User's Manual

Model DRC-80

Digital Cryogenic Thermometer

Obsolete Notice:

This manual describes an obsolete Lake Shore product. This manual is a copy from our archives and may not exactly match your instrument. Lake Shore assumes no responsibility for this manual matching your exact hardware revision or operational procedures. Lake Shore is not responsible for any repairs made to the instrument based on information from this manual.

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Specifications, DRC-80 Thermometer

Input:

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

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

Sensor Input: Dual-sensor input. 4-terminal input for each sensor. Selection is via front-panel pushbuttons.

Sensor Excitation: 10-microampere current source. Stability ±0.005%.

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.

Input Resistance: Greater than 1000 megohms.

Maximum Sensor Power Dissipation: 25μW at 4.2K

Temperature Readout:

Display: 4-digit, 1.1cm (0.43") LED shows temperature directly in Kelvin.

Resolution: 0.1K. "Scale Expand" increases resolution to 0.01K for temperatures below 30K, 0.05K from 30K to 100K (no increase in accuracy).

Accuracy (20-25°C ambient): ±0.5K at 4K and 77K, ±1.0K at 330K with standard Sensor. See DRC-Precision Option for accuracy with Lake Shore calibrated Sensor.

Temperature Coefficient (10-20°C and 25-45° ambient): ±0.01K/°C.

Response Time: Less than 1 second to rated accuracy.

General:

Monitor Output: Buffered output of Display Sensor voltage (additional outputs listed below as options).

Dimensions, Weight: 216mm wide x 102mm high x 330mm deep (8.5 in x 4 in x 13 in). Style L, half-rack package. Net weight 3.6 kg (7.9 lbs).

Power: 90-110, 105-125, or 210-250VAC (switch-selected), 50 or 60Hz.

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

Options and Accessories Available:

Model 8022. Parallel BCD output for DRC-80. TTL compatible. Provides BCD output of temperature in Kelvin and Sensor selected (either from front-panel or optional SW-10A) .

Model 8024. IEEE-488 output for DRC-80. Provides digital output of temperature in Kelvin and Sensor selected (either from front-panel or optional SW-10A).

Model 8025. Analog output proportional to Kelvin temperature for use with recorders or other readouts. 10mV/K at < 10 ohm output resistance (field installable) .

Model 8022/25. Combination of 8022 (BCD output) and 8025 (Analog output) installed in same unit .

Model SW-10A. 10-Sensor Selector Switch for use with DRC Thermometer or Controller. Push-button selection of any one of up to 10 sensors. Connects to Sensor "B" position of instrument. Sensor selected is also identified via 8022 or 8024 digital interfaces. Dimensions: 216mm wide x 102mm high x 330mm deep (8½ in x 4 in x 13 in). Style L half-rack package .

Model RM-3H. Rack mounting hardware to mount either one or two Style L half-rack unit(s) in standard 3½" rack space .

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. Specify Sensor input position (A or B or 1-10 on SW-10A) to assure proper location of calibration within PROM. First calibration stored .
Subsequent calibrations stored in same PROM .

Model DT-500-DRC Sensor. Silicon Diode Temperature Sensor for DRC-80 (1.5mm diameter x 4.1mm long). Specify response curve .

Model DT-500CU-DRC-36. Silicon Diode Temperature Sensor for DRC-80 (8mm diameter x 3.3mm thick with mounting hole). Specify response curve .

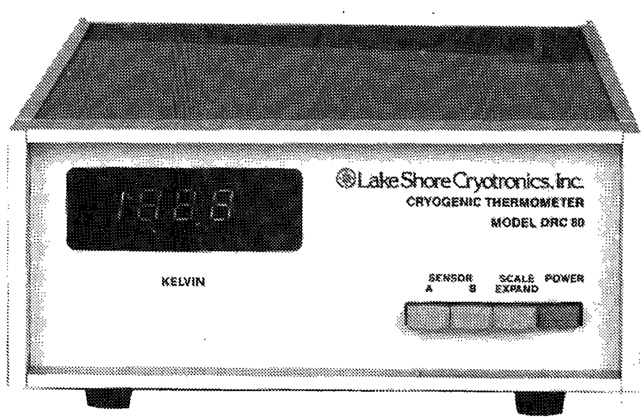

FIGURE 1.1 Model DRC-80 Digital Cryogenic Thermometer

SECTION I

General Information

1.1 Introduction

The following is a description of the DRC-80 Cryogenic Digital Thermometer. The DRC-80 Series of instruments is designed to be used with the Model DT-500-DRC and DT-500CU-DRC-36 silicon diode sensors manufactured by Lake Shore Cryotronics, Inc.

Several different diode sensor curves are available for use with this instrument. When ordering replacement sensors, care must be taken to assure that the correct sensor curve is specified. Multiple curves are needed so that Lake Shore can assure the customer that replacement sensors will be available at any time in the future. For details, please see Section 1.4.

1.2 Description

The DRC-80 Series is comprised of completely self-contained units providing direct digital readout in Kelvin temperature units and, for the controllers, temperature control by direct analog comparison between the sensor voltage and an analog equivalent of the digital temperature set point. The DRC-80 displays temperature to 0.1 Kelvin over its operating range of 1-400 Kelvin for normal operation. In the scale expand mode, the resolution is 0.01 Kelvin below 30 Kelvin and 0.05 Kelvin from 30K to 100 Kelvin.

The specified range of operation is 4.0 to 380K* utilizing standard DRC series sensors which have been pre-selected to provide uniform characteristics over this range. These sensors conform to the standard table (see Table 3.3) to 0.5K or better below 77K and better than 1 Kelvin above 77K. The instrument, however, displays down to 1K although accuracy is only specified above 4K. Pre-selection allows the DRC-80 Series to be used with the DT-500-DRC and DT-500CU-DRC-36 sensors without adjustments of any kind. Since the standard sensors are interchangeable, the instruments may be used to read out any number of sensors with equal accuracy when selected through an appropriate switch such as the SW-10A.

The DRC-80 has dual sensor inputs. Sensor selection is made via front-panel pushbuttons.

As a standard feature, all units are equipped with buffered analog output of the display sensor voltage. This allows the instrument user the ability to record the display sensor voltage versus time or to use a digital voltmeter to measure the display sensor voltage directly. Since this output is buffered, a high input impedance recorder or voltmeter is not required.

*If possible, temperatures above 330K should be avoided with DRC Series sensors since these sensors may slightly shift their values below 20K if heated above 330K.

If the sensor is calibrated by the user or by Lake Shore Cryotronics, Inc., temperature may be determined to approximately 10mK.

Five options are available with the DRC-80 Series of instruments. One option is an analog signal which is proportional to temperature (Model 8025) and has a sensitivity of 10 mV/K.

A second option is a ten-position switch (SW-10A) for multiple sensor readout. This switch is a separate half-rack box which plugs into the Sensor "B" position of the DRC-80. The sensor selected is also identified via digital interface of the DRC-80, if present.

Another option is a custom cut PROM (DRC-Precision Option) which corresponds to the calibration curve of the customer's DT-500 Series sensor. A combination of a calibration and custom cut PROM will increase display accuracy to better than .1 Kelvin over the calibrated range. Please note that any sensor may be used with this option, i.e., the customer is not restricted to the DRC Series sensors.

There are two computer options available; each will output the displayed temperature and sensor selected from the SW-10A. The Model 8022 is in a parallel BCD format while the Model 8024 is in the popular IEEE-488 format.

The DRC-80 Series is designed around an 3870 microprocessor and associated support circuits. The DRC curve is stored in a PROM which can handle up to 32 break points. The data consists of a table of temperature and voltage associated with each break point. These straight line segments can generate the DRC curve to an accuracy of better than 0.1 Kelvin over the entire temperature range (4.0 - 400 K).

1.3 Major Assemblies Supplied

The DRC-80 Series includes as standard equipment, in addition to the digital thermometer-controller, the following:

A. Operating and Servicing Manual

B. Two five Pin Plugs for Temperature Sensor Cables

C. One seven Pin Plug for Monitor of Sensor Output Voltage and the DRC8-L/A option

Model DT-500 Series silicon diodes are not supplied as part of the DRC-80 instrument.

Complete Specifications, Accessory Equipment and Customs Options are listed in the front of the Manual.

1.4 Ordering of Replacement or Additional Sensors

Two different sensor configurations are available for use with the Model DRC-80 Series instruments. These are the DT-500-DRC and the DT-500CU-DRC-36 sensors. Their description is included elsewhere in this manual. All sensor configurations are available if the diode is calibrated and a special PROM is cut.

More than one curve presently exists which can be used with the DRC-80 Series instruments. If additional sensors are ordered for use with your instrument, you must be certain to order the correct curve so that your instrument will have its stated accuracy. The proper curve may be determined in one of the following ways:

A. Specify the sensor serial number that is currently being used with the instrument (serial number is found on the end of the plastic box in which the sensor was received).

B. Specify the serial number of your instrument. Our records will indicate with which sensor the instrument is compatible.

C. Remove the top of your instrument and observe the indicator on the PROM.

D. The fourth way is to measure the diode voltage at 4.2K and give this value to Lake Shore Cryotronics, Inc. when re-ordering sensors.

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SECTION II

Installation

2.1 Introduction

This section contains information and instructions necessary for the installation and shipping of the model DRC-80 Cryogenic Thermometer. Included are initial inspection instructions, power and grounding requirements, installation information and instructions for repackaging for shipment.

2.2 Initial Inspection

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 the company of such filings. In case of parts' shortages, please advise the company. The standard Lake Shore Cryotronics warranty is given on the title page.

2.3 Power Requirements

Before connecting the power cable to line voltage, insure that the instrument is of the proper line voltage and fused accordingly. The line voltage and fuse are shown on the rear panel of the instrument.

The line voltage can be changed by switching line voltage selector switch (S2 - Figure 6.3 DRC-80 Component Layout) located on the main printed circuit board of the unit.

Nominal permissible line voltage fluctuation is ±10% at 50 to 60 Hz.

2.4 Grounding Requirements

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.

2.5 Installation

The DRC-80 Thermometer is all solid state and does not generate significant heat. It may therefore be rack mounted in close proximity to other equipment in dead air spaces. The heat from such adjacent equipment should not subject the thermometer to an ambient temperature in excess of 50°C (122°F).

As with any precision instrument, it should not be subjected to the shock and vibrations which usually accompany high vacuum pumping systems.

The recommended cable diagrams for the sensor diodes are shown in Figure 2.1 (a). The use of a four wire diode connection is highly recommended to avoid introducing lead IR drops which will occur if the alternate two lead sensor cable connection is used. For example, for a two lead connection, every 25 ohms of cable resistance corresponds to a .1 K error above 30 Kelvin. The alternate wiring scheme shown in Figure 2.1 (b) may be used for the diode in less critical applications where lead resistance can be kept small. The indicated shielding connections are the recommended standard practice to avoid ground loops.

2.6 Repackaging for Shipment

Before returning an instrument to the factory, should repair be necessary, please discuss the malfunction with a factory representative. He may be able to suggest several field tests which will preclude returning a satisfactory instrument to the factory when the malfunction is elsewhere. If it is indicated that the fault is in the instrument after these tests, the representative will provide shipping and labeling instructions for returning it.

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

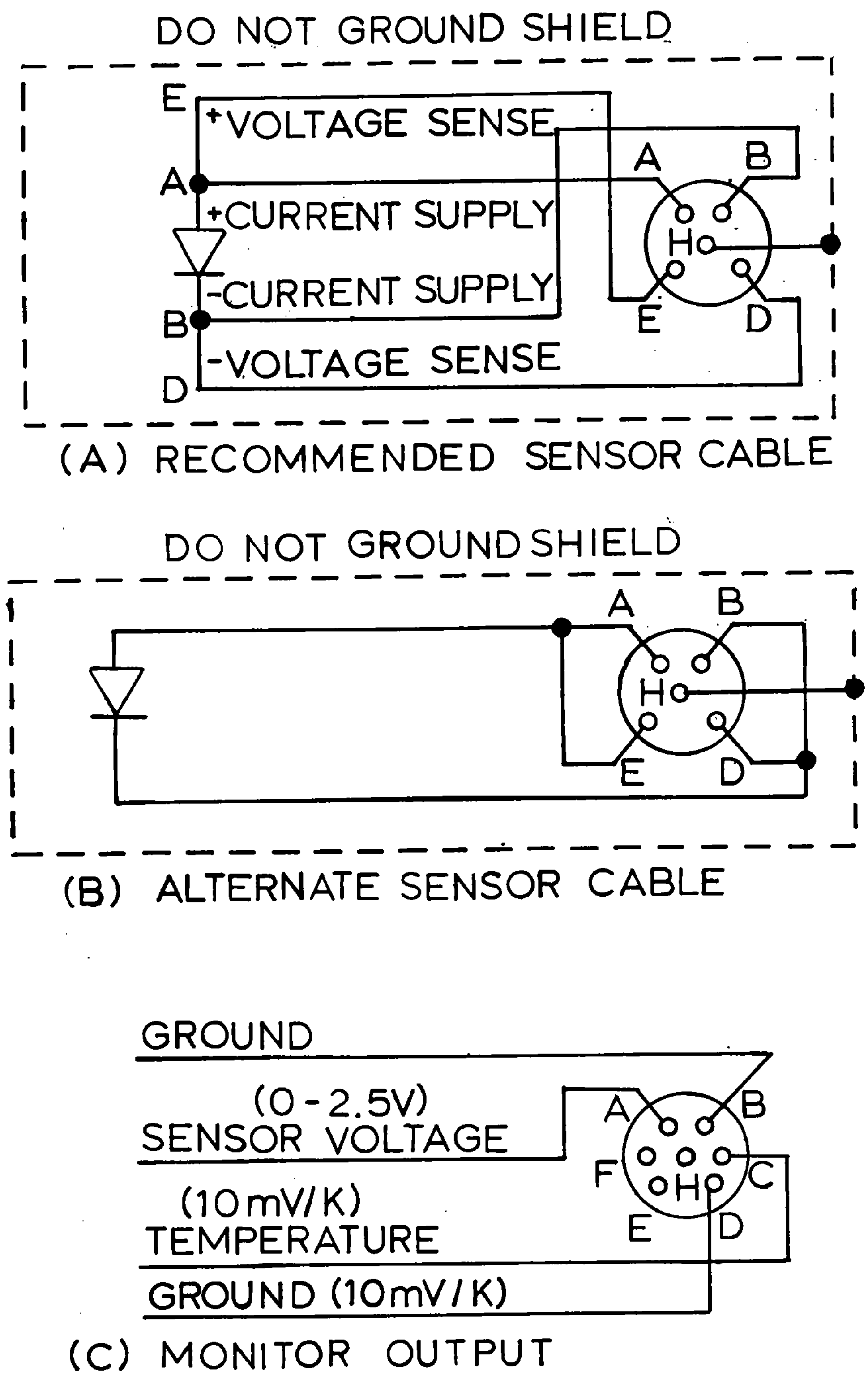
A. Owner and Address

B. Instrument Model and Serial Number

C. Malfunction Symptoms

D. Description of External Connections and Cryostats

If the original carton is available, repack the instrument in a plastic bag, place in carton using original spacers to protect protruding controls, and close carton. Seal lid with paper or nylon tape. Affix mailing labels and "FRAGILE" warnings.



<u>FIGURE 2.1</u> Sensor, Cable, and Monitor Connections

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SECTION III

Operating Instructions

3.1 Introduction

This section contains a description of the operating controls and their adjustment under normal operating conditions, and typical controller applications. These instructions are based upon the instrument having been installed as outlined in Section II. The diode polarity as shown in Figure 2.1 (a), in particular, must be correct.

3.2 Controls, Indicators, Connectors

The operating controls, indicators and connectors on the DRC-80 instrument's front and rear panels are shown in Figures 3.1, and 3.2. The numbers with leaders to various controls in the figures are keyed to the entries in Table 3.1.

Table 3.1 - Entry Number Correlation

NO. KEY	NAME	FUNCTION
1	POWER	A.C. line switch (ON/OFF) (Display serves as indicator light).
2	Scale Expand	With button out, the display reads to 0.1K at all temperatures; with button in detent position, temperature reads to 0.01K below 30K, 0.05K between 30K and 100K, and to 0.1K above 100K.
3	Sensor B	Selects Sensor B.
4	Sensor A	Selects Sensor A.
5	NO LABEL	Digital temperature display located behind filter panel. Sensor displayed depends on sensor selected.
6	NO LABEL	A.C. line cord
7	Fuse	A.C. line fuse
8	Sensor A	Sensor input lead terminals (Pin A, I+, Pin E, V+, Pin B, I-, Pin D, V-, Pin H, Shield).

9	Monitor	Analog output of sensor voltage (0-2.5V, Pin A) and optional linear analog output of temperature(0-4V, Pin C). Pin B is ground for sensor voltage while Pin D is ground for L/A output.
10	Sensor B	Same as Sensor A
11	Interface	BCD input of set point/output of temperature. Also IEEE interface port.

3.3 Temperature Readout

The sensor(s) and heater should be installed following the suggestions listed in the "Installation and Application Notes for Cryogenic Sensors" brochure in Section VIII.

Connect the sensor(s) to the instrument following the diagram in Figure 2.1.

Depress the power switch and observe that the display shows the proper temperature relative to the sample temperature.

The sensor and readout display should follow the curve in Table 3.2. This curve illustrates typical values expected of the DT-500-DRC or DT-500CU-DRC-36 sensors.

If the diode or lead wires are shorted, the display will read ----. If the diode is connected backwards, the display will read 428.0 for all curves. In the case of an open current or voltage lead, the display will slowly drift higher in temperature. The curves and appropriate PROM markings are given below:

Curve	PROM U13
0	Version 3
A	Version 6
B	Version 2
D	Version 4
E	Version 5

If the instrument or sensor does not agree with values listed in the table, within the accuracy of the system, consult sections on installation and/or section on troubleshooting to determine the cause and cure of the malfunction.

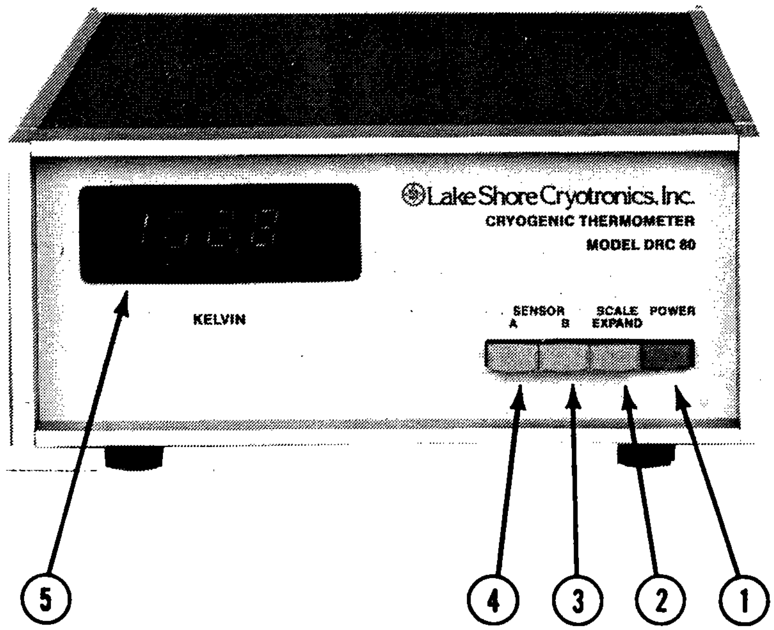

FIGURE 3.1 DRC-80 Front Panel

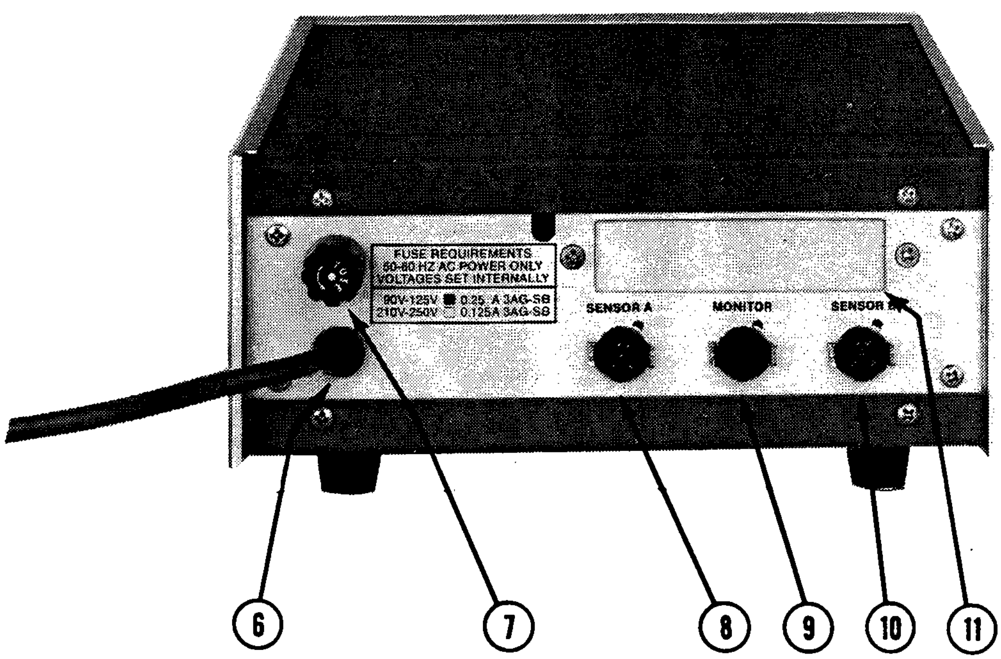

FIGURE 3.2 DRC-80 Rear Panel

Table 3.2

DT-500DRC (D) Voltage-Temperature Characteristic

BP#	TEMP (K)	PROM VOLTAGE
	1.4	2.5984
	1.5	2.5958
	1.6	2.5932
	1.7	2.5906
	1.8	2.5880
	1.9	2.5854
30	2.0	2.5828
	2.2	2.5735
	2.4	2.5643
	2.6	2.5551
	2.8	2.5458
29	3.0	2.5366
	3.2	2.5226
	3.4	2.5086
	3.6	2.4946
	3.8	2.4807
	4.0	2.4667
	4.2	2.4527
	4.4	2.4387
	4.6	2.4247
	4.8	2.4108
	5.0	2.3968
	5.5	2.3618
	6.0	2.3269
	6.5	2.2919
	7.0	2.2570
	7.5	2.2220
	8.0	2.1871
	8.5	2.1521
28	9.0	2.1172
	9.5	2.0909
	10.0	2.0646
	11.0	2.0119
	12.0	1.9592
27	13.0	1.9066
	14.0	1.8338
26	15.0	1.7610
	16.0	1.6984
25	17.0	1.6359
	18.0	1.5646

DT-500DRC (D) Voltage-Temperature Characteristic

BP#	TEMP (K)	PROM VOLTAGE
	19.0	1.4932
	20.0	1.4219
24	21.0	1.3505
	22.0	1.3006
23	23.0	1.2507
	24.0	1.2114
22	25.0	1.1720
21	26.0	1.1486
20	27.0	1.1308
19	28.0	1.1190
18	29.0	1.1116
17	30.0	1.1058
16	32.0	1.0970
15	34.0	1.0902
	36.0	1.0850
	38.0	1.0798
14	40.0	1.0746
	45.0	1.0633
	50.0	1.0520
13	55.0	1.0407
	60.0	1.0287
	65.0	1.0166
12	70.0	1.0046
	75.0	.99172
	80.0	.97890
	85.0	.96609
11	90.0	.95327
	95.0	.93987
	100.0	.92647
	105.0	.91307
	110.0	.89966
	115.0	.88626
	120.0	.87286
	125.0	.85946
10	130.0	.84606
	135.0	.83228
	140.0	.81850
	145.0	.80472
	150.0	.79094
	155.0	.77716

DT-500DRC (D) Voltage-Temperature Characteristic

BP#	TEMP (K)	PROM VOLTAGE
	160.0	.76338
	165.0	.74961
9	170.0	.73582
	175.0	.72170
	180.0	.70757
	185.0	.69344
	190.0	.67931
	195.0	.66518
	200.0	.65105
	205.0	.63693
	210.0	.62280
	215.0	.60867
8	220.0	.59455
	225.0	.58080
	230.0	.56707
	235.0	.55334
7	240.0	.53960
	245.0	.52649
	250.0	.51337
	255.0	.50026
	260.0	.48714
6	265.0	.47403
	270.0	.46057
	275.0	.44711
	280.0	.43365
5	285.0	.42019
	290.0	.40613
	295.0	.39208
	300.0	.37802
4	305.0	.36397
	310.0	.34940
	315.0	.33482
	320.0	.32025
	325.0	.30568
	330.0	.29111
	335.0	.27654
	340.0	.26197
3	345.0	.24739
	350.0	.23325
	355.0	.21911
	360.0	.20497
2	365.0	.19083
	370.0	.17774
	375.0	.16464
1	380.0	.15155

Table 3.2

DT-500DRC (E1) Voltage-Temperature Characteristic

BP#	TEMP (K)	PROM VOLTAGE
30	1.4	2.6591
	1.5	2.6567
	1.6	2.6542
	1.7	2.6518
	1.8	2.6494
	1.9	2.6470
29	2.0	2.6446
	2.2	2.6355
	2.4	2.6265
	2.6	2.6175
	2.8	2.6084
28	3.0	2.5994
	3.2	2.5868
	3.4	2.5742
	3.6	2.5616
	3.8	2.5490
27	4.0	2.5364
	4.2	2.5221
	4.4	2.5077
	4.6	2.4934
	4.8	2.4791
	5.0	2.4648
	5.5	2.4290
	6.0	2.3932
	6.5	2.3574
	7.0	2.3216
	7.5	2.2858
	8.0	2.2500
	8.5	2.2142
26	9.0	2.1784
	9.5	2.1516
	10.0	2.1247
	11.0	2.0708
	12.0	2.0170
25	13.0	1.9632
	14.0	1.9011
	15.0	1.8390
	16.0	1.7769
	17.0	1.7148
24	18.0	1.6527

DT-500DRC (E1) Voltage-Temperature Characteristic

BP#	TEMP (K)	PROM VOLTAGE
	19.0	1.5724
	20.0	1.4922
	21.0	1.4120
23	22.0	1.3317
	23.0	1.2837
22	24.0	1.2357
21	25.0	1.1877
20	26.0	1.1559
19	27.0	1.1365
18	28.0	1.1239
17	29.0	1.1150
16	30.0	1.1080
15	32.0	1.0981
14	34.0	1.0909
13	36.0	1.0848
	38.0	1.0797
12	40.0	1.0746
	45.0	1.0630
	50.0	1.0515
	55.0	1.0399
11	60.0	1.0284
	65.0	1.0159
	70.0	1.0035
10	75.0	0.9911
	77.35	0.9849
	80.0	0.9780
	85.0	0.9649
	90.0	0.9518
	95.0	0.9388
9	100.0	0.9257
	105.0	0.9122
	110.0	0.8988
	115.0	0.8853
	120.0	0.8718
	125.0	0.8584
8	130.0	0.8449
	135.0	0.8311
	140.0	0.8173
	145.0	0.8035
	150.0	0.7896
	155.0	0.7758

DT-500DRC (E1) Voltage-Temperature Characteristic

BP#	TEMP (K)	PROM VOLTAGE
	160.0	0.7620
	165.0	0.7482
7	170.0	0.7344
	175.0	0.7202
	180.0	0.7060
	185.0	0.6918
	190.0	0.6777
	195.0	0.6635
	200.0	0.6493
	205.0	0.6351
	210.0	0.6210
	215.0	0.6068
6	220.0	0.5926
	225.0	0.5789
	230.0	0.5651
	235.0	0.5514
5	240.0	0.5377
	245.0	0.5246
	250.0	0.5115
	255.0	0.4984
	260.0	0.4853
4	265.0	0.4722
	270.0	0.4588
	275.0	0.4454
	280.0	0.4320
3	285.0	0.4186
	290.0	0.4045
	295.0	0.3904
	300.0	0.3763
2	305.0	0.3622
	310.0	0.3476
	315.0	0.3330
	320.0	0.3184
	325.0	0.3038
1	330.0	0.2893

3.4 Analog Output of Temperature

The analog output of temperature takes the display temperature and converts it to an analog signal which has a sensitivity of 10 mV/K under normal operation. Under scale expand, this signal increases to 100 mV/K below 100K due to the movement of the decimal point. The analog output voltage is located on the monitor connector (Key 9 of Figure 3.2).

3.4.1 Field Installation of DRC Options - 8022 and 8025

The installation of either the Model 8022 option (Parallel BCD) or 8025 (10 mV/K) can be done as follows:

1) Remove instrument cover.

2) Insert the model 8022/25 option board into instrument JE connector (the instrument has its edge card connector configured such that the option board can only be inserted in one way).

3) Take 50 pin ribbon connector, with mounting plate attached, and place it in Interface opening, J4 (after any existing plate is removed).

Note: Ribbon cable is only present for Model 8022 option.

4) Connect black (or green) and white wires of option board to 7 pin rear panel connector J3. White goes to pin C and black (or green) goes to pin D.

5) Replace instrument cover.

3.5 Standard DT-500DRC-and DT-500CU-DRC-36 Curves

The standard DT-500-DRC and DT-500CU-DRC-36 curve is explained in Section 3.3. The Tables include a list of PROM sensor voltages and break-points used in the linearization of the DRC curve to arrive at the correct temperature readout.

3.6 Rack Mounting the DRC-80

The DRC-80 cryogenic thermometer can be rack mounted with the RM-3H rack mounting hardware as shown in Figure 3.3. This hardware kit also allows the mounting of two style L half-rack units as shown in Figures 3.4 and 3.5.

3.7 The 10-Sensor Selector Switch

The 10-Sensor Selector Switch includes an umbilical which ties to the DRC-80 main printed circuit board (via a 16-pin ribbon cable header which plugs into internal socket JC (see Figure 6.3, DRC-80 Component

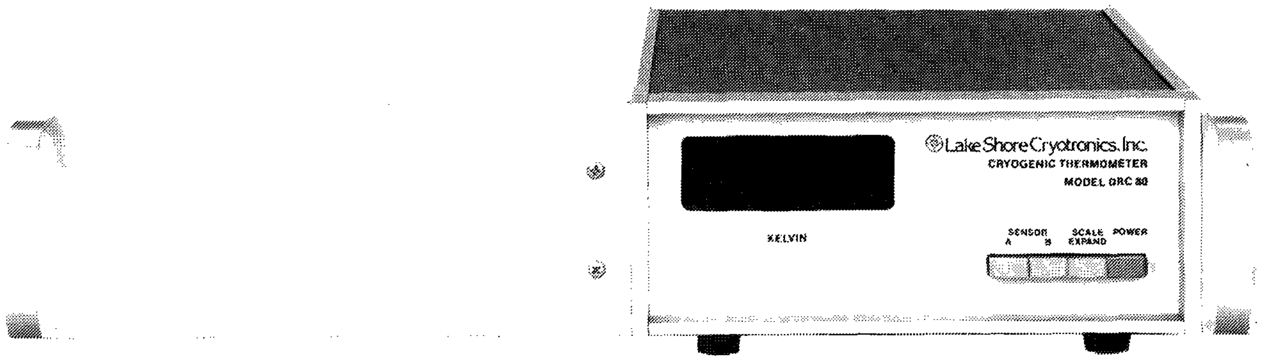

FIGURE 3.3 Model DRC-80 shown with RM-3H Rack Mounting Hardware.

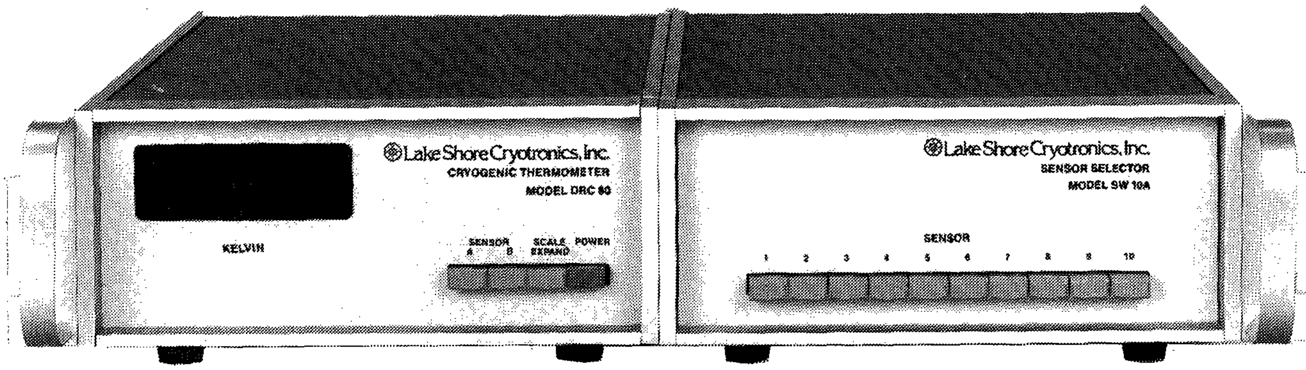

FIGURE 3.4 Model DRC-80 and SW-10A shown with RM-3H Rack Mounting Hardware.

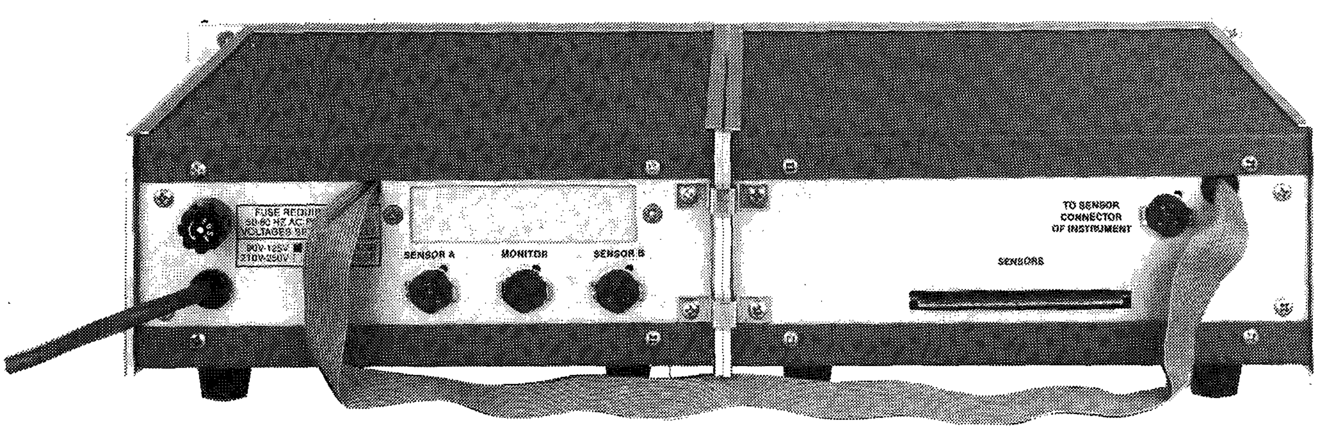

FIGURE 3.5 Model DRC-80 and SW-10A Rear View showing RM-3H Rack Mounting Hardware and Umbilical Cord Connections.

Layout) and a cable to connect the selected sensor leads to the DRC-80 (Sensor plug B is Key 10 of Figure 3.2).

The SW-10A is supplied with an 18" cable which is shielded and has male 5-pin amphenol connectors at each end (see Figure 3.5, SW-10A Option). This cable connects between J11 of the SW-10A and the B sensor plug of the DRC-80. Sensors are connected to the SW-10A via printed circuit edge J10. A 36-pin edge card connector and hood has been supplied with the SW-10A. Connectors to this edge J10 are given in Table 3.3. The hood mechanical assembly is given in Figure 6.9, SW-10A Hood Assembly.

Provisions have been made in the DRC-80 for setting the switch position which the instrument will see (S6). Since the software of the DRC-80 allows for calibrated curves to be programmed into the 10 positions of the SW-10A, a specific curve (or position) can be called up through the use of S6.

S6 is actually four switches (4 position dip switch). B0 (LSB) of switch position is between pins 1 and 8 and B3 (MSB) is between pins 4 and 5.

As an example, if the customer had precision options in positions 1, 2 and 3 of the DRC-80 and wanted to use dip switches to call up the curves (instead of the SW-10A umbilical), he could insert a four station dip switch and turn on or off the desired position.

Switch S6 should not be used in conjunction with 16 pin header JC of the SW-10A. The location for S6 is an 8 pin socket placed near JC (see Fig. 6.3, DRC-80 Component Layout).

3.8 Remote Parallel BCD Output Option

The BCD option consists of a 16 bit parallel output of temperature along with a scale expand bit to indicate decimal point, and a 4 bit output of switch position from the SW-10A.

Table 3.4 can be used for output line coding. The BCD out is handled through connector J4 (denoted on back panel as INTERFACE), a 50 pin connector on the rear panel of the instrument.

Data latches internal to the instrument provide a 1-2-4-8 code using positive logic with standard TTL levels of 0.4 volts or less for low (logic 0) and 2.4 volts or higher for the high (or 1) state under full load conditions. The drivers are sufficient to drive two standard loads, 3.2 mA, in the low state.

The sensor temperature output is externally gated through the use of an internally generated data valid pulse.

Table 3.3

SW-10A CONNECTOR DETAIL

Function	Sensor	Edge Connector Contact
Shield	All	1
I-	All	2
V+	1	A
V-	1	B
I+	1	3
V+	2	C
V-	2	D
I+	2	4
V+	3	E
V-	3	F
I+	3	5
V+	4	H
V-	4	J
I+	4	6
V+	5	K
V-	5	L
I+	5	7
V+	6	M
V-	6	N
I+	6	8
V+	7	P
V-	7	R
I+	7	9
V+	8	S
V-	8	T
I+	8	10
V+	9	U
V-	9	V
I+	9	11
V+	10	17
V-	10	18
I+	10	12

Table 3.4

BCD TEMPERATURE OUTPUT - MODEL DRC-SERIES
REMOTE OUTPUT

2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49

BCD TEMPERATURE OUTPUT

PIN		PIN	
1	800/80	2	
3	400/40	4	
5	200/20	6	
7	100/10	8	
9	80/8	10	
11	40/4	12	
13	20/2	14	
15	10/1	16	
17	8/.8	18	
19	4/.4	20	
21	2/.2	22	
23	1/.1	24	
25	.8/.08	26	
27	.4/.04	28	
29	.2/.02	30	SW-B0
31	.1/.01	32	SW-B1

BCD TEMPERATURE OUTPUT

PIN		PIN	
33	Data Valid	34	Ground
35	Trend Bit 1 - .01 0 - .1	36	SW-B2
37	SW-B3	38	
39	Not used	40	+ 5V
41		42	
43		44	
45		46	
47		48	
49	Not used	50	Not used

3.9 IEEE Interface Option

The IEEE interface option available for the DRC-80 fully complies with the IEEE standard 488-1978 and incorporates the functional, electrical and mechanical specifications of the standard.

3.9.1 General IEEE Specifications and Operation

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".

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.

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 and consist of:

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

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.

Transfer of the information on the data lines is accomplished through the use of three signal lines: 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.

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.

The following table shows cable connector contact wiring for the IEEE-488 bus:

Contact	Signal Line	Contact	Signal Line
1	DIO1	13	DIO5
2	DIO2	14	DIO6
3	DIO3	15	DIO7
4	DIO4	16	DIO8
5	EOI(24)	17	REN(24)
6	DAV	18	Gnd(6)
7	NRFD	19	Gnd(7)
8	NDAC	20	Gnd(8)
9	IFC	21	Gnd(9)
10	SRQ	22	Gnd(10)
11	ATN	23	Gnd(11)
12	SHIELD	24	Gnd(LOGIC)

Note: Gnd(n) refers to the signal ground return of the referenced contact. EOI and REN return on contact 24.

3.9.2 Specific Operation of the DRC8-IEEE Interface, Model 8024

The DRC-8-IEEE Model 8024 provides a digital output of temperature in Kelvin, as well as the status of the front panel switches and SW-10 switch position.

Address and function selection are made via a switch package located on the rear panel of the DRC-80 (see Figure 3.6, DRC-IEEE Panel Layout). Positions 4-8 of the switch are the address switches for the interface with 4 being the most significant bit and 8 being the least significant bit. As an example: with switches 5, 6, and 7 ON (or down), and switches 4 and 8 OFF (or up), the address selected is 14 (or E base 16). The DRC-80 IEEE Interface is a talker only. The talk mode can be de-selected by turning switch 3 ON (or down).

Switch position 1 is used to select the order in which the output delimiters are put onto the IEEE bus. The following table gives the delimiter orientation versus switch position:

Switch 1 Position	Delimiter Order (Delm 1)(Delm 2)
Up (OFF)	(LF) (CR)
Down (ON)	(CR) (LF)

The use of this switch allows the DRC8-IEEE to interface to controllers which accept both forms of delimiters to terminate input strings. NOTE: the address switches are updated on power up only. The address and delimiter orientation is read only when the instrument is turned on. Any change in the address switch while the instrument is on will be ignored.

The DRC8-IEEE transmits and receives all characters in ASCII. The cable connector meets IEEE-488, 1978 standards and is polarized for proper cable insertion.

In the talker mode the interface outputs switch settings, front panel settings, and display temperature. The data is output in the form of two string variables. After each of the variables is output, delimiters DELM 1 and DELM 2 are transmitted. After the second variable, the last delimiter has the EOI line set for end of transmission.

NOTE: In programming for an input from the DRC8-IEEE interface two string variables must be used (or read into the computer) or the interface will hang up, waiting to output all of the data. In outputting data to an array, the array must have enough elements to allow the input of both variables from the DRC8-IEEE interface (in this case the number of elements is 13).

Since there are two sets of delimiters output, and most computers use these delimiters to terminate string variables, the need for two string variables arises. An example of a transmission is as follows:

Function	Format for Data	Format Limits (X)
Front Panel	XX(DELM1)(DELM2)	0-9, A-F
Temperature	XXXX.XX(DELM1)(DELM2)	numberics only

The two front panel characters are output in a packed format with individual bits representing a piece of data. The front panel indicators are denoted as follows:

Bit	8	7	6	5	4	3	2	1

a) Bits 1-4 — SW-10 A Display Sensor switch settings with bit 1 being the Least Significant Bit and bit 4 being the Most Significant Bit.

b) Bit 5 — N/A

c) Bit 6 — N/A

d) Bit 7 — Display Sensor — 0 A; 1 B

e) Bit 8 — Scale EXPAND Mode — 0 Button Out (Normal); 1 Button In (Expanded Scale)*

NOTE: The expanded scale bit is set only if the button is in and the display temperature is below 100.0°K.

A chart which shows the pushbutton information and corresponding output character is shown below. (This is data represented by the first character of the Panel information variable, or bits 5-8 above.)

Output Character	Bit Representation	Expanded Scale	Display Sensor
0	0000	NO	A
4	0100	NO	B
8	1000	YES	A
C	1100	YES	B

The SW-10A switch position is represented by the characters 1-9, and A. The 1-9 stands for positions 1 thru 9, the A stands for position 10. The switch position information is only present for the B display sensor. When the A position is selected as display sensor, the position is returned as zero. (When there is no position present for the B display sensor, the switch position is returned as zero.)

An example of the panel information for a DRC instrument that is in the expanded scale mode, has B as display sensor, and has an SW-10A position of 2 would look like: C2.

An example for a transmission for an instrument which has: switch 1 of the IEEE address switch up at power on, scale expand button in, A as display sensor, no SW-10A input, and a display of 24.06°K would look like:

80(LF)(CR)0024.06(LF)(CR)
EOI SET ON FINAL (CR)

3.9.3. Sample Programming

This section contains some sample programming for the DRC8-IEEE option.

3.9.3.1 Commodore Pet/CBM 2001

Set the address switch to 6 by putting address switches 6 and 7 down; 8, 5 and 4 up. Make sure switch 3 is up (off) to allow the DRC8-IEEE to talk. Set switch 1 up (off) to select (LF)(CR) as the delimiter orientation. NOTE: The address switch is updated only on power up. Connect the CBM IEEE cable to the DRC8-IEEE interface. Turn on the PET and enter the program below, including line numbers, by pressing the RETURN key after every line. After entering the program, type RUN and press the RETURN key. The display will then return the data from the instrument.

```
10  OPEN2.6
20  INPUT#2,P$,T$
30  CLOSE2
40  PRINT
50  PRINT
60  PRINT"PANEL       ";P$
70  PRINT"TEMPERATURE";T$
80  END
```

3.9.3.2 HP-85

Set the address switch to 6 by putting address switches 6 and 7 down; 8, 5 and 4 up. Make sure switch 3 is up (off) to allow the DRC8-IEEE to talk. Set switch 1 down (on) to select (CR)(LF) as the delimiter orientation. NOTE: The address switch is updated only on power up. Connect the DRC8-IEEE to the IEEE interface of the HP-85. Turn on the unit and enter the program below, including line numbers, by pressing the END LINE key after every line. Press the RUN key. The display will then return the data from the instrument.

```
10  ENTER706;P$,T$
20  PRINT
30  PRINT
40  PRINT"PANEL       ";P$
50  PRINT"TEMPERATURE";T$
60  END
```

3.9.3.3 HP-9845B

Set the address switch to 6 by putting address switches 6 and 7 down; 8, 5 and 4 up. Make sure switch 3 is up (off) to allow the DRC8-IEEE to talk. Set switch 1 down (on) to select (CR)(LF) as the delimiter orientation. NOTE: The address switch is updated only on power up. Connect the DRC8-IEEE to the 98034A IEEE interface of the 9845B. Turn on the unit and enter the program below, including line numbers, by pressing the STORE key after each line is entered. Press the RUN key. The display will then return the data from the instrument.

```
10  DIMP$[5],T$[10]
20  ENTER706;P$,T$
30  PRINT
40  PRINT
50  PRINT"PANEL      ";P$
60  PRINT"TEMPERATURE";T$
70  END
```

3.9.3.4 HP-9825A

Set the address switch to 6 by putting address switches 6 and 7 down; 8, 5 and 4 up. Make sure switch 3 is up (off) to allow the DRC8-IEEE to talk. Set switch 1 down (on) to select (CR)(LF) as the delimiter orientation. NOTE: The address switch is updated only on power up. Connect the DRC8-IEEE to the 98034A IEEE interface of the 9825A. Turn on the unit and enter the program below by pressing the STORE key after each line is typed. Press the RUN key. The printer will read the data from the instrument.

```
0  dim P$[5],T$[10]
1  red 706,P$,T$
2  prt P$
3  prt T$
4  end
```

3.9.3.5 HP-9835A

Set the address switch to 6 by putting address switches 6 and 7 down; 8, 5 and 4 up. Make sure switch 3 is up (off) to allow the DRC8-IEEE to talk. Set switch 1 down (on) to select (CR)(LF) as the delimiter orientation. NOTE: The address switch is updated only on power up. Connect the DRC8-IEEE to the 98034A interface of the HP-35A. Turn on the unit and enter the program below by pressing the STORE key after each line is typed. Press the RUN key. The display will return the data from the instrument.

```
10  ENTER706;P$,T$
20  PRINT
30  PRINT
40  PRINT"PANEL      ";P$
50  PRINT"TEMPERATURE";T$
60  END
```

3.9.4 Field Installation of DRC-IEEE, Model 8024

The DRC8-IEEE Model 8024 is easily field installed as follows:

1) Remove instrument cover.

2) Remove blank plate from Interface opening, J4.

3) Plug 24 pin umbilical into DRC-80 board connector JD[1] (see Fig. 6.3, DRC-80 Component Layout).

4) Place Model 8024 board in the unit and install with screws. (Component side up).

5) Replace instrument cover.

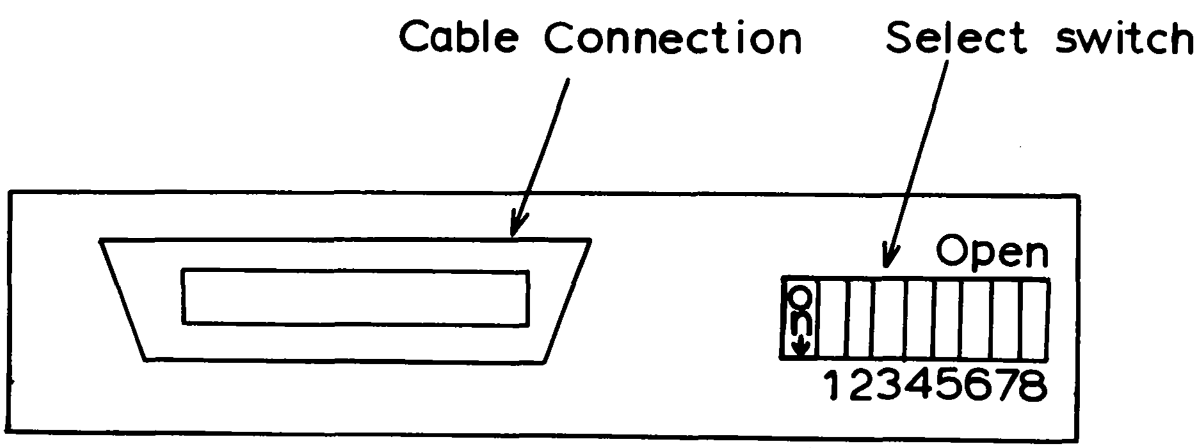

Figure 3.6 DRC80-IEEE
Panel Layout

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SECTION IV

Theory of Operation

4.1 Introduction

The Lake Shore DRC-80 is the ideal Cryogenic Thermometer for lab or system use. Its features, options, and accessories enable it to handle routine measurements or complex multi-point monitoring assignments with equal ease.

Its wide measurement range covers the spectrum of most cryogenic temperature needs. The dual-sensor input enables two sensors to be used concurrently, either for verification or for monitoring temperature at different points. This multi-input capability can be further expanded with the Model SW-10A, 10-position Selector Switch which conveniently mounts side-by-side with the 80 in a standard 3½" rack opening. Sensor selection is via front-panel pushbuttons.

The display sensor voltage is fed to an Analog-to-Digital converter pair (A/D), where it is converted to a digital voltage signal proportional to the sensor voltage. The multiplexed BCD outputs from the A/D are sampled and verified by the microprocessor. The microprocessor executes a program which takes the sampled sensor voltage and, using break point voltage and temperature information stored in a tabulor array, calculates the associated Kelvin temperature to better than 0.01 Kelvin. The microprocessor then outputs the temperature information to the display board. The decoder/driver decodes this temperature data, latches the information and drives the display digits.

The sensor display voltage is also available as a buffered output through the monitor plug on the rear of the instrument.

The microprocessor also controls the BCD and IEEE options.

4.2 Detailed Description

A detailed description of the operation of the DRC instrument is outlined in the following sections. The Figures required for each section will be denoted in that discussion.

4.2.1 Power Supplies

Please refer to Figure 6.1 (Schematic #1) for the following discussion. There are four different power supplies incorporated in the DRC-80 instrument. The main power transformer, TX1, has split primaries for 115 or 230 volt AC operation. The slide switch, S2, selects the proper line voltage.

The first secondary is output through leads 1 and 3. This secondary is rectified by CR1 and a floating 15 volt supply is obtained through C1, C5, and the positive 15 volt regulator U1. This supply is used to power the constant current source for the diode.

The second secondary, through leads 2, 4, and 6, is a full wave bridge rectified by CR2-5. A +15 volt supply is generated by C2, C6 and a positive 15 volt regulator U2. The negative 15 volt supply is generated by C3, C7 and voltage regulator U3. Both these supplies are used in the A/D converter, the buffer section, and the L/A option.

The third secondary is through leads 8, 10, and 12 and is full wave rectified by CR6-7. The five volt supply that is used by the TTL 1C's is formed by C4, C8, and a 5 volt positive voltage regulator U4.

4.2.2 Precision Constant Current Source and Front Panel Switching

A 10μA floating constant current source is used to excite either Sensor A or B depending on the switch position chosen by the front panel switches, S5 (Sensor A) or S4 (Sensor B).

A precision reference voltage is generated by an internally stabilized precision voltage reference (U5) and resistor R1 which determines the bias current for the zener reference. Resistor R6 has a nominal 499K value so that when the voltage picked off the stable reference is close to 4.99V, the output current determined by the operational amplifier (U6) and the output FET(U7) will be exactly 10μA with a compliance voltage greater than 10V.

The 10μA current is directed to Sensor A or Sensor B by the switch S5. Switch S4 directs the positive sensor voltage of Sensor A or B to the A/D converter pair. Note that both the Sensor A and Sensor B low voltage terminals are tied together to analog ground. Therefore, the I^- return of the current source will be slightly below ground (by a few millivolts, depending on lead resistance). Since S5 and S4 are interlocking switches, the switch S4 is used to tell the microprocessor which sensor has been selected. This information is important to the microprocessor only if a calibrated sensor is present or if a SW-10A ten-position switch option is present in Sensor position B.

Switch S3 indicates to the microprocessor whether or not scale expand below 100K is desired.

Switch S1 is the ON-OFF switch. Power ON is indicated by a lighted display board.

4.2.3 A/D Converter and Microprocessor System

The analog-to-digital convertor consists of a high input impedance precision 4½ digit I.C. pair (8052A/7103A, U12 and U10) that produces a BCD output that is accurate to ±1 count over its entire 40,000 count range. The 7103A (U10) runs on a 50K Hz clock cycle generated by a 7555 clock (U11) and its associated components (R11, R12, and C11). This clock frequency allows for one reading every 0.8 seconds. The digital output signal is in a bit-parallel, byte serial form. The A/D converter output is multiplexed by U14 and U15 and input to the microprocessor.

In addition to the A/D voltage information, the microprocessor inputs the sensor-selected, scale expand switch position, and in the case of the SW-10A, the position selected. The microprocessor outputs temperature information in BCD form to the display as well as to the options (BCD or IEEE), if present. If a ten-position switch is also present, the sensor position selected is also output to the option (BCD or IEEE).

The microprocessor system used in the DRC-80 is a 38P70 which utilizes a piggy-back memory architecture. A 3870μp was originally a mask-memory part with the user tied to one program form when the part was fabricated. The piggy-back variation of the part allows for variable memory space (between 8K and 64K of PROM) to be placed on the top of the μp. This allows all lines that were used for addresses and data to be used for Input/Output.

The microprocessor unit (MPU) has an internal RAM scratchpad memory used for programming. The unit uses an internally generated clock which is derived from the resistor fro R21 (and C21 if needed). The MPU has 4 8-bit bi-directional ports used for communication to and from the processor. Two of these ports, Port 0 and 5, are used for internal control of the instrument (A/D input, BCD temperature output to BCD L/A option and display, and internal housekeeping). The remaining two ports, Port 1 and 4, are used for option access (IEEE-488).

4.2.4 Software - DRC-80 Cryogenic Thermometer

Figure 4.1 is a flow chart of the major steps in the cryogenic thermometer program. When the instrument is turned on, the program does a power ON reset and starts the software program at the beginning. At this point, the program initializes internal registers to be used in the program. The program first checks for an A/D converter overrange and then inputs multiplexed A/D information. When the A/D tells it there is fresh data ready, (the program loops until the A/D information is ready), the program then verifies that no illegal characters are present and stores the reading.

The program then inputs display sensor information. There is one standard curve for the instrument and there are a maximum of <u>twelve</u> additional curves. There can be a calibrated curve for Sensor A, B, and ten different switch positions generated by the SW-10A. The program, through the use of some internal identifiers, determines the proper curve to be used.

Once the curve is determined, the proper Voltage-Temperature Break

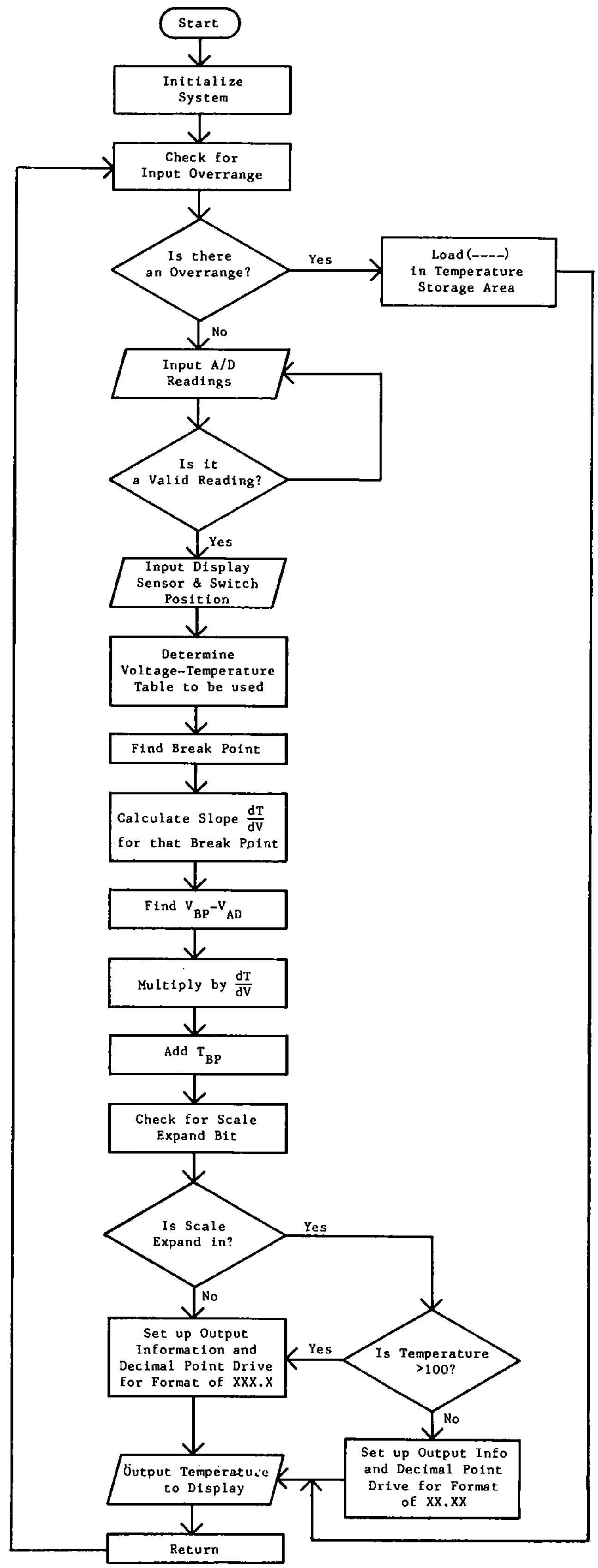

FIGURE 4.1 Software Flow Diagram for DRC-80 Digital Thermometer

Point is determined. The program finds the correct break point for temperature determination by checking each breakpoint voltage to see if it is lower than the input voltage. As the break point is found, the temperature is calculated using the following equation:

$$T = (V_{BP} - V_{AD}) * \frac{dT}{dV} + T_{BP}$$

where:

T	is temperature in K
V_{BP}	is break point voltage
V_{AD}	is input voltage
$\frac{dT}{dV}(S_{BP})$	is slope between successive break points
T_{BP}	is break point temperature

After the correct temperature has been calculated, the program looks to see if the instrument is in the scale expand mode. In this mode, the front panel display converts to a resolution of .01K below 30K and 0.05K between 30K and 100K. The temperature data is output in a bit-parallel, digit-serial form and is latched into the display board.

4.2.5 Digital Display Board

The display board receives its data in a bit-parallel/digit-serial form. The information is latched into the display decoder/driver, U101, which drives the display digits DS1-4.

Control of the decimal point is carried out by the BCD/decimal decoder/driver, U102. This driver receives its information directly from the microprocessor.

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SECTION V

Calibration and Troubleshooting

5.1 Introduction

This section contains the instructions for calibrating and troubleshooting the DRC-80 instrument.

5.2 Test Equipment

A high input impedance digital voltmeter and oscilloscope, and a precision resistor connected to simulate the diode wired according to Figure 2.1 (b) are normally sufficient to test and calibrate the DRC-80 instrument.

5.3 General Remarks

On installation, one of the major problems is an improperly connected temperature sensing diode. It is advised that other portions of the cryogenic system be tested before the instrument is troubleshooted. Some checks that could be made are:

1) Open or shorted sensor leads (especially in an area of frequent disassembly).

2) Leakage paths between heater and sensor leads that induce electrical feedback in addition to thermal feedback.

If the malfunction points toward the instrument, more detailed tests should be made.

5.4 Instrument Calibration

The DRC-80 has been factory calibrated. If a recalibration is needed, the following procedure should be followed. Please refer to the component layout for the DRC-80, Figure 6.3 for the following discussion:

5.4.1 Current Source

A precision resistor of not less than .01% tolerance should be connected across pins A and B (Figure 2.1) of the A Sensor socket. A high input impedance voltmeter connected across the precision resistor should measure a voltage equal to 10 microamperes times the value of the resistor. For example, a 100K ohm ±.01% resistor should read 1.0000 volts within 100 μvolts. If recalibration is needed, the voltage across the 100K resistor can be adjusted by varying resistor R3.

5.4.2 A/D Converter

To adjust the A/D converter, a voltage needs to be applied across pins E and D (Figure 2.1) of the display sensor connector. A variable 200K resistor hooked up as in Fig. 2.1 (a), or precision voltage source in place of the diode are ideal ways to generate this voltage. If a resistor is used, it should be varied until one of the breakpoint voltages, indicated in the Voltage-Temperature Characteristic Table is generated; (A high impedance voltmeter must be used for this adjustment). After an appropriate voltage is obtained, the display should be calibrated by adjusting trimpot R16 until the display reads the correct temperature. If a precision voltage source is used, a breakpoint voltage should be dialed in and the display should be calibrated as above. A breakpoint temperature above 40K should be used since the voltage sensitivity with temperature is lower at the higher temperatures (2.5 mV/^{o}K) than for temperatures below 30K.

5.4.3 Adjustment of Output Buffer

With a constant voltage fed into the instrument, place a voltmeter between pins A & B of connector J3. U9 is a buffer of input voltage and should have an output equal to input. R4 is varied to obtain the proper buffered signal.

5.4.4 DRC8-L/A Option Model 8025 (if present)

The output of the DRC8-L/A Model 8025 is 10 mV/K in the normal display mode. In other words, 100.0 ^{o}K on the display corresponds to a 1.0000V output between pins C and D of monitor connector J3. To recalibrate the option, two adjustments need to be made. With a low temperature on the display (e.g., 22.0 ^{o}K), adjust the offset adjustment potentiometer R89 (see Fig. 6. , DRC-80 BCD L/A Layout) until the output corresponds to 10 mV/K. Then take the display to a higher temperature (e.g., 300 ^{o}K). Adjustment of Gain Potentiometer R88 will bring the output to 10 mV/K. The procedure may need one more iteration, that is, go to the low temperature on the display, adjust the offset, then adjust the gain.

5.5 Instrument Tests

The first check to be made would be to check the input line fuse. The type of fuse and line voltage are shown on the rear panel of the instrument. If the input line voltage and sensor input voltage have been checked, the following sequence should be followed:

1) Check all power supplies for proper operation. The voltages can be noted on Fig. 6.3, DRC-80 Parts Layout.

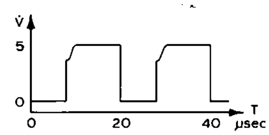
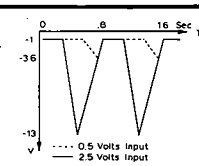
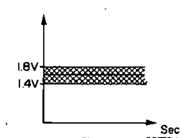
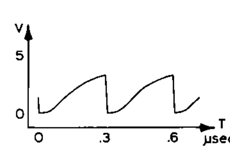
2) Check for the waveforms at the following pins and refer to Fig. 5.1 for waveforms.

Signal paths should also be checked. If signals are present at source components and not at destination components, a printed circuit problem requiring a repair of the printed circuit foil may be required. Continuity checks between points will turn up any unwanted open circuits in signal paths.

If the signals at the component pins outlined in Table 5.1 are present, and a problem still exists, a factory representative should be contacted.

Table 5.1

DRC-80 Signals Associated with Figure 5.1

Signal	Function	Wave Form
a) Pin 12 of U10 or Pin 3 of U11	Clock signal of A/D converter. The frequency should be about 50K Hz. If not present, replace U11. Also check R12, R11, and C11.	
b) Pin 14 of U12	Integrated signal of A/D to determine the count period. The period should be about .35 seconds. If not present, check U10 and U11.	
c) Pin 7 of U10	This is a D.C. level that is the reference voltage for the integrator. The value should be between 1.4 and 1.8 volts. If not present, check U12. Also check resistance string R15-18 for proper value and operation.	
d) A/D Output of U10	The digit drives (Pins 19, 24, 25, 26, and 27) are positive going pulses and last for 200 clock pulses. The scan sequence is D5 (MSD), D4, D3, D2, and D1 (LSD). The BCD pins (pins 20-23) are positive going signals that go on simultaneously with the digit device. If not present, and signals a), b), and c) are correct, replace U10.	See Figure 5.1 on following page
e) Pin 2 of U13	This is the µP clock signal. This is generated by an external RC network with the help of the main processor. If not present, check R21, C21, and U13 for proper operation.	

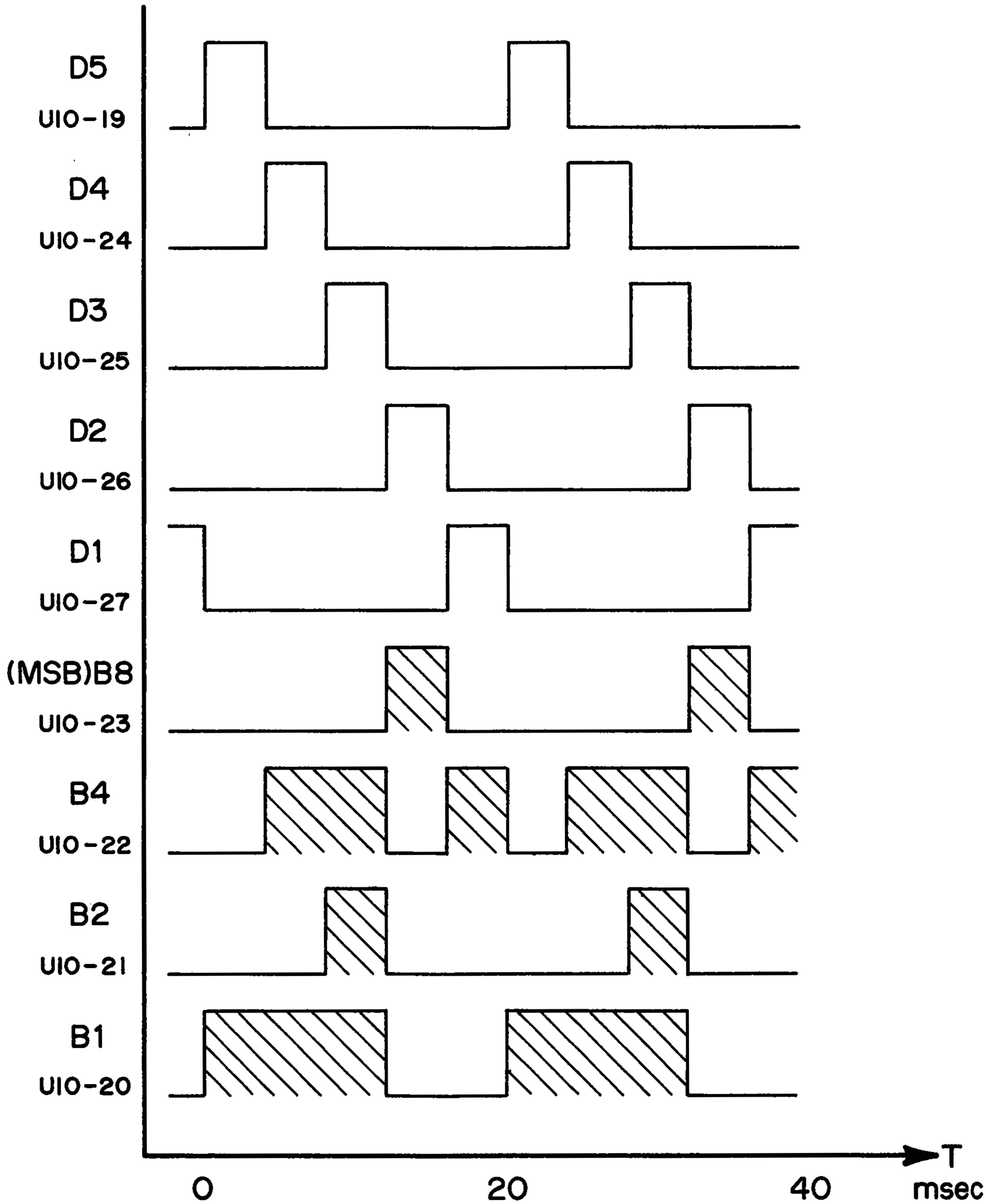


Figure 5.1 DRC-80 A/D Typical Output Signals

SECTION VI

DRC-80
REPLACEABLE PARTS LIST

CAPACITORS

CIRCUIT DESIGNATION	VALUE	RATING	TYPE
C1	470 µf	35V	E. AL.
C2	470 µf	35V	E. AL.
C3	470 µf	35V	E. AL.
C4	2700 µf	25V	E. Al.
C5	.1 µf	100V	Poly.
C6	.1 µf	100V	Poly.
C7	.1 µf	100V	Poly.
C8	.68 µf	100V	Poly.
C9	150 µf	500V	Mica D.
C10	.0015 µf	100V	Mylar
C11	330 pf	500V	Mica. D.
C12	.68µf	100V	Poly.
C13	1.5 µf	25V	Tan.
C14	330 pf	500V	Mica D.
C15	.33 µf	100V	Mylar
C16	.68 µf	100V	Poly.
C17	.68 µf	100V	Poly.
C18	.68 µf	100V	Poly.
C19	.33 µf	100V	Mylar
C20	.68 µf	100V	Poly.
C21	18 pf	500V	Mica D.
C22	.1 µf	100V	Poly.

CONNECTORS

CIRCUIT DESIG.	DESCRIPTION	MFR. and PART NO.
J1	5 Pin Socket (Sensor A)	Amphenol 126-218 (mates with 126-217)
J2	5 Pin Socket (Sensor B)	Amphenol 126-218 (mates with 126-217)
J3	7 Pin Socket	Amphenol 126-198 (mates with 126-195)
J4	BCD Out/IEEE Out (Interface)	Lake Shore Cryotronics, Inc.
JA	10 Contact PC Mount (Display Board)	AMP MOD II 3-86018-5 (mates to JG)

CONNECTORS

CIRCUIT DESIG.	DESCRIPTION	MFR. and PART NO.
JB	10 Contact PC Mount (Display Board	AMP MOD II 3-86018-5 (mates to JH)
JC	14 Pin IC Socket (SW-10 Input of switch position)	Cambion 703-5314-01-04-12
JD	16 Pin IC Socket (IEEE Micro Interface)	Cambion 703-5316-01-04-12
JE	24 Contact Edge Card (BCD/L-A Option)	TRW 50-24B-10
JG	10 Contact PC Mount (To Display Board)	AMP MOD II 87228-5 (mates to JA)
JH	10 Contact PC Mount (To Display Board)	AMP MOD II 87228-5 (mate to JB)
JL	12 Contact PC Mount (Power Transformer)	AMP 350213-1 (mates to 1-480 287-0)

DIODES

CIRCUIT DESIG.	TYPE	MFR. and PART NO.
CR1	Silicon	IN4006
CR2	Silicon	IN4006
CR3	Silicon	IN4006
CR4	Silicon	IN4006
CR5	Silicon	IN4006
CR6	Silicon	MR501
CR7	Silicon	MR501
CR8	Silicon	IN743A
CR9	Silicon	IN743A
CR10	Silicon	IN4148
DS1	7 Segment LED (Least significant LED)	Hewlett-Packard 5082-7651
DS2	7 Segment LED (2nd Significant Digit)	Hewlett-Packard 5082-7651
DS3	7 Segment LED (3rd Significant Digit)	Hewlett-Packard 5082-7651
DS4	7 Segment LED (Most Significant Digit)	Hewlett-Packard 5082-7651

INTEGRATED CIRCUITS

CIRCUIT DESIGNATION	DESCRIPTION	MFR. and PART NO.
U1	15V Positive Voltage Regulator	7815
U2	15V Positive Voltage Regulator	7815
U3	15V Negative Voltage Regulator	7915
U4	5V Positive Voltage Regulator	7805
U5	Temp. Stabilizer Voltage Reference (Current Source)	LM399H
U6	Operational Amplifier	LM308N
U7	F.E.T. (Current Source Driver)	3N163
U8	Not Present	
U9	Operational Amplifier	OP07EJ
U10	A/D Converter Building Block	71C03
U11	Timer Circuit	7555
U12	A/D Converter Building Block	8052
U13	Microprocessor Unit	38P70 Plus Prom (Memory Dependent)
U14-15	Tri-State 4-line to 4-line Multiplexers	74LS257

MISCELLANEOUS

CIRCUIT DESIG. or FIG. NO.	DESCRIPTION	MFR. and PART NO.
	Main Fuse	
	3 AG, Slow Blow	
	90V-125:3/4A	Bussmann MDL 3/4
	210V-250V:4/10A	Bussmann MDL 4/10
	Fuseholder	Littlefuse 342004A
TX1	Power Transformer	LSCI Supplied TX696-107
	Power Cord 115V	Belden 17236
	CEE Color Coded 230V	Belden 17740C
	Strain Relief	H.H. Smith 939
	Heat Sink for U4	Aavid 60130-020B

RESISTORS

CIRCUIT DESIGNATION	VALUE	RATING	TYPE
R1	3.74K	1% ¼W	Mt.F.
R2	10K	1% ¼W	Mt.F.
R3	5K Trimpot	I Source Adjust.	
R4	20K Trimpot	Operational Amplifier Adjust	
R5	4.75K	1% ¼W	Mt.F.
R6	499K	1% ¼W	Mt.F.
R7	Not Present		
R8	Not Present		
	Not Present		
R10	4.75K	1% ¼W	Mt.F.
R11	10K	1% ¼W	Mt.F.
R12	33.2K	1% ¼W	Mt.F.
R13	36.5K	1% ¼W	Mt.F.
R14	301K	1% ¼W	Mt.F.
R15	1.18K	1% ¼W	Mt.F.
R16	5K Trimpot	A/D Adjust	
R17	196 ohm	1% ¼W	Mt.F.
R18	107 ohm	1% ¼W	Mt.F.
R19	121K	1% ¼W	Mt.F.
R20	121K	1% ¼W	Mt.F.
R21	19.6K	1% ¼W	Mt.F.
R22	4.75K	1% ¼W	Mt.F.
R23	10 ohm	1% ¼W	Mt.F.
R24-27	4.7K	4 Element Resistance Network	
R101	3.74K	1% ¼W	Mt.F.
R102-105	330 ohm	4 Element Resistance Network	

SWITCHES

CIRCUIT DESIGNATION	DESCRIPTION	MFR. and PART NO.
S1	Power Switch	LSCI Supplied, DRC-80
S3	Scale Expand Switch	LSCI Supplied, DRC-80
S4	Sensor B	LSCI Supplied, DRC-80
S5	Sensor A	LSCI Supplied, DRC-80
S2	115/230 Switch	Switchcraft
S6	Not Present	

DRC-80 BCD L/A
REPLACEABLE PARTS LIST

CAPACITORS

CIRCUIT DESIGNATION	VALUE	RATING	TYPE
C56	.033 f	100V	Mylar
C57	.68 f	100V	Poly.
C58	.68 f	100V	Poly.
C59	.68 f	100V	Poly.

CONNECTOR

CIRCUIT DESIGNATION	DESCRIPTION	MFR. and PART NO.
J4	50 pin PC Mount Header	T&B Ansley 609-5022M

INTEGRATED CIRCUITS

CIRCUIT DESIGNATION	USED IN	PART NO.
U51	BCD, L/A	74LS175
U52	BCD, L/A	74LS175
U53	BCD, L/A	74LS175
U54	BCD, L/A	74LS175
U56	BCD only	74123
U61	L/A only	OP15FJ
U62	L/A only	DAC HP16D
U63	BCD, L/A	7420

RESISTORS

CIRCUIT DESIGNATION	VALUE	RATING	TYPE
R76	2 MEG	1% ¼W	Mt.F.
R86	2 MEG	1% ¼W	Mt.F.
R87	511K	1% ¼W	Mt.F.
R88	50K Trimpot		
R89	50K Trimpot		

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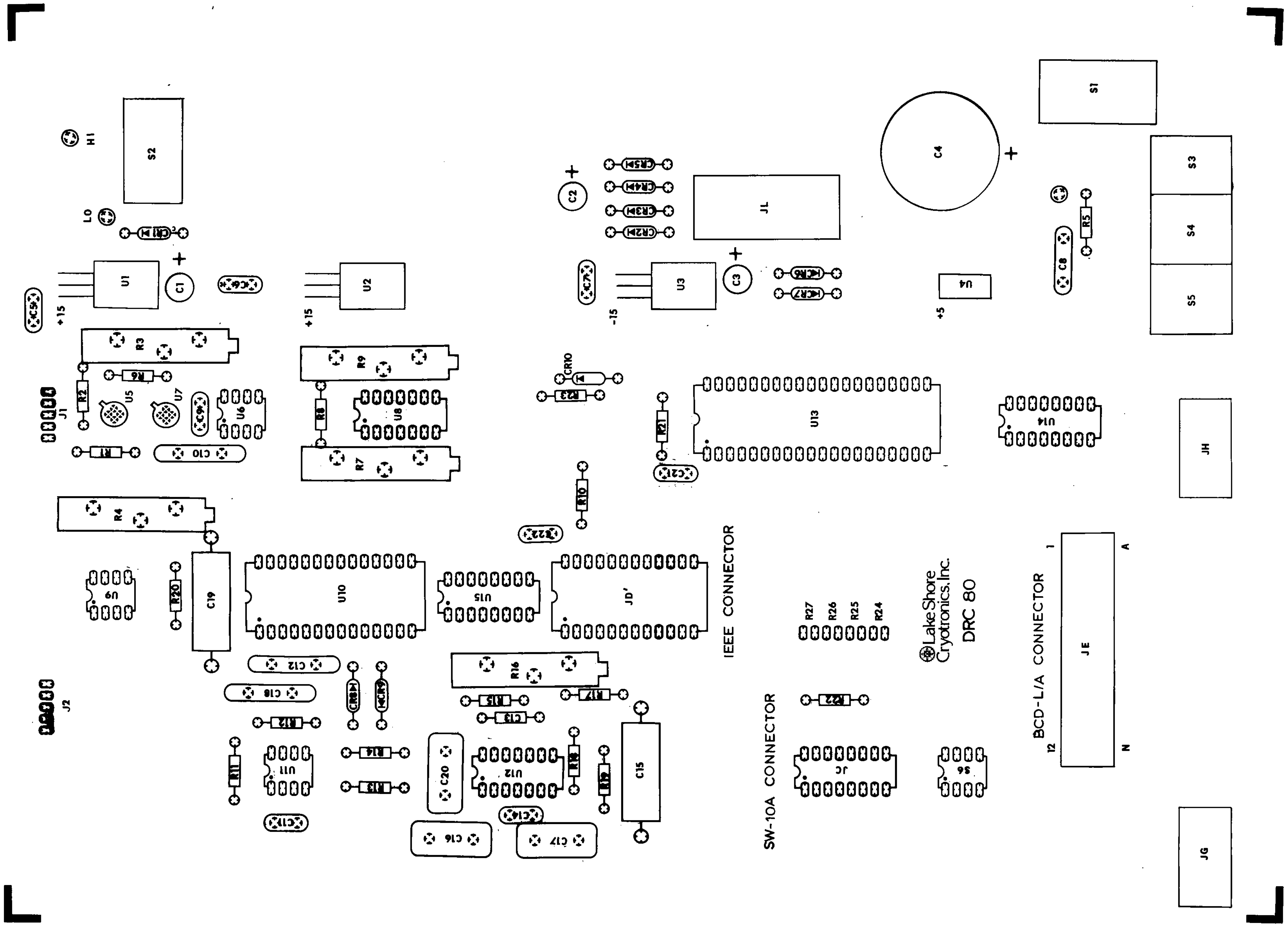


ITEM NO	QTY REQ'D	PART OR IDENTIFICATION NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR SIZE	MATERIAL OR NOTE

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
X XX ± 03 X XXX ± 005
ANGULAR ± 1 2
MACHINE FINISH
BREAK SHARP CORNERS
REMOVE ALL BURRS
DO NOT SCALE DRAWING

NEXT ASSEMBLY | USED ON | MATERIAL:

APPLICATION

CONTRACT NO

DRAWN KS	DATE 6-5-81
CHECKED	DATE 6 19 81
APP'D	DATE 6 19 81
APP'D	DATE

CUSTOM | PROT | PROD

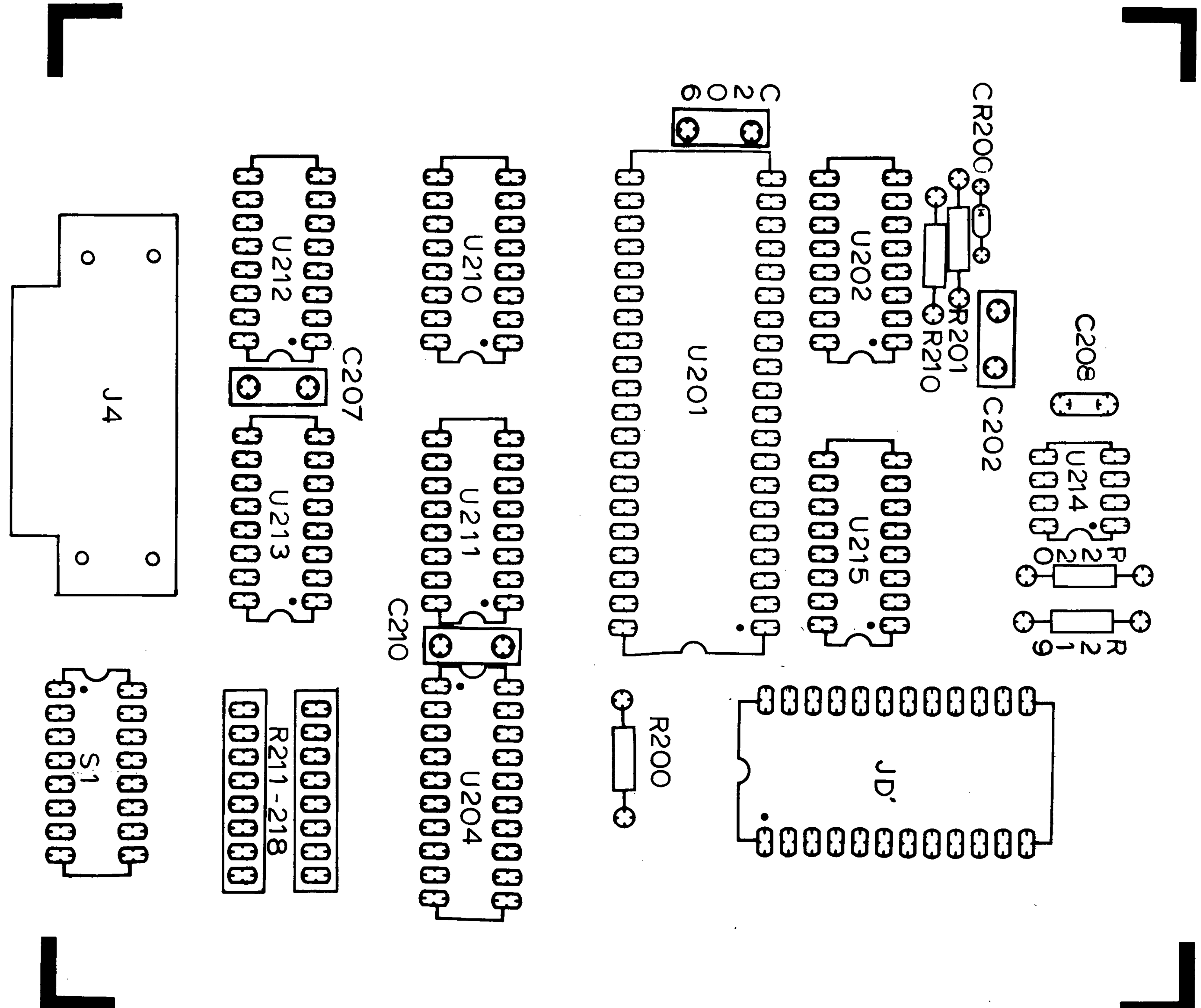
DESIGN ACTIVITY

LAKE SHORE CRYOTRONICS, INC.
Westerville, Ohio 43081

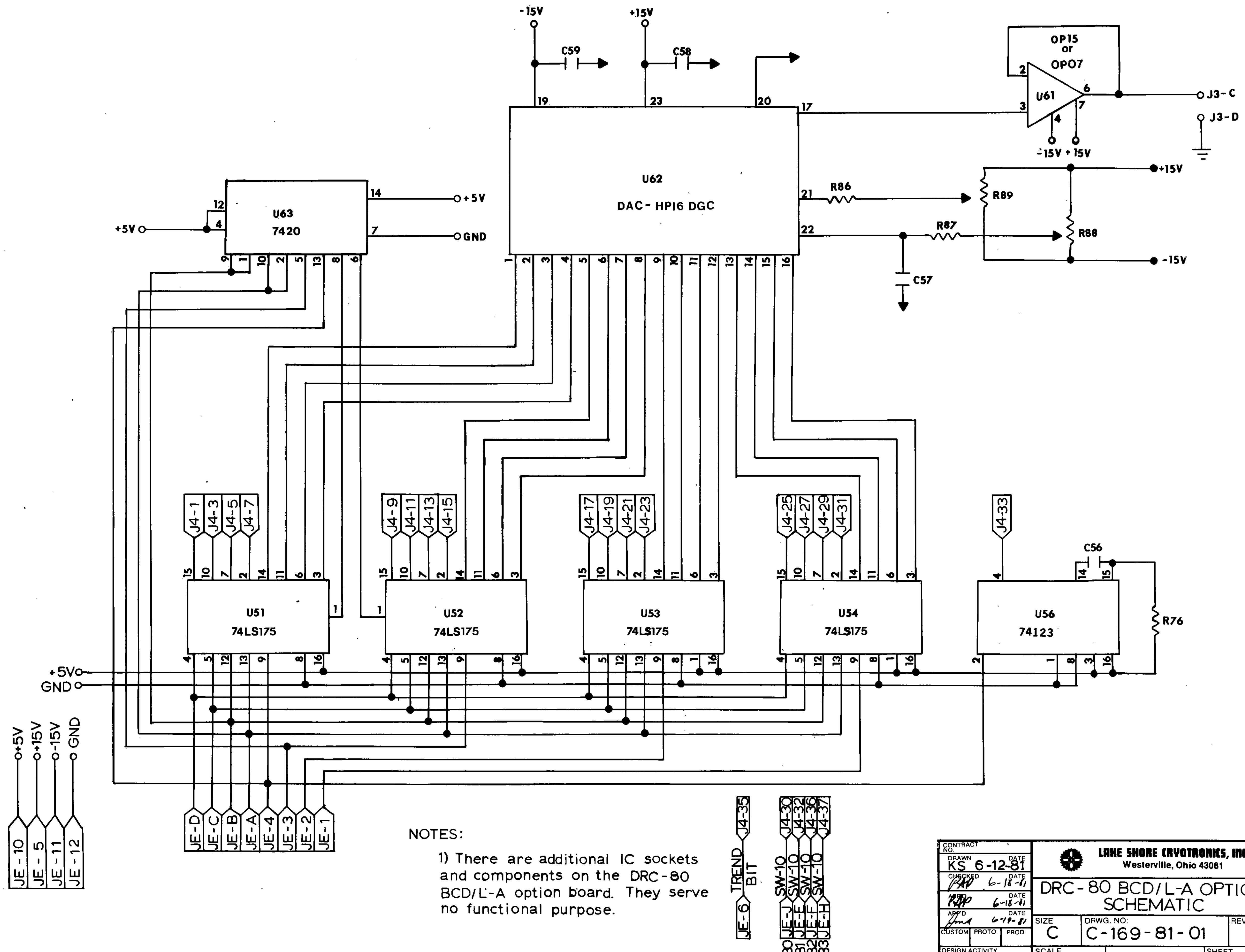
DRC-80 PARTS LAYOUT

SIZE D | DRWG. NO: D-157-81-01 | REVISION

SCALE | SHEET OF



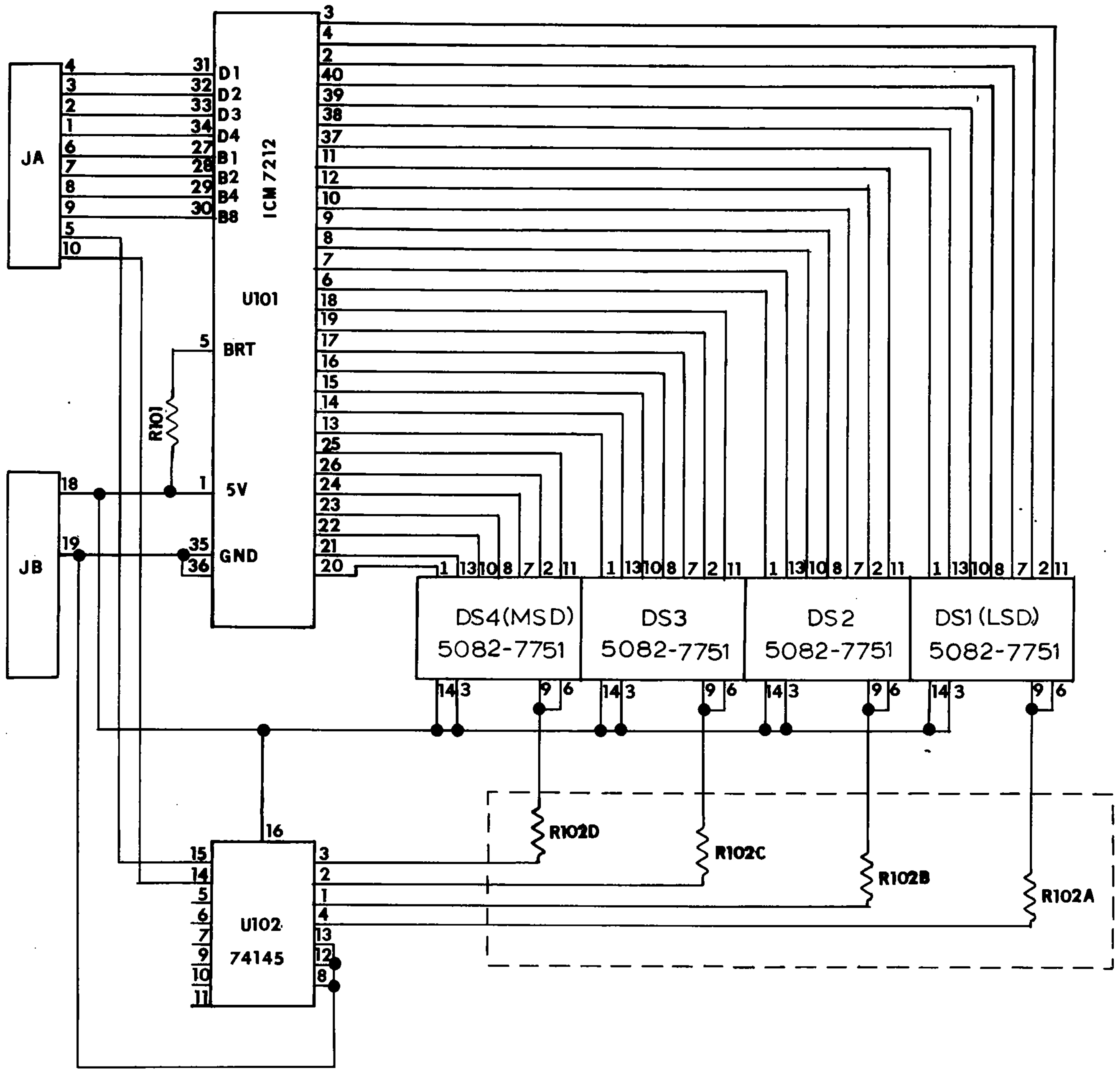
CONTRACT NO.	**LAKE SHORE CRYOTRONICS, INC.** Westerville, Ohio 43081
DRAWN KS DATE 6-19-81	
CHECKED JB DATE 7-14-81	DRC 80 IEEE PARTS LAYOUT
APP'D DATE 7-14-81	
APP'D DATE 7-14-81	SIZE B · DRWG. NO: B - 204 - 81-01 · REVISION
CUSTOM · PROTO. · PROD.	
DESIGN ACTIVITY	SCALE · SHEET OF



NOTES:

1) There are additional IC sockets and components on the DRC-80 BCD/L-A option board. They serve no functional purpose.

CONTRACT NO.	LAKE SHORE CRYOTRONICS, INC. Westerville, Ohio 43081
DRAWN KS 6-12-81	
CHECKED 6-18-81	DRC-80 BCD/L-A OPTION SCHEMATIC
APPD 6-18-81	
APP'D 6-19-81	
CUSTOM / PROTO / PROD.	SIZE C — DRWG. NO: C-169-81-01 — REVISION
DESIGN ACTIVITY	SCALE — SHEET OF



NOTES:

1) JA AND JB MATE TO MAIN BOARD CONNECTORS JG AND JH RESPECTIVELY.

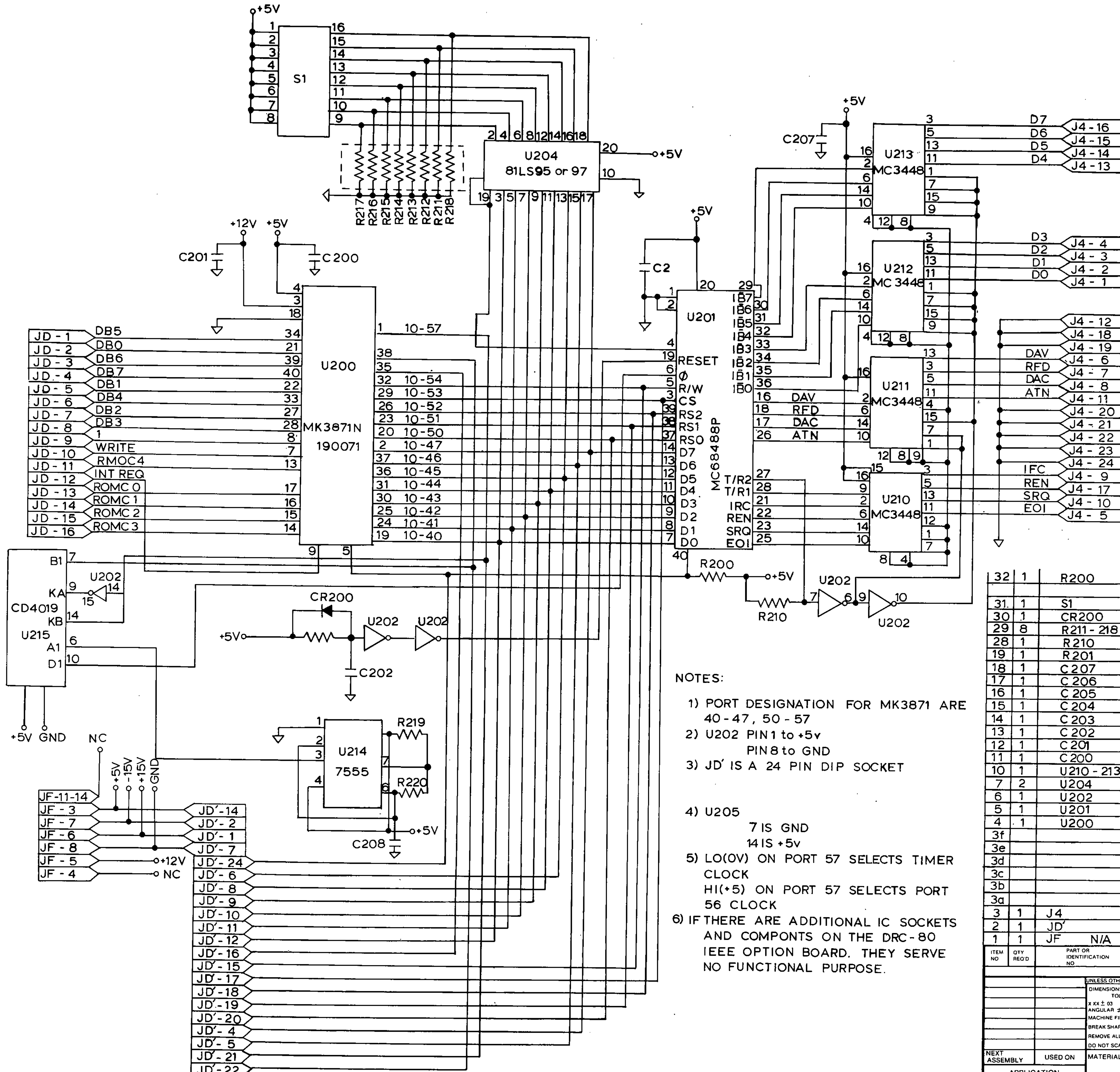
2) PINS 5, 6, 7, 9, 10, 11 OF U102 ARE N.C.

CONTRACT NO.
DRAWN KS 6-10-81
CHECKED 6-18-81
APP'D 6-18-81
APP'D 6-19-81
CUSTOM PROTO. PROD.
DESIGN ACTIVITY

LAKE SHORE CRYOTRONICS, INC.
Westerville, Ohio 43081

DRC 80 DISPLAY BOARD SCHEMATIC

SIZE C
DRWG. NO. 168-81-01
REVISION
SCALE
SHEET OF



NOTES:

1) PORT DESIGNATION FOR MK3871 ARE 40-47, 50-57
2) U202 PIN 1 to +5v
PIN 8 to GND
3) JD′ IS A 24 PIN DIP SOCKET
4) U205
7 IS GND
14 IS +5v
5) LO(0V) ON PORT 57 SELECTS TIMER CLOCK
HI(+5) ON PORT 57 SELECTS PORT 56 CLOCK
6) IF THERE ARE ADDITIONAL IC SOCKETS AND COMPONTS ON THE DRC-80 IEEE OPTION BOARD. THEY SERVE NO FUNCTIONAL PURPOSE.

ITEM NO	QTY REQ'D	PART OR IDENTIFICATION NO	NOMENCLATURE OR DESCRIPTION	SPECIFICATION OR SIZE / MATERIAL OR NOTE
32	1	R200	4.7K	
			ALCO DSS-8	8-SWITCH DIP SWITCH
31	1	S1	CUTLER HAMMER SEZA V591-8	
30	1	CR200	1N4148	MOTOROLA
29	8	R211-218	4.7K	1/4w %
28	1	R210	4.7K	"
19	1	R201	10Ω	"
18	1	C207	.1uf	PLESSY BOX TYPE
17	1	C206	.1uf	" " "
16	1	C205	.1uf	" " "
15	1	C204	.1uf	" " "
14	1	C203	.1uf	" " "
13	1	C202	.1uf	" " "
12	1	C201	.1uf	" " "
11	1	C200	.1uf	" " "
10	1	U210-213	MC3448AP	MOTOROLA
7	2	U204	DM81LS95 or 97N	NATIONAL
6	1	U202	CD4049BN	NATIONAL OR MOTOROLA
5	1	U201	MC68488P	MOTOROLA
4	1	U200	MK3871/90071	MOSTEK
3f			BELDEN 9642	3'3" IEEE CABLE
3e			6-32 x 3/8 PFHMS	
3d			229966-4	DUST COVERS
3c			552661-1	BUS INTERFACE CONN. KITS
3b			552633-4	REAR PANEL MOUNT HARDW.
3a			552791-1	Pc. R.A. RECEPTACLE
3	1	J4	AMP IEEE SOCKET	
2	1	JD′	24PIN DIP SOCKET	MATES W/HEADER TO DRC-JD′
1	1	JF N/A	14 PIN DIP SOCKET	MATES W/HEADER TO DRC-JF

LIST OF MATERIALS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
X.XX ± .03 X.XXX ± .005
ANGULAR ± 1°2′
MACHINE FINISH
BREAK SHARP CORNERS
REMOVE ALL BURRS
DO NOT SCALE DRAWING

MATERIAL:

NEXT ASSEMBLY | USED ON

APPLICATION

CONTRACT NO

DRAWN KS DATE 6-11-81
CHECKED DATE
APPD DATE
APPD DATE

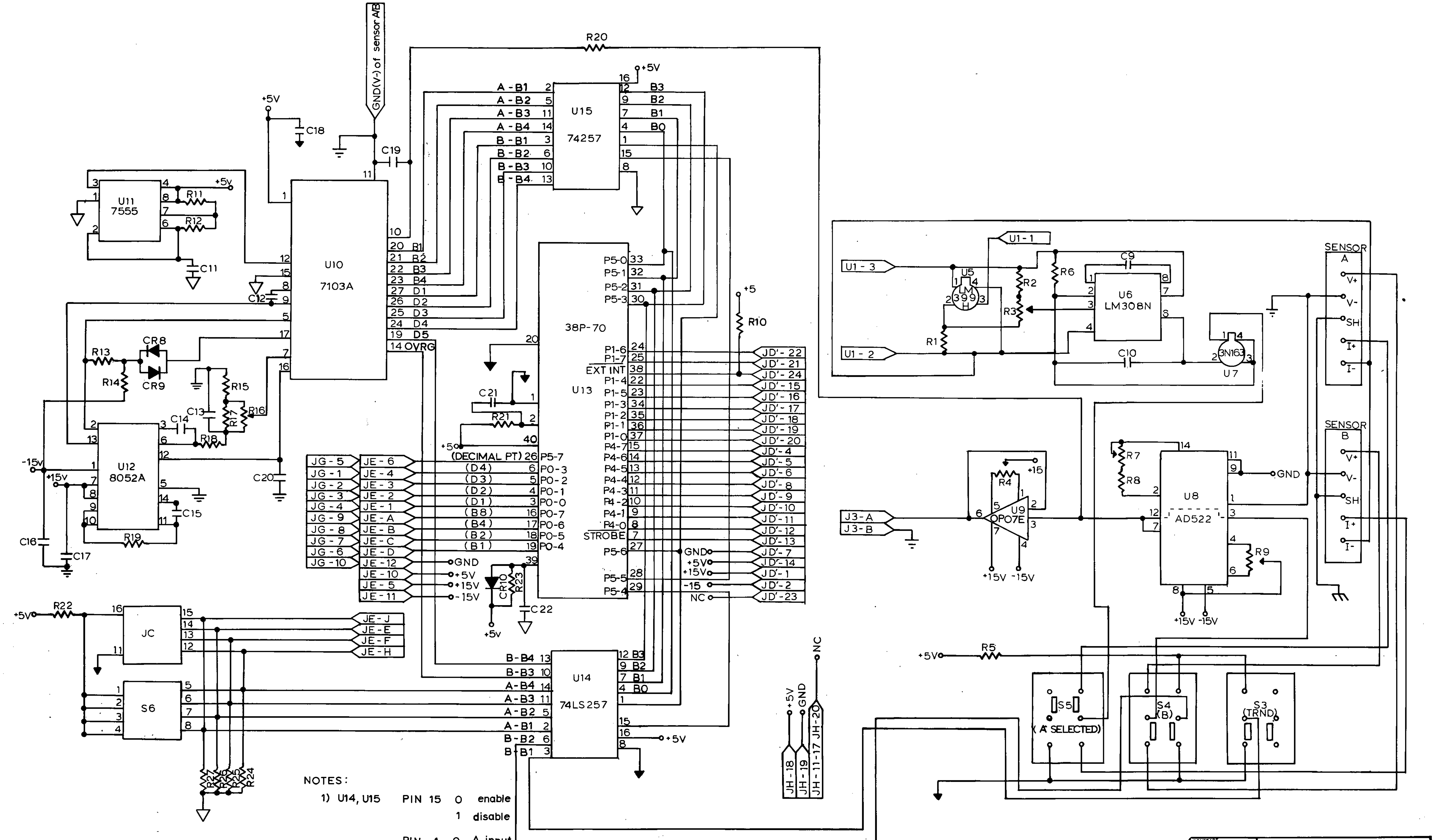
CUSTOM PROTO PROD
DESIGN ACTIVITY

LAKE SHORE CRYOTRONICS, INC.
Westerville, Ohio 43081

DRC-80 IEEE
SCHEMATIC

SIZE D | DRWG. NO. D-156-81-01 | REVISION

SCALE | SHEET OF



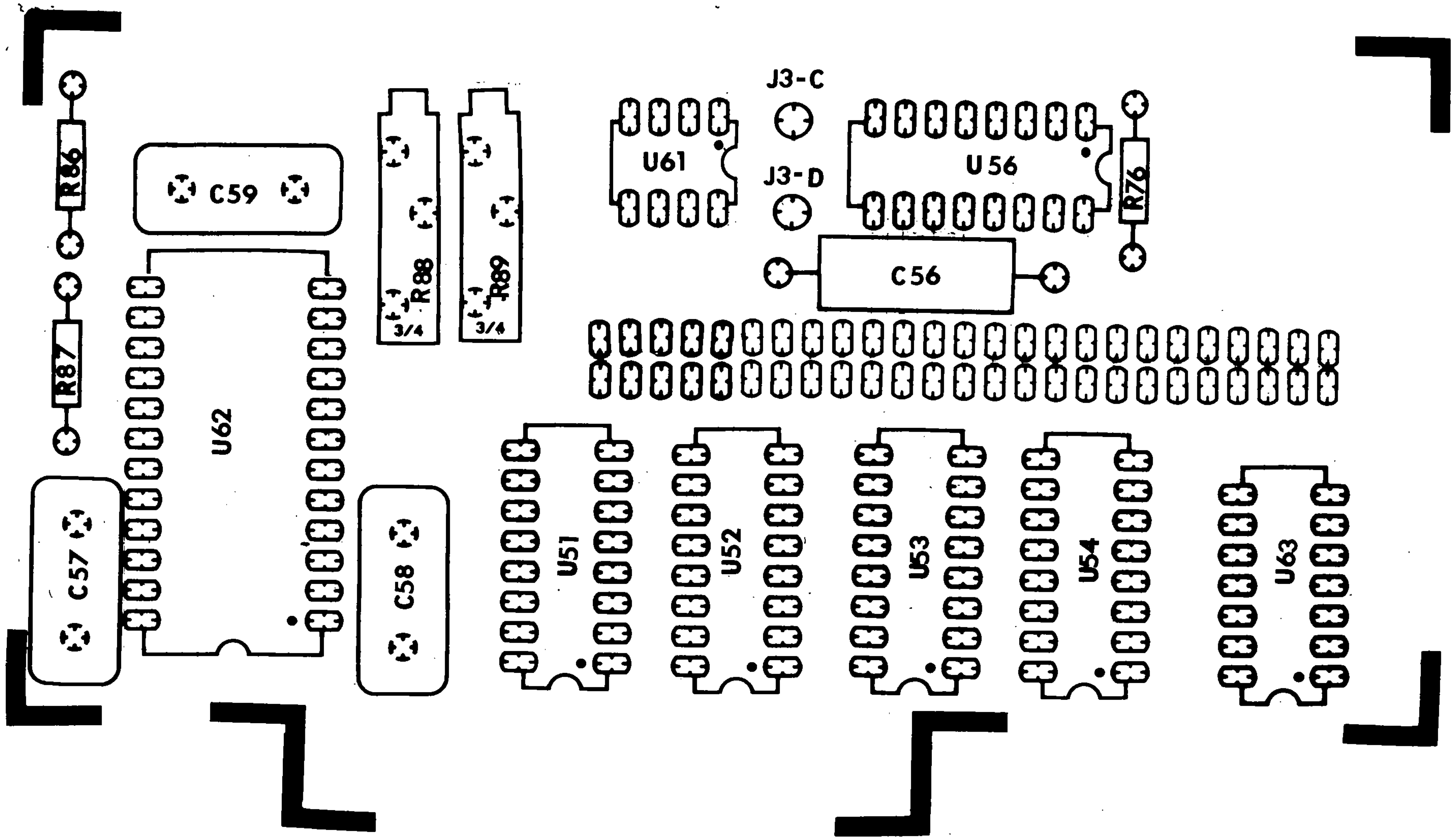
NOTES:

1) U14, U15 PIN 15 0 enable
1 disable

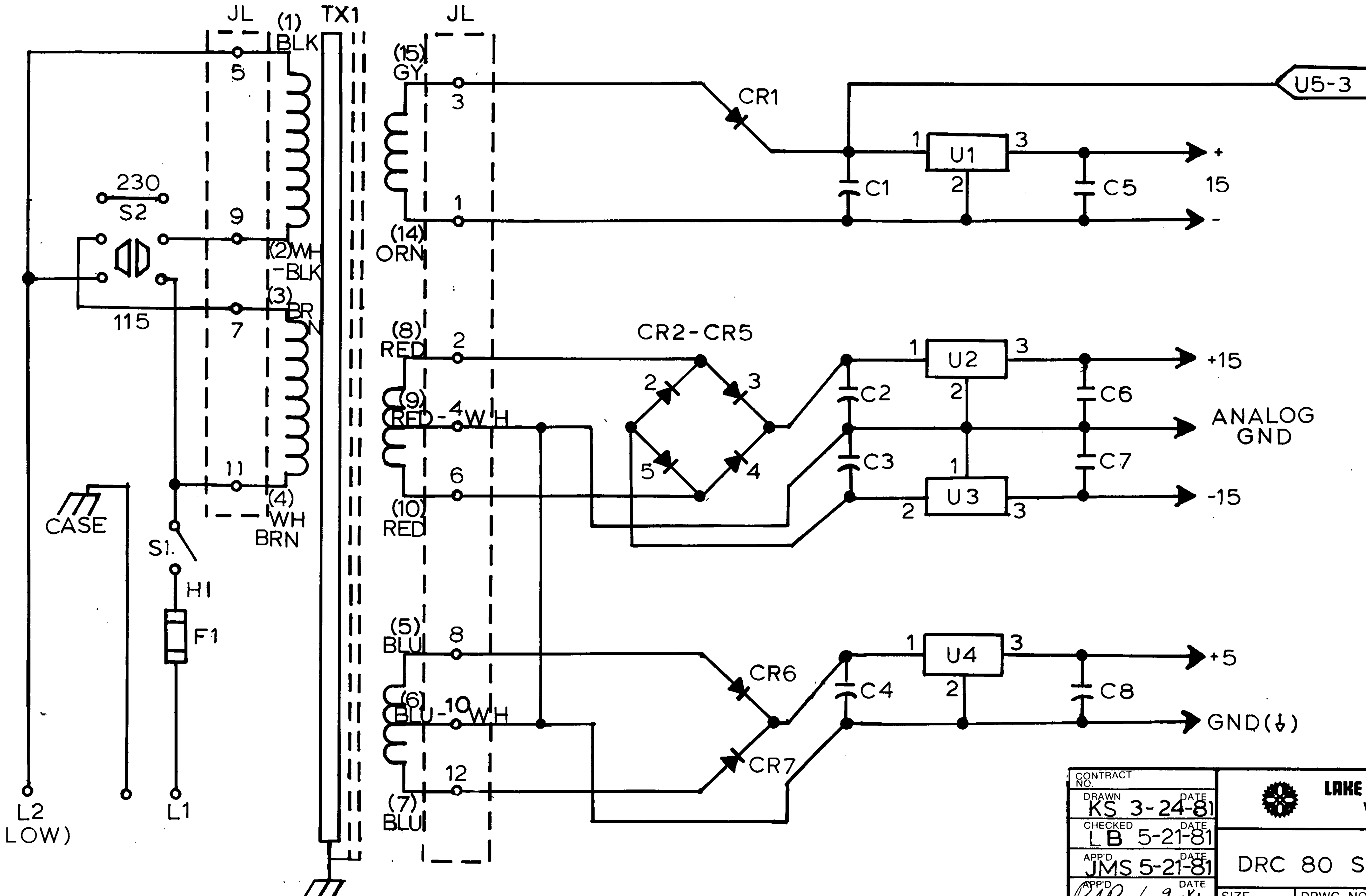
PIN 1 0 A input
1 B input

2) C21 IS NOT PRESENT

CONTRACT NO.	LAKE SHORE CRYOTRONICS, INC. Westerville, Ohio 43081
DRAWN KS DATE 3-19-81	DRC-80 SCHEMATIC #2
CHECKED DATE 6-18-81	
DATE 6-18-81	
APP'D DATE 6-19-81	SIZE / DWG NO. D-145-81-01 / REVISION
CUSTOM / PROTO / PROD	
DESIGN ACTIVITY	SCALE / SHEET OF



CONTRACT NO.			LAKE SHORE CRYOTRONICS, INC. Westerville, Ohio 43081		
DRAWN		DATE			
CHECKED CB		DATE 7-14-81	DRC 80 BCD L/A PARTS LAYOUT		
APP'D		DATE 7-14-81			
APP'D		DATE 7-14-81	SIZE B	DRWG. NO: B-203-81-01	REVISION
CUSTOM	PROTO.	PROD.			
DESIGN ACTIVITY			SCALE		SHEET OF



CONTRACT NO.	**LAKE SHORE CRYOTRONICS, INC.** Westerville, Ohio 43081
DRAWN KS DATE 3-24-81	
CHECKED LB DATE 5-21-81	DRC 80 SCHEMATIC #1
APP'D JMS DATE 5-21-81	
APP'D PAP DATE 6-9-81	SIZE B — DRWG. NO: B-178-81-01 — REVISION
CUSTOM / PROTO. / PROD.	
DESIGN ACTIVITY	SCALE — SHEET OF