%,1/4W	103-420			2
R11	RES,MTF,10K,1%,1/4W	103-358			REF
R12	RES,MTF,1K,1%,1/4W	103-265			2
R13	RES,MTF,100,1%,1/4W	103-216			2
R14	RES,MTF,100,1%,1/4W	103-216			REF
R15	RES,MTF,100K,1%,1/4W	103-420			REF
R16	RES,MTF,10K,1%,1/4W	103-358			REF
R17	TRIMPOT,5K	103-080	BOR	3299X-1-502	1
R18	RES,MTF,316,1%,1/4W	103-224			1
R19	RES,MTF,1.37K,1%,1/4W	103-269			1
R20	RES,MTF,80.6K,1%,1/4W	103-413			1
R21	RES,MTF,86.6K,1%,1/4W	103-416			1
R22	RES,MTF,12.4K,1%,1/4W	103-354			1
R23	RES,MTF,1K,1%,1/4W	103-265			REF
R24	RES,MTF,4.75K,1%,1/4W	103-306			REF
R25	RES,MTF,4.75K,1%,1/4W	103-306			REF
R26	TRIMPOT,100K	103-081	BOR	3299X-1-104	1
R31	RES,MTF,10K,1%,1/4W	103-358			REF
R32	RES,MTF,10K,1%,1/4W	103-358			REF
RN-1	RES NET,33K,9-1 COM	103-113	BOR	4310R-101-333	1
RN-2	RES NET,2.2K,4 IND (R27,R28,R28,R30)	103-150	BOR	4308R-102-222	1
S1A	CAL ENABLE (4 DIP RA)	105-405	GYH	76PSB04	2
S1B	CAL ENABLE (4 DIP RA)	105-405	GYH	76PSB04	REF
U1	IC,MICROPROCESSOR	104-509	OKI	M80C51VS	1
U2	IC,EEPROM	104-652	XICOR	X2404	1
U3	IC,OP AMP	104-001	PMI	OP07EP	2
U4	IC,OPTOCOUPLER	104-345	HP	HCPL-2731	2
U5	IC,OPTOCOUPLER	104-345	HP	HCPL-2731	REF
U6	IC,D/A CONVERTER	104-419	BB	DAC703BH-5	1
U7	IC,ANALOG SWITCH	104-060	NAT	LF13202	1
U8	IC,OP AMP	104-001	PMI	OP07EP	REF
U9	IC,SWITCHED CAPACITOR	104-078	LT	LTC1043	2

Table 8213C-4. Cont'd.

ITEM NO	DESCRIPTION	LSCI STOCK NO	MFR	MFR PART NO	TOT QTY
U10	IC, SWITCHED CAPACITOR	104-078	LT	LTC1043	REF
U11	IC, A/D CONVERTER	104-465	TDYN	TSC500CPE	1
U12	IC, OP AMP	104-086	TDYN	TSC911ACPA	3
U13	IC, OP AMP	104-086	TDYN	TSC911ACPA	REF
U14	IC, BINARY COUNTER	104-098	NAT	CD4020BCN	1
U15	REGULATOR, -5V	102-020	MOT	79L05	1
U16	IC, OP AMP	104-086	TDYN	TSC911ACPA	REF
U17	IC, EPROM	104-660	INT	27C64-3	1
XS1B	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	9
XU1	SOCKET, 40 PIN DIP	106-507	AUG	540-AG11D	1
XU2	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU3	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU4	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU5	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU6	SOCKET, 24 PIN DIP	106-505	AUG	524-AG11D	1
XU7	SOCKET, 16 PIN DIP	106-503	AUG	516-AG11D	3
XU8	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU9	SOCKET, 18 PIN DIP	106-509	AUG	518-AG11D	2
XU10	SOCKET, 18 PIN DIP	106-509	AUG	518-AG11D	REF
XU11	SOCKET, 16 PIN DIP	106-503	AUG	516-AG11D	REF
XU12	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU13	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
XU14	SOCKET, 16 PIN DIP	106-503	AUG	516-AG11D	REF
XU16	SOCKET, 8 PIN DIP	106-501	AUG	508-AG11D	REF
Y1	CRYSTAL, 5.000M HZ	103-990	MTRON	MP1 5.000M HZ	1

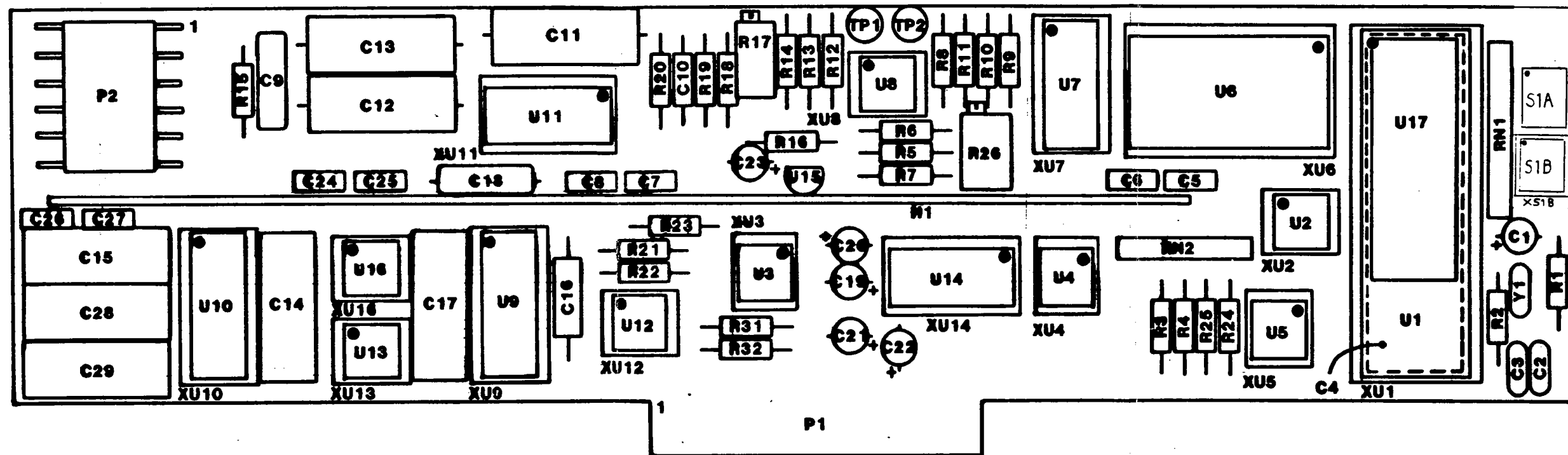


Figure 8218C-3. Model 8218C Resistance
Input Card Component Layout
(Version 2).

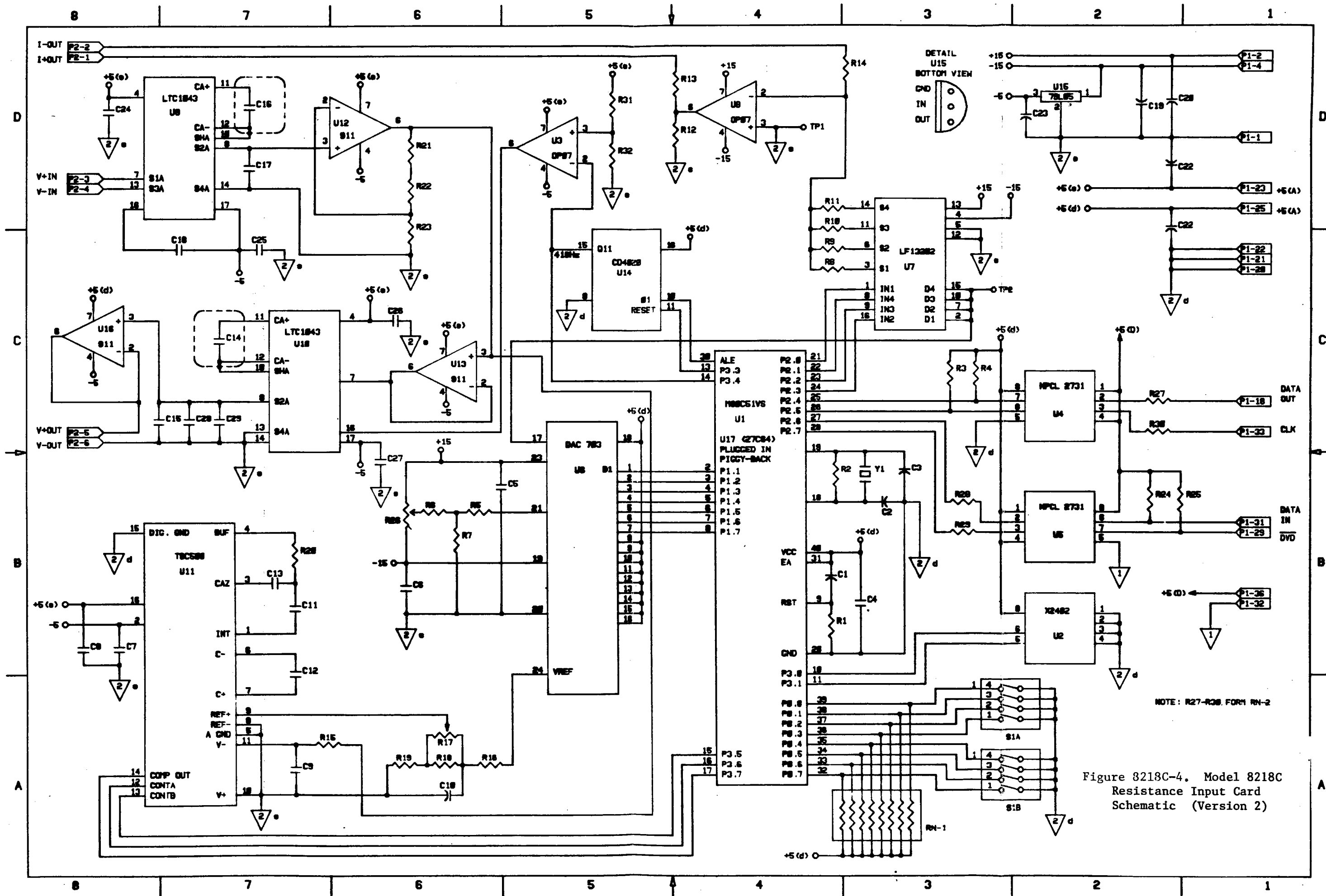


Figure 8218C-4. Model 8218C Resistance Input Card Schematic (Version 2)