Model 818 ☒ Model 819 ☐ Serial Number 20879

This manual applies to instruments with Serial Number 20000 and higher.

BESSRC

USER'S MANUAL

MODEL 818/819

CRYOPUMP MONITOR

Curve 0	DT-500DI-8B	☐
Curve 1	DT-500DI-8A	☐
Curve 2	DT-500DRC-D	☐
Curve 3	DT-500DRC-E1	☐
Curve 4	CTI Curve C	☐
Curve 5	DT-500DI-8C	☐
Curve 6	DT-470 Curve 10	☐
Curve 7	_____	☐
Curve 8	_____	☐
Curve 9	_____	☐

LakeShore®

Measurement and Control Technologies

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Manual No. MAN-818 24 June 1988

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The information contained in this manual pertains to the installation, operation, remote programming, options and accessories and calibration procedures for the Lake Shore Cryotronics, Inc. Model 818 and 819 Cryopump Monitors.

1.2 DESCRIPTION

The Model 818/819 is a microprocessor controlled instrument which provides direct digital display of temperature with up to 4 digits of resolution in K, ^{o}C or ^{o}F and sensor voltage to one millivolt.

The Model 818 features one input with two alarms. The alarms can be used to safeguard or initiate and control automatic cryopump regeneration cycles. The alarms are configured as HI and LO alarms. The alarm set points are front panel setable with function keys and up/down keys, and may be checked without changing their values. The alarm set point resolution is 0.1 K, ^{o}C or ^{o}F over the temperature range of the sensor. The temperature ranges for the sensors is described in Table 3-1. For security, the up/down keys can be deactivated by a DIP switch on the rear panel of the unit. Each setpoint features a deadband around the setpoint to eliminate or reduce chattering of the relay contacts.

The Model 819 features four inputs with two alarms (as described above) for each input. The 819 can also scan between channels with dwell times of 0(skip), 5, 10, 30 or 60 seconds for each channel.

The Model 818/819 is direct reading in temperature when used with the Lake Shore DT-470 or DT-500 Series Temperature Sensors. All DT-470 sensors follow the same temperature response curve. Four bands of tracking accuracy are offered so that sensor selection may be made with both technical and economical considerations for any given application. Low temperature (2 to 100K) accuracies range from 0.25K for band 11 to 1K for band 13. The units have a specified temperature range of 4 to 475 kelvin when used with the DT-470 sensors and 4 to 325 with DT-500 sensors.

Diode sensor voltages are digitized with a resolution of 100 microvolts out of 3 volts full scale. The accuracy of the electronics when used with DT-470 sensors is better than ±0.01K below 28K and ±0.1K above 28K. The equivalent display temperature is rounded to 0.1 above 100 and 0.01 below 100.

The Model 818/819 features an RS-232C Serial Interface which allows the user to monitor the temperature, and monitor and change the alarm set point values from a host computer.

The sensor input(s), alarm contacts, and RS-232C lines are all available on the rear panel of the instrument.

1.3 SPECIFICATIONS

The instrument specifications for the are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument was tested. Any changes in these specifications will be covered by a revision page, a change sheet, or both, to this manual.

1.4 OPTIONS

Two options are available for the 818. The 818-MN Monitor Output option adds a buffered output of sensor voltage. The 818-LA Analog Output option adds a 1mV/K linearized analog output of temperature with a resolution of 1mV and a full scale output of 1 volt.

Other accessories available for both the 818 and 819 are listed in Table 1-1.

Table 1-1. Specifications, Model 818 and 819 Cryopump Monitors

INPUT CHARACTERISTICS:

Inputs: 818: one. 819: four. Input measurement is four lead (two current and two voltage). Display sensor for the 819 can be selected from the front panel or remote interface, or display can be set to SCAN between inputs. Dwell time can be set independently for each input at 0 (skip), 5, 10, 30 or 60 seconds.

Input Range: 0 to 3 volts with a resolution of 0.1 millivolts.

Sensor Excitation: 10 microampere constant current.

Temperature Range: 4 to 475K with Lake Shore DT-470 Series Sensors or 4 to 325K with DT-500 Series Sensors.

Sensor (order separately): Lake Shore DT-470 or DT-500 Series Silicon Diode Sensors.

DISPLAY READOUT:

Display: 4 digit LED display in voltage or temperature (K, ^{o}C, ^{o}F).

Display Resolution: 0.1 degrees above 100, 0.01 degrees below 100; voltage to 1 mV.

Temperature Accuracy: Dependent on sensor type. See Lake Shore Cryotronics, Inc. Sensor catalog for details on the DT-470 and DT-500 Series Silicon Diode Sensors.

ALARMS:

HI and LO Alarms: Front panel setable with HI/LO ALARM keys and UP (▲) and DOWN (▼) keys. Alarms can be checked without changing them. The alarm set point resolution is 0.1 K, ^{o}C or ^{o}F over the temperature range of the sensor (see Table 3-1). Front panel operation can be negated by rear panel security DIP switch. Deadband is ±0.025K for the setpoint less than 100 (any units) and ±0.25 for the setpoint greater than 100. Status of alarm is displayed on front panel.

Alarm Relay Contact Specifications:

Style:	Single Contact
Arrangment:	1 Form C
Contact Material:	Silver Nickel
Initial Contact Resistance:	100 milliohms

Absolute Maximum Rating (resistive):

Maximum Switching Power:	150 Watts
Maximum Volt-Amperes:	1250 VA
Maximum Switching Voltage:	250 V AC, 30 V DC
Maximum Switching Current:	5 Amperes
UL/CSA Rating:	125, 250 V AC
	5 A 30 V DC
	0.6 A 110 V DC

Expected Life (Minimum Operations):

Mechanical	10^7
Electrical	2×10^5

Operating Time (Approx):	10 milliseconds
Release Time (Approx):	10 milliseconds

GENERAL:

Remote Interface: RS-232C Serial Interface with 3-wire half-duplex asynchronous transmission fixed at 300 baud, 7 bits per character, odd parity, and 1 Stop Bit. Connector is an RJ-11 modular socket.

Output of temperature, channel and alarm status and input/output of alarm setpoint values and alarm reset.

Dimensions, Weight: 105mm wide x 132mm high x 254mm deep (4.125in x 5.25in x 10in) DIN quarter-rack panel.

Power: 90-125 or 210-250 VAC (selected via rear panel switch), 50 or 60 Hz. 818: 7 watts. 819: 10 watts.

OPTIONS AND ACCESSORIES:

818-MN: Adds buffered output of sensor voltage (818 only).

818-LA: Adds 1mV/K linearized analog output of temperature. Resolution is 1mV and full scale output is 1 volt (818 only).

2001: RJ-11 10 foot Modular RS-232 Phone cord.

2002: RJ-11 to DB-25 Adaptor.

SECTION II

INSTALLATION

2.1 INTRODUCTION

This section contains infromation and instructions pertaining to instrument set-up. Included are inspection procedures, power and grounding requirements, a description of sensor and interface connectors and repackaging instructions.

2.2 INITIAL INSPECTION

This instrument was electrically, mechanically and functionally inspected prior to shipment. It should be free from mechanical damage and in perfect working order upon receipt. To confirm this, the instrument should be visually inspected for damage and tested electrically to detect any concealed damage upon receipt. 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 promptly with the carrier, and/or insurance company. Please advise Lake Shore Cryotronics, Inc. of such filings. In case of parts shortages, advise LSCI immediately. LSCI can not be responsible for any missing parts unless notified within 30 days of shipment. The standard Lake Shore Cryotronics Warranty is given on the first page of this manual.

2.3 PREPARATION FOR USE

2.3.1 Power Requirements

The Model 818/819 requires a power source of 50 to 60 Hz single phase 90-125 or 210-250 VAC. The unit is fused at 0.25 ampere for 115 VAC and at 0.125 ampere for 230 VAC operation.

CAUTION

Verify that the 115/230 line voltage selection switch (Figure 3-2, Key 2) located on the rear panel of the Model 818/819 is set to the AC voltage source to be used and that the proper fuse is installed before inserting the power cord and turning on the instrument.

2.3.2 Power Cord

A three-prong detachable power cord for 120 VAC operation which mates with the rear panel UL/IEC/ICEE Standard plug is included with the instrument.

2.3.3 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.

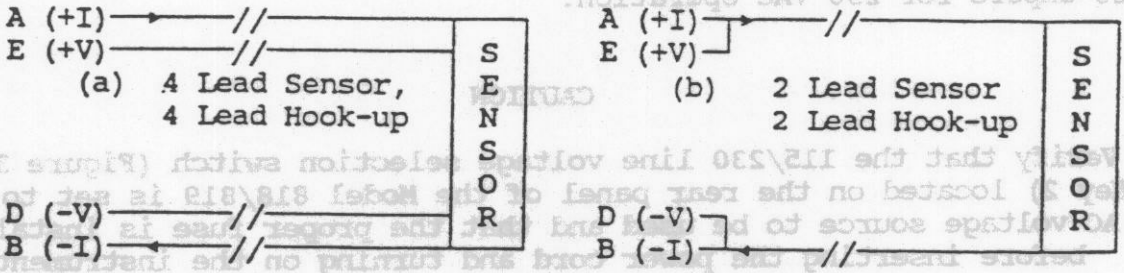
2.3.4 J1 Sensor Input Connections

The Model 818 has one rear panel 5-pin sensor input connector designated J1 INPUT 1. The 819 has four rear panel 5-pin sensor input connectors designated J1-1, J1-2, J1-3 and J1-4 for inputs 1 thru 4. The lead connection definition for the sensor(s) is given in Table 2-1 and is shown in Figure 2-1.

Table 2-1. Sensor Connections for the J1 INPUTS

Terminal	Description
A	+ Current Out
B	- Current Out
D	- Voltage Sense
E	+ Voltage Sense
H	Shield

Figure 2-1. Sensor Connections



The use of a four wire connection (Figure 2-1 a) is highly recommended to avoid introducing IR drops in the voltage sensing pair which translates into a temperature measurement error. An alternate two wire connection (Figure 2-1 b) may be used in less critical applications where lead resistance is small and small readout errors can be tolerated.

The Lake Shore Cryotronics, Inc. QUAD-LEAD™ 36 Gauge Cryogenic wire is ideal for connections to the sensor since the four leads are run together and color-coded. The wire is Phosphor Bronze with a Formvar insulation and Butryral bonding between the four leads. Color coding is red, green, clear and blue on the four leads which makes it extremely easy to determine one wire from another.

2.3.5 J2 Serial I/O

The RS-232C Serial Interface connector is a rear panel mounted RJ-11 modular socket. The connector pins are numbered 1 thru 6 going from left to right. The connector pin assignments are given in Table 2-2.

Note: When converting from the RJ-11 to DB-25 connector, pins 5, 6, 8 and 20 of the DB-25 connector may need to be shorted together for proper interface operation.

Table 2-2. J2 Serial I/O Connections

Pin #	Description
1 and 2	Received Data (Into Unit)
3 and 4	Signal Ground
5 and 6	Transmitted Data (From Unit)

2.3.6 J3 Alarms

The HI and LO alarm contacts are present on card edge connections on the rear panel. The 818 has one 6 contact card edge connector for the HI and LO alarms and the 819 has one 6 contact card edge (identical to the 818) for the Input 1 HI and LO alarms and one 18 contact card edge connector for the Input 2 thru Input 4 HI and LO alarms. The top and bottom contacts of the card edge are identical in definition and the mating connector supplied has them shorted together. The SPDT alarm contacts are in groups of three, 1 - COM - 2 or NO - 1H - NC representing the contacts for the Input 1 HI alarm with 1 or NO representing the (N)ormally (O)pen state and 2 or NC representing the (N)ormally (C)losed state. The card edge is slotted between pins 2 and 3 to allow for mating connector keying. The alarm action is given in Section 3 of this manual.

2.3.7 J4 Monitors

If an 818 has an 818-MN or 818-LA Option installed the J4 Monitors connector is present. The connector pin assignments are given in Table 2-3.

Table 2-3. J4 Monitors Connections

Terminal	Description
A	V+ MN Output
B	V- MN Output
C	V+ LA Output
D	V- LA Output
H	Shield

2.4 REPACKAGING FOR SHIPMENT

If the Model 818/819 appears to be operating incorrectly please contact LSCI or a factory representative for a Returned Goods Authorization (RGA) number before returning the instrument to our service department.

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

1. Returned Goods Authorization Number.
2. Instrument Model and Serial Number.
3. User's Name, Company, Address and Phone Number.
4. Malfunction Symptoms.
5. Description of Measurement System.

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

SECTION III

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section contains information and instructions concerning the operation of the Model 818 and 819 Cryopump Monitors. Included is a description of the front and rear panel controls and indicators.

3.2 CONTROLS AND INDICATORS

Figures 3-1 and 3-2 identify the 818 and 819 displays, annunciators, controls and connectors. The identification of each item is keyed in the appropriate figure.

> Note: The unit will complete an internal update cycle of between 1/4 and 1/2 second before responding to a front panel key entry. If a key is pressed for less than 1/2 second, it may be ignored.

3.3 VOLTAGE OR TEMPERATURE DISPLAY

The 818 and 819 Cryopump Monitors will read in voltage or temperature (kelvin, celsius or fahrenheit). The chosen units may be changed by depressing the ▲ key or the ▼ key. The units may also be changed over the RS-232C Serial Interface.

3.4 STANDARD CURVES

Several standard curves are stored within the 818 and 819 Cryopump Monitors. Different curves may be assigned to every channel of the 819 Cryopump Monitor. These curves are numbered 0 thru 9 and are listed on the front cover of this manual as well as Table 3-1. The curve the unit is configured for is also indicated on the front cover. Curve 6 (DT-470 Curve 10) is the standard curve which will be selected unless specified differently upon ordering. A table of voltage versus temperature for these standard curves is given in Appendix A at the end of this manual.

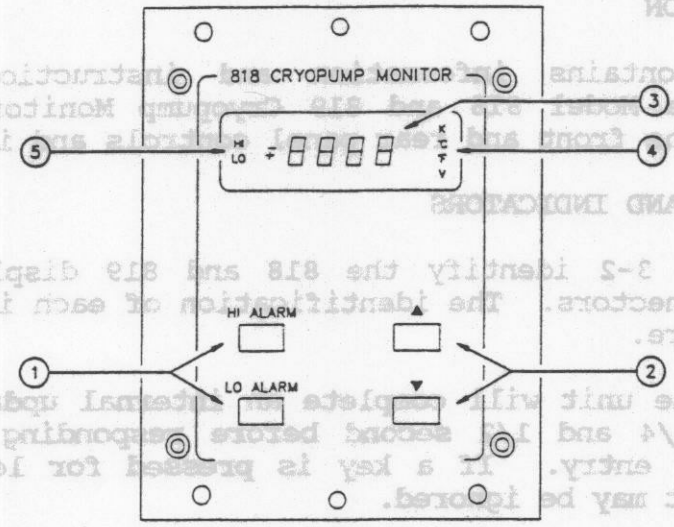
3.4.1 Curve and Alarm Action Selection

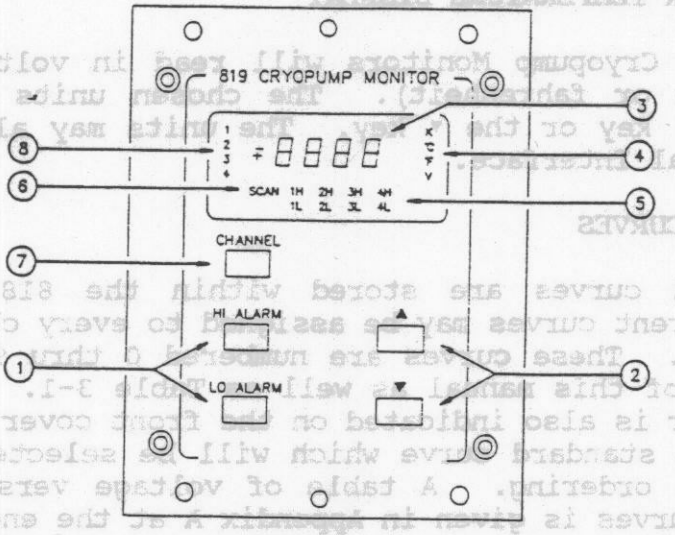
To change the curve selected or to check to see which curve is selected, or to check or change the alarm action, use the following procedure:

1. For the 819, press the **CHANNEL** key and the ▲ or ▼ key until the desired channel is reached.

2. Turn ON (1) DIP switch number 4 on the rear of the instrument marked **CURVE SET**.

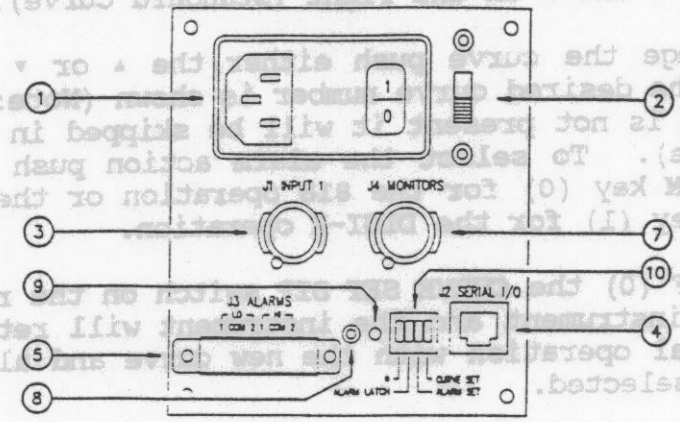
Figure 3-1. Model 818 and 819 Cryopump Monitor Front Panel Description

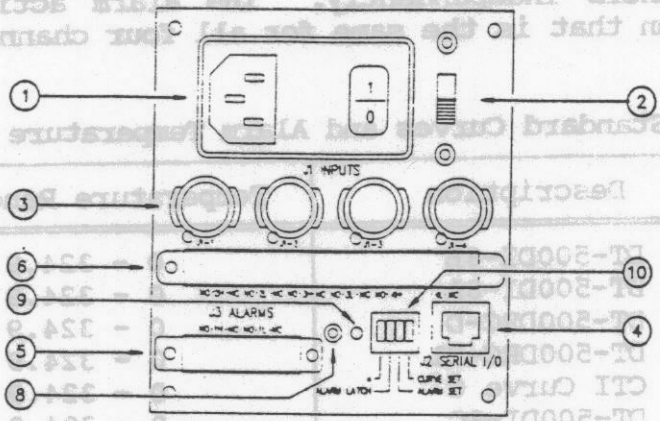




1. HI ALARM and LO ALARM Keys
2. Increment (▲) and Decrement (▼) Keys
3. 4 Digit Display
4. Units Indicators (V, K, °C, °F)
5. HI and LO Alarm Status Indicators (One for each Channel)
6. SCAN Indicator
7. CHANNEL Key
8. Active Channel Indicators

Figure 3-2. Model 818 and 819 Cryopump Monitor Rear Panel Description





1. Line cord receptacle with fuse and ON/OFF switch
2. 115/230 AC Voltage Selection Switch
3. J1 INPUTS - INPUT 1 (818) or J1-1, J1-2, J1-3, and J1-4 (819)
4. J2 SERIAL I/O (Serial Interface)
5. J3 ALARMS - Channel 1 LO and Channel 1 HI Outputs
6. J3 ALARMS - Channels 2, 3 and 4 LO and HI Outputs
7. J4 MONITORS Connector
8. I ADJ (Current Source ADJustment Potentiometer)
9. CAL (Calibration) ENABLE Push Button
10. 4 Position Configuration DIP Switch
    - Switch 1 - RESERVED (*)
    - Switch 2 - ALARM LATCH
    - Switch 3 - ALARM SET
    - Switch 4 - CURVE SET

3. Note that the display will now show the number 0 or 1 on the left (alarm action) and a number between 0 and 9 on the right (standard curve).

4. To change the curve push either the ▲ or ▼ key until the desired curve number is shown (Note: if a curve is not present it will be skipped in the sequence). To select the alarm action push the **LO ALARM** key (0) for the 818 operation or the **HI ALARM** key (1) for the DIGI-K operation.

5. Turn OFF (0) the **CURVE SET** DIP switch on the rear of the instrument and the instrument will return to normal operation with the new curve and alarm action selected.

Note: A different curve can be assigned to each of the four 819 channels independently. The alarm action is a global function that is the same for all four channels.

Table 3-1. Standard Curves and Alarm Temperature Limits

Curve #	Description	Temperature Range (K)
0	DT-500DI-8B	0 - 324.9
1	DT-500DI-8A	0 - 324.9
2	DT-500DRC-D	0 - 324.9
3	DT-500DRC-E1	0 - 324.9
4	CTI Curve C	0 - 324.9
5	DT-500DI-8C	0 - 324.9
6	DT-470 Curve 10	0 - 474.9
7	_____	_____
8	_____	_____
9	_____	_____

3.5 ALARM OPERATION

The Model 818 has the capability to set two alarm trip points (HI and LO) associated with the single sensor input. The Model 819 has four sensor inputs and two alarm trip points (also HI and LO) for each of the inputs; a total of eight alarm trip points.

The deadband is ±0.025 for the setpoint less than 100 (any units) and ±0.25 for the setpoint greater than 100. If the display is in voltage

then the deadband will assume appropriate kelvin units.

3.5.1 Observing the Alarm Setpoints

To observe the HI alarm setpoint press the **HI ALARM** key on the front panel. The HI alarm setpoint will be displayed in the temperature units indicated. If the units are V (volts) then the units indicator will change to K (kelvin) and the setpoint will be displayed in kelvin. Similarly, to observe the LO alarm press the **LO ALARM** key.

3.5.2 Alarm Action

The Model 818 and 819 have two different alarms that can be selected when the sensor curve is selected. Alarm action 0 is the 818 operation and alarm action 1 is the DIGI-K operation. Refer to Table 3-2 for a truth table of the respective alarm actions.

3.5.3 Latching or Non-Latching of the HI and LO Alarms

When the **ALARM LATCH** DIP switch on the rear panel is OFF (0), the relays will be closed or open as specified in Table 3-2. If the sample sensor temperature oscillates around the HI or LO alarm setpoint temperature then the relay will open and close in an oscillatory fashion following the alarm action. There is a deadband around the setpoint as specified above to eliminate chattering of the relay contacts.

When the **ALARM LATCH** switch is ON (1), when the alarm relays take on a latching configuration. When the sample sensor temperature forces the alarm to go from NO to NC, the relays will remain closed. There are three ways to return the relay to the open condition.

1. From the Front Panel: hold the **HI ALARM** and **LO ALARM** keys down for more than 2 seconds. The **ALARM STATUS** light(s) will go out indicating that the alarms were returned to the open condition.

2. From the Rear Panel: disable the **ALARM LATCH** switch (Configuration DIP Switch 2) momentarily.

3. Use the R (RESET) command on the RS232C interface.

3.5.4 Setting the HI and LO Alarms

The alarms may be changed if the **ALARM SET** switch (Configuration DIP Switch 3) on the rear panel is set ON (1). To change the alarms from the front panel, use the following procedure:

1. Turn ON (1) Configuration DIP Switch 3, marked **ALARM SET**, on the rear panel of the instrument.

Table 3-2. Alarm Action

(a) Alarm Action 0 (818)

Display Reading Compared to:		Contact Positions			
		LO Alarm		HI Alarm	
LO Alarm	HI Alarm	NO - COM	COM - NC	NO - COM	COM - NC
Greater	Greater	Open	Closed	Closed	Open
Greater	Lower	Open	Closed	Open	Closed
Lower	Greater	Closed	Open	Closed	Open
Lower	Lower	Closed	Open	Open	Closed
Power OFF		Open	Closed	Open	Closed

(b) Alarm Action 1 (DIGI-K)

Display Reading Compared to:		Contact Positions			
		LO Alarm		HI Alarm	
LO Alarm	HI Alarm	NO - COM	NC - COM	NO - COM	NC - COM
Greater	Greater	Closed	Open	Closed	Open
Greater	Lower	Closed	Open	Open	Closed
Lower	Greater	Open	Closed	Closed	Open
Lower	Lower	Open	Closed	Open	Closed
Power OFF		Open	Closed	Open	Closed

2. Press either the **HI ALARM** or **LO ALARM** key and observe the alarm setting in the display window. To change the setting, push either the ▲ or ▼ key until the desired setting is reached. Note: the alarms can only be set in temperature. If voltage is the display units, the display will default to kelvin if an alarm key is pushed. The alarm set point resolution is 0.1 K, ^{o}C or ^{o}F. The alarm set point is bounded by the temperature range of the sensor listed in Table 3-1.

3. For the 819, press the **CHANNEL** key and the ▲ or ▼ key until the desired channel is reached. Then implement step 2.

4. The alarms take on the new values immediately. The **ALARM SET** switch only deactivates the ability to set the alarms if it is in the OFF (0) position.

3.6 CHANNEL SELECTION FOR THE 819

The 819 has four sensor inputs, or channels, numbered 1 thru 4. The display input can be changed by pressing the **CHANNEL** key and either the ▲ or ▼ key. The channel input position is displayed to the left of the display. Note that holding in the **CHANNEL** key for greater than one second will toggle the scan mode and greater than two seconds will result in the display of dwell time for the selected channel.

3.6.1 Channel Scan

In hold mode the 819 internally scans each channel and updates the alarms approximately every 8 seconds. In scan mode the 819 continuously monitors the displayed channel and updates the alarms of the displayed channel. If a channel is excluded from the scan sequence (its dwell time is set to 0), the alarms of this channel are not updated. To enable or disable the scan, hold the **CHANNEL** key in for greater than one second. The 819 will enter the **SCAN** mode as indicated by the **SCAN** annunciator. This key is a toggle.

3.6.2 Setting the Dwell Time for a given Channel

To set the dwell time for a given channel, hold in the **CHANNEL** key for greater than two seconds and use the ▲ and ▼ keys to increment or decrement the dwell times between 0 (skip), 5, 10, 30 and 60 seconds. Next increment the channel and repeat the dwell time setting process.

2. Press either the **HI ALARM** or **LO ALARM** key and observe the alarm setting in the display window. To change the setting, push either the ▲ or ▼ key until the desired setting is reached. Note: the alarms can only be set in temperature. If voltage is the display units, the display will default to Kelvin if an alarm key is pushed. The alarm set point resolution is 0.1 K, °C or °F. The alarm set point is bounded by the temperature range of the sensor listed in Table 3-1.

3. For the 819, press the **CHANNEL** key and the ▲ or ▼ key until the desired channel is reached. Then implement step 2.

4. The alarms take on the new values immediately. The **ALARM SET** switch only deactivates the ability to set the alarms if it is in the OFF (0) position.

3.6 CHANNEL SELECTION FOR THE 819

The 819 has four sensor inputs, or channels, numbered 1 thru 4. The display input can be changed by pressing the **CHANNEL** key and either the ▲ or ▼ key. The channel input position is displayed to the left of the display. Note that holding in the **CHANNEL** key for greater than one second will toggle the scan mode and greater than two seconds will result in the display of dwell time for the selected channel.

3.6.1 Channel Scan

In hold mode the 819 internally scans each channel and updates the alarms approximately every 8 seconds. In scan mode the 819 continuously monitors the displayed channel and updates the alarms of the displayed channel. If a channel is excluded from the scan sequence (its dwell time is set to 0), the alarms of this channel are not updated. To enable or disable the scan, hold the **CHANNEL** key in for greater than one second. The 819 will enter the SCAN mode as indicated by the **SCAN** annunciator. This key is a toggle.

3.6.2 Setting the Dwell Time for a given Channel

To set the dwell time for a given channel, hold in the **CHANNEL** key for greater than two seconds and use the ▲ and ▼ keys to increment or decrement the dwell times between 0 (skip), 5, 10, 30 and 60 seconds. Next increment the channel and repeat the dwell time setting process.

SECTION IV

REMOTE OPERATION

4.1 RS-232C SERIAL INTERFACE

The Models 818 and 819 Cryopump Monitors feature a serial RS-232C interface which allows the units to communicate to a host computer. Table 4-1 defines the RS-232C Interface Specifications:

Table 4-1. Model 818/819 RS-232C Interface Specifications

Transmission	- Three Wire
Connector	- RJ-11 Modular Socket
Timing Format	- Asynchronous
Transmission Mode	- Half Duplex
Baud Rate	- 300
Bits per Character	- 7 (not including start, stop or parity bits)
Parity Type	- Odd
Number of Stop Bits	- 1
Data Interface Levels	- Transmits/Receives using EIA voltage levels

4.2 INTERFACE COMMANDS

The tables on the following pages define the RS-232C Interface Commands and their format. On input, the quantities designated by the letter 'A' are alphanumeric (A-Z), by the letter 'N' are integer (no decimal point), by the letter 'S' are signs (plus or minus) and by the letter 'F' are floating point (with a decimal point).

Floating point numbers can be entered with or without the decimal point. For example, when an input format is indicated as F_1, then any of the following are permitted: 5, 5.0, 24, 98.3, 235.

Floating point numbers refer to temperature. Temperature is to be entered to 0.1 degrees. The temperature is bounded by the upper and lower limits of the sensor listed in Table 3-1. If entered with greater precision, they will be truncated to the specification given above.

Table 4-2. 818/819 Command/Request Summary for Display and Alarm Parameters

PROGRAMMING COMMANDS	DESCRIPTION OF TRANSMISSION TO THE 818/819
$F0A_1$	Function 0 - Select Display Units. Forms of the command are F0K, F0C, F0F and F0V for display in kelvin, celsius, fahrenheit and volts respectively.
HF_1 or UF_1 N_1HF_1	High Alarm Set Point on the 818. High Alarm Set Point and Channel on the 819. Alarm action for the HI and LO alarms is given in Table 3-1. N_1 is the channel number in the 819. Example: For a high alarm setpoint of 300 degrees on a 818 the command is H300. For a high alarm setpoint of 31.2 degrees on channel 3 of an 819 the command is 3H31.2. The units are those selected from the instrument keyboard or from a previous use of command $F0A_1$.
LF_1 N_1LF_1	Low Alarm Set Point on the 818. Low Alarm Set Point and Channel on the 819. Alarm action for the HI and LO alarms is given in Table 3-1. N_1 is the channel number in the 819. Example: For a low alarm setpoint of 21.1 degrees on a 818 the command is L21.1. For a low alarm setpoint of 21.1degrees on channel 3 of an 819 the command is 3L21.1. The units are those selected from the instrument keyboard or from a previous use of command $F0A_1$.
R	Reset the alarms.

****

Table 4-2. Cont'd.

OUTPUT REQUEST COMMANDS	DESCRIPTION OF TRANSMISSION TO THE 818/819
S	Request the Sensor Reading, Alarms and Alarm Status (818 only).
WS	Request the Sensor Reading and Alarm Status
WA or A	Request the Switch ID and Alarm Data.
WD	Request the Sensor Reading(s).

Table 4-3. 819 Command/Request Summary for Scan Parameters

PROGRAMMING COMMAND	DESCRIPTION OF TRANSMISSION TO THE 819
YN_1N_2	Set the N_1 channel dwell time where N_1 is the channel number 1 through 4 N_2 is the dwell time index which is 0 for zero seconds (skip) 1 for 5 seconds 2 for 10 seconds 3 for 30 seconds 4 for 60 seconds Example: For a dwell time of 30 seconds on channel 2, the command is Y23.
YCN_1	Select channel N_1 where N_1 is 1 to 4 Example: YC3 for the scanner to be moved to channel 3.
YS	Enable the Scan function.
YH	Hold (disable) the scan.

****

Table 4-3. Cont'd.

OUTPUT REQUEST COMMAND	DESCRIPTION OF TRANSMISSION TO THE 819
WY	Request the Scan Data

4.2.1 Output Data Commands

The following table defines the output of the unit when given the WS, S (in the 818), WA or WY (819) output data command. Note: Alarms are always given with 4 digits and a decimal point. The alarm status is an ASCII character; A for Active and I for Inactive.

Table 4-4. 818/819 Output Data Commands

COMMAND	DESCRIPTION OF OUTPUT FROM THE 818/819
S	Sample Sensor Reading, Alarm Setpoints Alarm Status (818 only).
818 only	$S_SF_SA_S(,)S_1F_1(,)S_1F_2(,)A_1(,)A_2$(CR)(LF) $S_SF_SA_S$ is the Sign, Sensor reading and units in K,F,C, or V. S_1F_1 is the alarm sign and setpoint of Alarm 1 S_2F_2 is the alarm sign and setpoint of Alarm 2 A_1 is the status of Alarm 1, A_2 is the status of Alarm 2
WS	Sample Sensor Reading and Alarm Status
818:	$S_SF_SA_S(,)A_H(,)A_L$(CR)(LF) $S_SF_SA_S$ is the Sign, Sensor reading and units in K,F,C, or V. A_H is status of the High Alarm A_L is status of the Low Alarm
819:	$S_SF_SA_S(,)A_{H1}(,)A_{L1}(,)A_{H2}(,)A_{L2}(,)A_{H3}(,)$ $A_{L3}(,)A_{H4}(,)A_{L4}$(CR)(LF) $S_SF_SA_S$ is the Sign, Sensor reading and units in K,F,C, or V. A_{Hx} is the alarm status of the High Alarm for Channel x A_{Lx} is the alarm status of Alarm Low Alarm for Channel x

Table 4-4. Cont'd.

COMMAND	DESCRIPTION OF OUTPUT FROM THE 818/819
WA	Switch ID and Alarm Data
818:	$N_1(,)HS_HF_H(,)LS_LF_L(CR)(LF)$
	N_1 is the Switch ID - 0 through 7 and is the sum of 2 if the alarm is set plus 4 if relay latching is desired. S_HF_H is the High alarm sign and setpoint S_LF_L is the Low alarm sign and setpoint
819:	$N_1(,)HS_{H1}F_{H1}(,)LS_{1L}F_{L1}(,)HS_{H3}F_{H2}(,)LS_{L2}F_{L2}(,)$ $HS_{H3}F_{H3}(,)LS_{L3}F_{L3}(,)HS_{H4}F_{H4}(,)LS_{L4}F_{L4}(,)(CR)(LF)$
	N_1 is the Switch ID - 0 through 7 and is the sum of 2 if the alarm is set plus 4 if relay latching is desired. $S_{H1}F_{H1}$ is the High alarm sign and setpoint of channel 1 $S_{L1}F_{L1}$ is the Low alarm sign and setpoint of channel 1 $S_{Hx}F_{Hx}$ is the High alarm sign and setpoint of channel x $S_{Lx}F_{Lx}$ is the Low alarm sign and setpoint of channel x
WD	Sensor Reading(s)
818:	$S_SF_SA_S$
	$S_SF_SA_S$ is the Sign, Sensor reading and units in K,F,S, or V.
819:	$S_{S1}F_{S1}A_{S1}(,)S_{S2}F_{S2}A_{S2}(,)S_{S3}F_{S3}A_{S3}(,)S_{S4}F_{S4}A_{S4}$
	$S_{S1}F_{S1}A_{S1}$ is the Sign, Sensor reading and unit in K,F,S, or V of channel 1. $S_{Sx}F_{Sx}A_{Sx}$ is the Sign, Sensor reading and unit in K,F,S, or V of channel x.

Table 4-4. Cont'd.

COMMAND	DESCRIPTION OF OUTPUT FROM THE 818/819
WY	Scan Information (819 only)
818:	A character 'N' will be returned to signify "No scanner".
819:	$A_1(,)N_1(,)N_2N_3(,)N_4N_5(,)N_6N_7(,)N_8N_9$(CR)(LF) A_1 is the scan status - (H)olding or (S)canning N_1 is the current channel # N_2N_3-N_8N_9 are the channel 1 through 4 dwell times in seconds

SECTION V

MAINTENANCE

5.1 INTRODUCTION

This section contains information necessary to maintain the Model 818 and 819 Cryopump Monitors.

5.2 FUSE REPLACEMENT

The line fuse is accessible from the rear of the 818/819. Use the following procedure to check and/or replace the fuse:

WARNING

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

1. Set the POWER switch to OFF and disconnect the power cord from the unit. The fuse compartment is located to the right of the power connector.

2. Open the fuse compartment by carefully prying open the cover with a small screw driver.

3. Remove the upper fuse holder by sliding it out of its position with the aid the screw driver.

CAUTION

For continued protection against fire hazard, replace only with the same type and rating of fuse as specified for the line voltage selected.

4. Replace the fuse with a 0.25 ampere fuse for 115 VAC operation or a 0.125 ampere fuse for 230 VAC operation.

5. Replace the fuse holder, close the fuse compartment and connect the power cord.

5.3 LINE VOLTAGE SELECTION

The rear panel, three-pronged line power connector permits the 818/819 to be connected to 115 or 230 VAC line voltages. Use the following procedure to change the line voltage:

WARNING

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

1. Set the POWER switch to OFF and disconnect the power cord from the unit. The line voltage selection switch is to the right of the power connector.

2. Use a small screw driver to slide the switch to the 115 or 230 VAC position.

3. Install the proper fuse as outlined in Section 5.2.

5.4 CALIBRATION

The following equipment is required to calibrate the 818/819:

1. Digital Voltmeter/Multimeter (DVM) - 4 1/2 digit resolution or better.

2. Precision Resistors - 25 K ohms and 125 K ohms with a tolerance of ± 0.01% or better.

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

5.4.1 Current Source Calibration

Use the following procedure to calibrate the 10 microampere current source:

1. Configure the 125 K ohm resistor to simulate a sensor in the two lead configuration as shown in Figure 2-1. For the 819, install the 125 K ohm resistor in INPUT 1. Set the 819 into scan mode with all dwell times set to 0, and select channel 1 as the display channel.

2. Connect the voltage leads of the DVM across the resistor and adjust the trimpot marked **I ADJ** on the back panel until the voltage across the resistor is 1.2500 volts ± 100 microvolts.

5.4.2 A/D Converter Calibration

Use the following procedure to calibrate the A/D converter:

1. Set the display unit to **V**.

NOTE

The accuracy of the A/D calibration using resistors depends on the accuracy of the current source calibration. The procedure in Section 5.4.1 (Current Source Calibration) should be completed prior to calibrating the A/D converter.

2. Configure the 125 K ohm resistor to simulate a sensor in the two lead configuration as shown in Figure 2-1. For the 819, install the 125 K ohm resistor in INPUT 1 and select channel 1 as the display channel.

3. Press the **CAL ENABLE** push button on the rear panel.

4. The display will read **-CAL-** to indicate that the unit is ready to store a new A/D calibration. Within 2 seconds press the front panel ▲ key (if the ▲ key is not pressed within 2 seconds, the display will return to normal display operation). The unit will display **-CAL-** for approximately 15 seconds to indicate calibration in process. When the calibration is complete, the display will return to normal display operation. The instrument should now display 1.250V.

5. Replace the 125 K ohm resistor with the 25 K ohm resistor.

6. Press the **CAL ENABLE** push button on the rear panel.

7. The display will read **-CAL-**. Within 2 seconds press the front panel ▼ key. Again, the unit will display **-CAL-** for approximately 15 seconds and then return to normal operation. The instrument should now display 0.250V.

8. Calibration is complete for the 818. For the 819, repeat procedures 2 thru 7 for channels 2, 3 and 4.

Table 5-1. Replacement Parts Lists - Model 818/819 Final Assembly

Replacement Parts List - Model 818 Final Assembly

Part Number 1024A

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
F1	106-026	1	AC LINE CORD PLUG/ FUSE HOLDER	SFR	FN382-6/12
J1	106-011	1	CONNECTOR, INPUT, 5 PIN	AML	126-218
S9	105-100	1	AC LINE SWITCH	SFT	4620LFR
MP1	106-010	1	5 PIN PLUG	AML	126-217
	106-223	1	6 PIN CARD EDGE CONN	TRW	50-6A-20-TRW
	115-006	1	POWER CORD	BEL	17250
	110-007	1	FUSE, 0.25A (115VAC)	BUS	MDL-L/41/4
	110-004	1	FUSE, 0.125A (230VAC)	LIT	313-1/8

Replacement Parts List - Model 819 Final Assembly

Part Number 1036

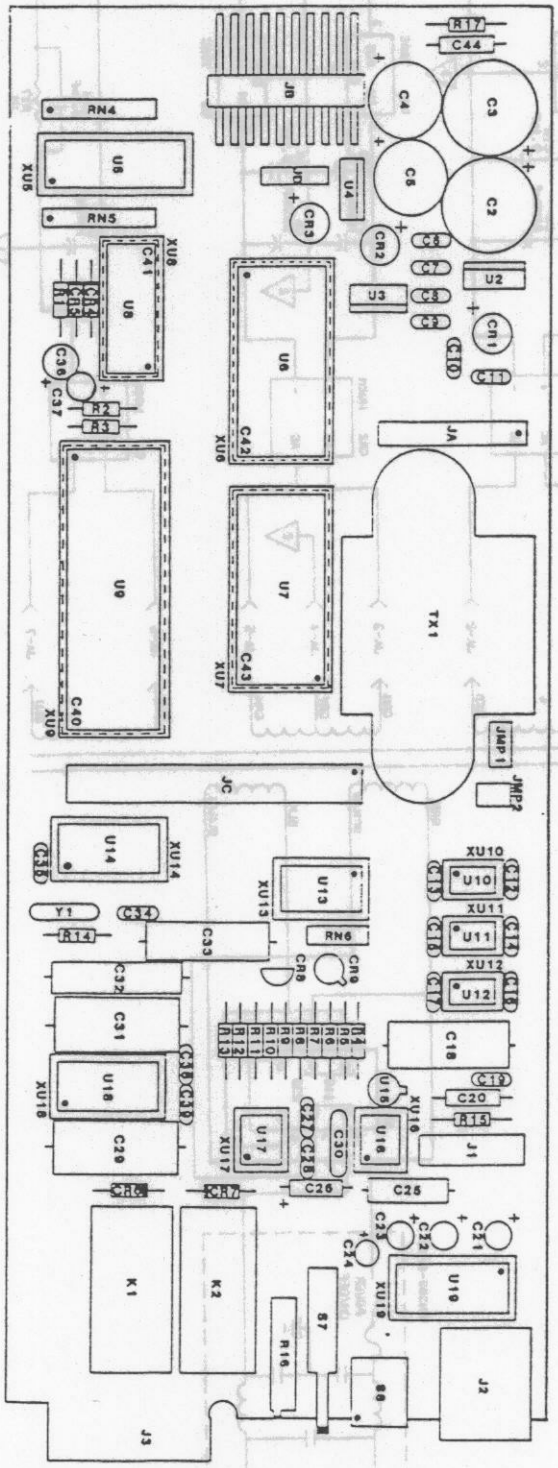
ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
F1	106-026	1	AC LINE CORD PLUG/ FUSE HOLDER	SFR	FN382-6/12
J1	106-011	1	CONNECTOR, INPUT, 5 PIN	AML	126-218
S9	105-100	1	AC LINE SWITCH	SFT	4620LFR
MP1	106-010	4	5 PIN PLUG	AML	126-217
	106-223	1	6 PIN CARD EDGE CONN	TRW	50-6A-20-TRW
	106-231	1	18 PIN CARD EDGE CONN	TRW	50-18A-20-TRW
	115-006	1	POWER CORD	BEL	17250
	110-007	1	FUSE, 0.25A (115VAC)	BUS	MDL-L/41/4
	110-004	1	FUSE, 0.125A (230VAC)	LIT	313-1/8

Table 5-2. Replacement Parts List - Model 818/819 Main Board

Part Number 113-190

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
C2	101-228	1	CAP,ELECT,1000MF,25V	PANS	ECEA1EV102S
C3	101-236	1	CAP,ELECT,2200MF,25V	PANS	ECEA1EV222S
C4,5	101-229	2	CAP,ELECT,1000MF,16V	PANS	ECEA1CV102S
C21-24	101-137	5	CAP,TA,10MF,35V	SPRG	199D106X0035DB1
C36	101-144	1	CAP,TA,33MF,35V	SPRG	199D336X0035EA2
CR1-3	102-008	3	BRIDGE RECTIFIER	GI	W02M
CR4,5	102-062	2	DIODE,SIL,G.P.		1N459A
CR6,7	102-001	2	DIODE,RECTIFIER	MOT	1N4006
CR8	102-041	1	VOLTAGE REFERENCE 2.5V	NAT	LM336BZ-2.5
CR9	102-040	1	VOLTAGE REFERENCE 1.22V	NAT	LM313H
J1	106-406	1	SOCKET STRIP,6/12 (819)	SAMT	SSW-112-01-G-S
J2	106-440	1	CONNECTOR(RJ-11)	VP	0200.000.186
JB	106-608	1	PIN STRIP,20 POS,RA	SAMT	MTSW-110-15-G-D-320-RA
JC	106-429	1	SOCKET STRIP,40 POS(819)	RN	SBQ-40-P-D-100-TG
JD	106-129	1	PIN STRIP,5/15 (819)	SAMT	TSW-120-01-G-S
K1,2	105-307	2	RELAY,SPDT,150W	ARO	NB1-DC12V
S7	105-701	1	SWITCH,CAL	C&K	TP11-H8AVBE
S8	105-402	1	DIP SWITCH,4 POS,RA	GYH	76SB04RA
TX1	109-103	1	TRANSFORMER	PH	PH-657
U2,4	102-011	2	REGULATOR,+5V	MOT	7805ACT
U3	102-021	1	REGULATOR,-5	MOT	7905CT
U5	104-310	1	IC,8 BIT MULTIPLEXER	NAT	81LS95
U6	8002-04	1	IC,EPROM	LSCI	
U7	104-653	1	IC,8KX8 NOVRAM	DAL	DS1225Y
U8	104-528	1	IC,8 BIT LATCH		P82C82
U9	104-511	1	IC,MICROPROCESSOR	INT	P80C31
U10	104-356	1	IC,OPTOCOUPLER	GI	74OL6010
U11,12	104-355	2	IC,OPTOCOUPLER	GI	74OL6000
U13	104-210	1	IC,O.C. HEX INVERTER		7406
U14	104-261	1	IC,3-8 LINE DECODER		74LS138
U15	102-074	1	MOSFET, P-CHANNEL ENH.	SIL	3N163
U16	104-005	1	IC,OP AMP	NAT	LM308N
U17	104-089	1	IC,OP AMP	MAX	MAX430CPA
U18	104-465	1	IC,A/D CONVERTER	TSC	TSC500CPE
U19	104-722	1	IC,SERIAL DRIVER	LT	LT1080CN
Y1	103-990	1	CRYSTAL,5.000 MHZ	MTRON	MP1 5.000 MHZ

Figure 5-1. Component Layout - Model 818/819 Main Board



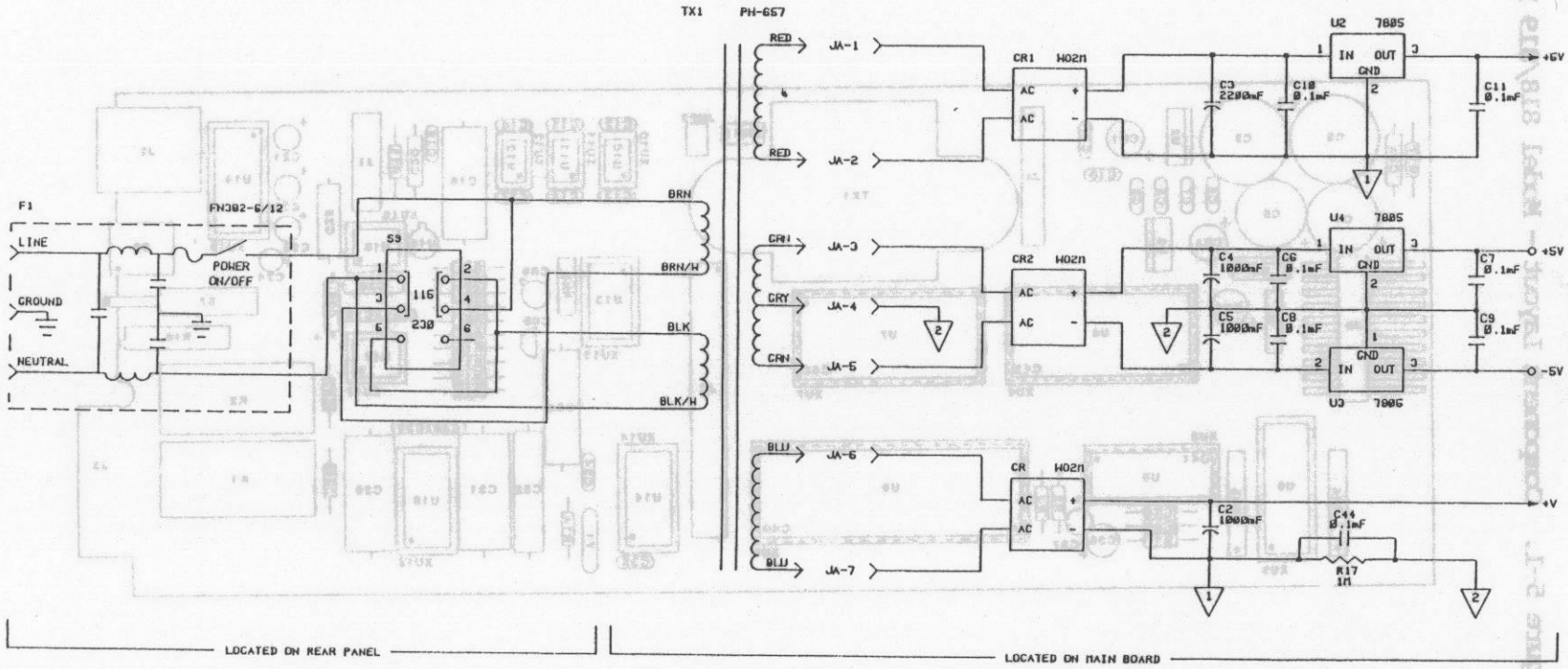


Figure [illegible] Schematic [illegible] Model [illegible] M[illegible] Board [illegible] S[illegible]

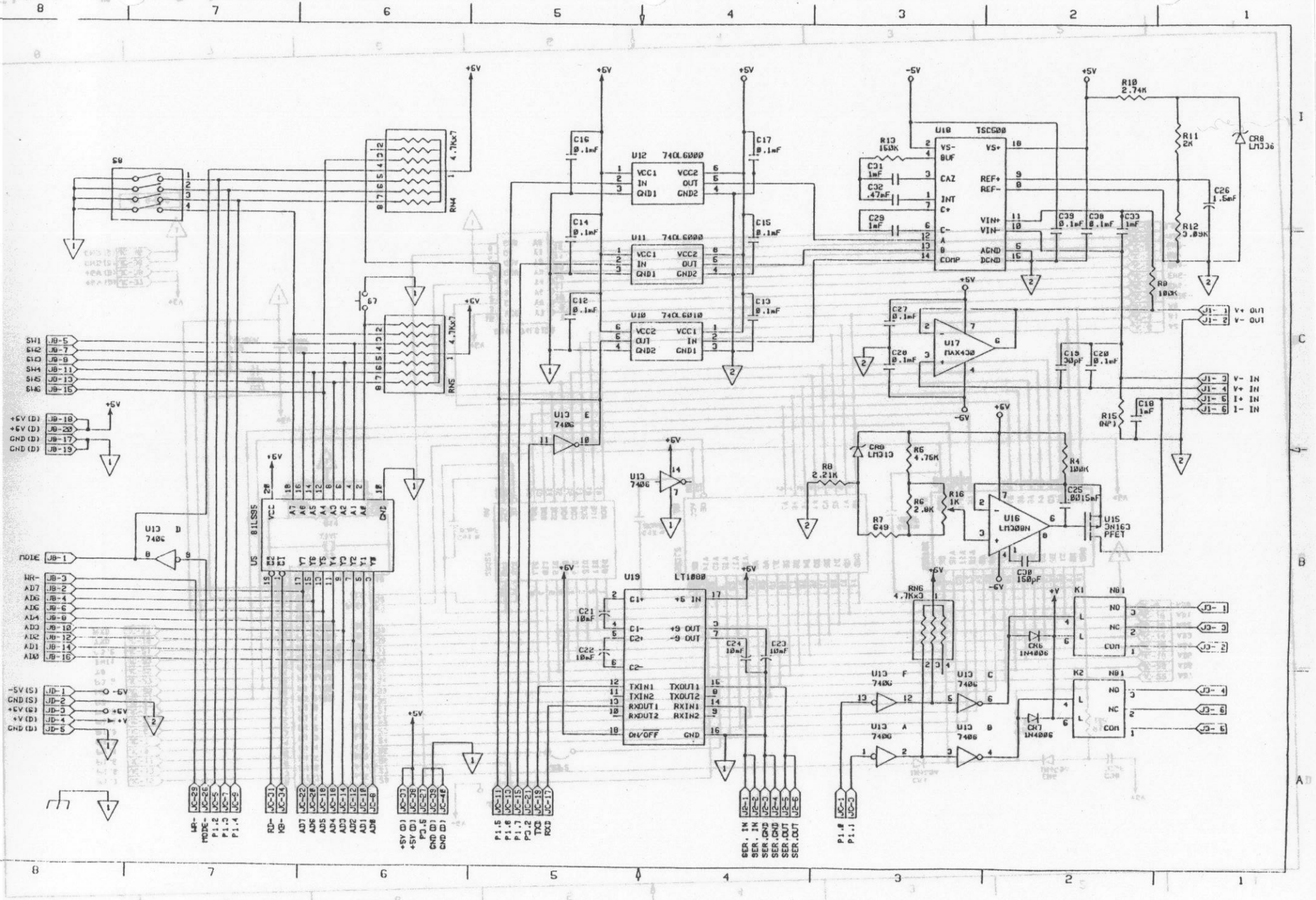


Figure 5-3. Schematic - Model 818/819 Main Board (Digital and Analog)

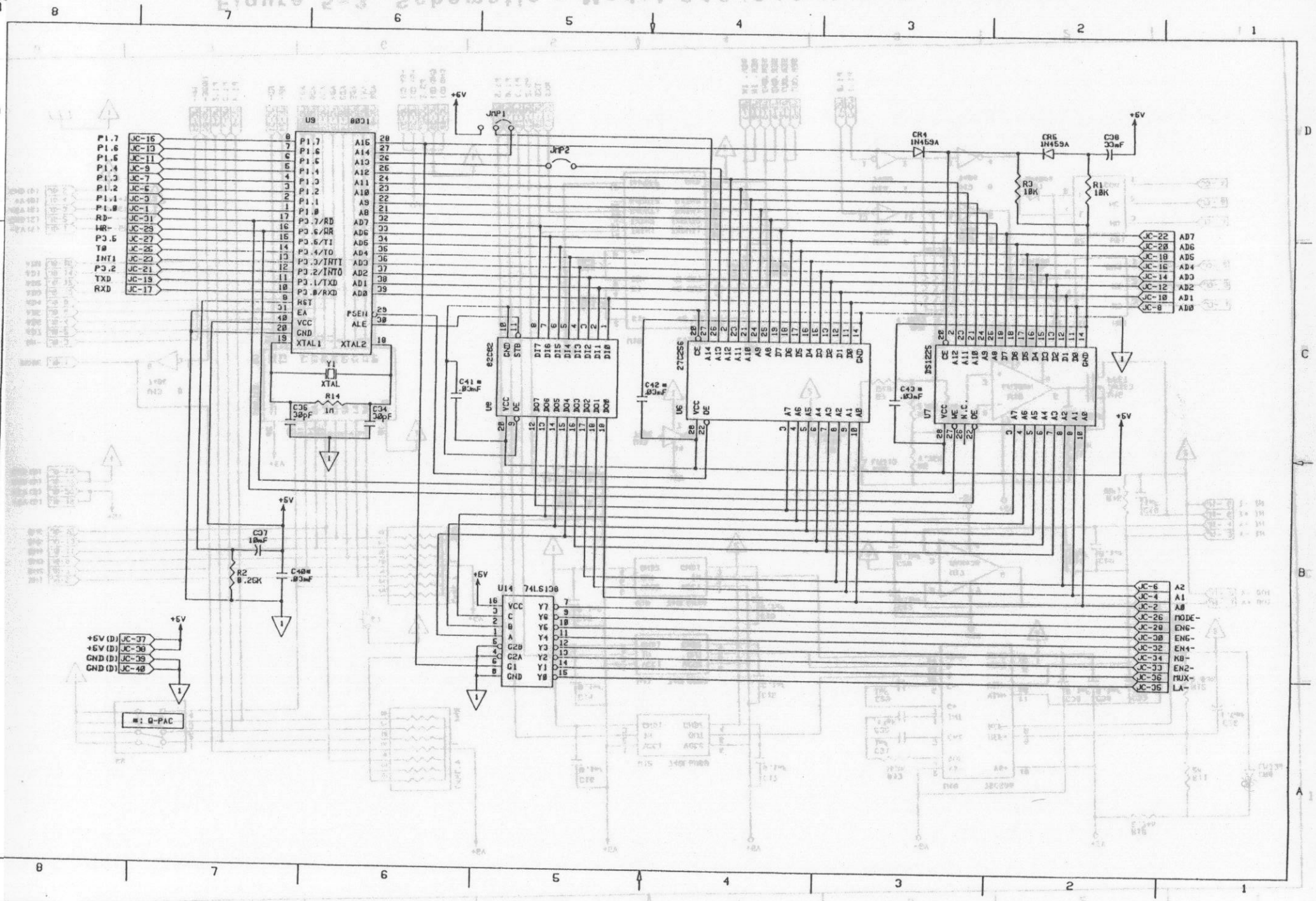


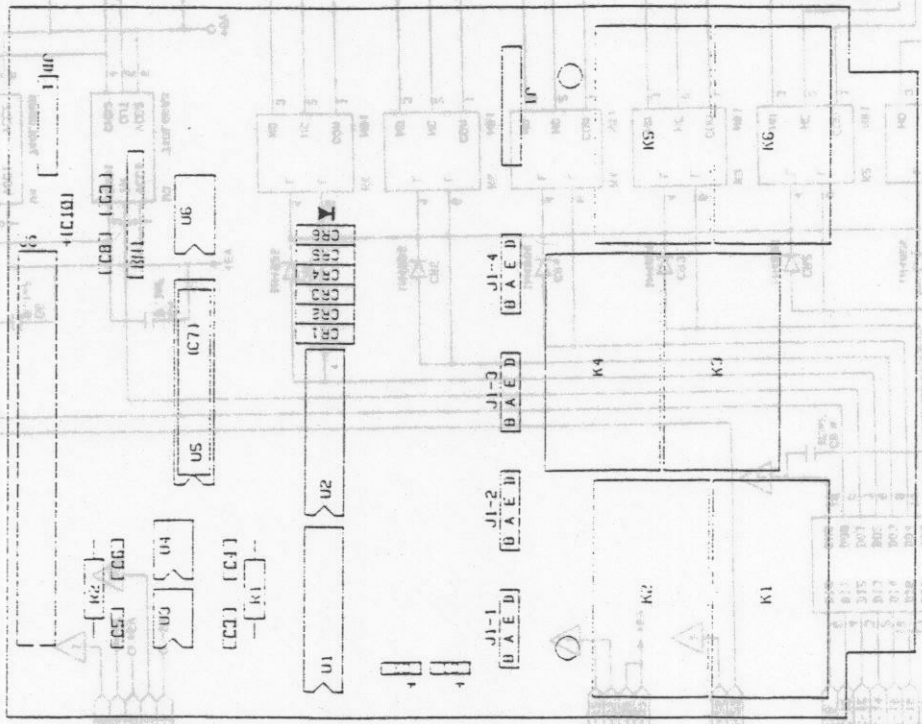
Figure 5 Schematic - Model 818/819 Main Board (Microprocessor)

Table 5-3. Replacement Parts List - Model 819 Multiplexer Assembly

Part Number 113-195

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
C1,2, C10	101-137	3	CAP,TA,10MF,35V	SPRG	199D106X0035DB1
CR1-6	102-001	6	DIODE,RECTIFIER	MOT	1N4006
J1.1-J1.4	106-129	4	TERMINAL PINS (4/20)	SAMT	TSW-120-10-G-S
J1	106-431	1	TERMINAL PINS (6/20)	SAMT	TSW-120-17-G-S
JC	106-615	1	PC HEADER,40 PIN	SAMT	TSW-120-17-G-D
JD	106-274	1	SOCKET HEADER,5 PIN	MOL	22-01-2051
K1-6	105-307	6	RELAY,SPDT,150W	ARO	NB1-DC12V
U1,2	104-069	2	IC,4 CHANNEL MUX	HAR	HI3-509A
U3,4	104-355	2	IC,OPTOCOUPLER	GI	740L6000
U5	104-995	1	IC,OCTAL POWER LATCH	NAT	DP8310
U6	104-051	1	IC,TIMER	INSL	ICM7555IPA

Figure 5-5. Component Layout - Model 819 Multiplexer Assembly



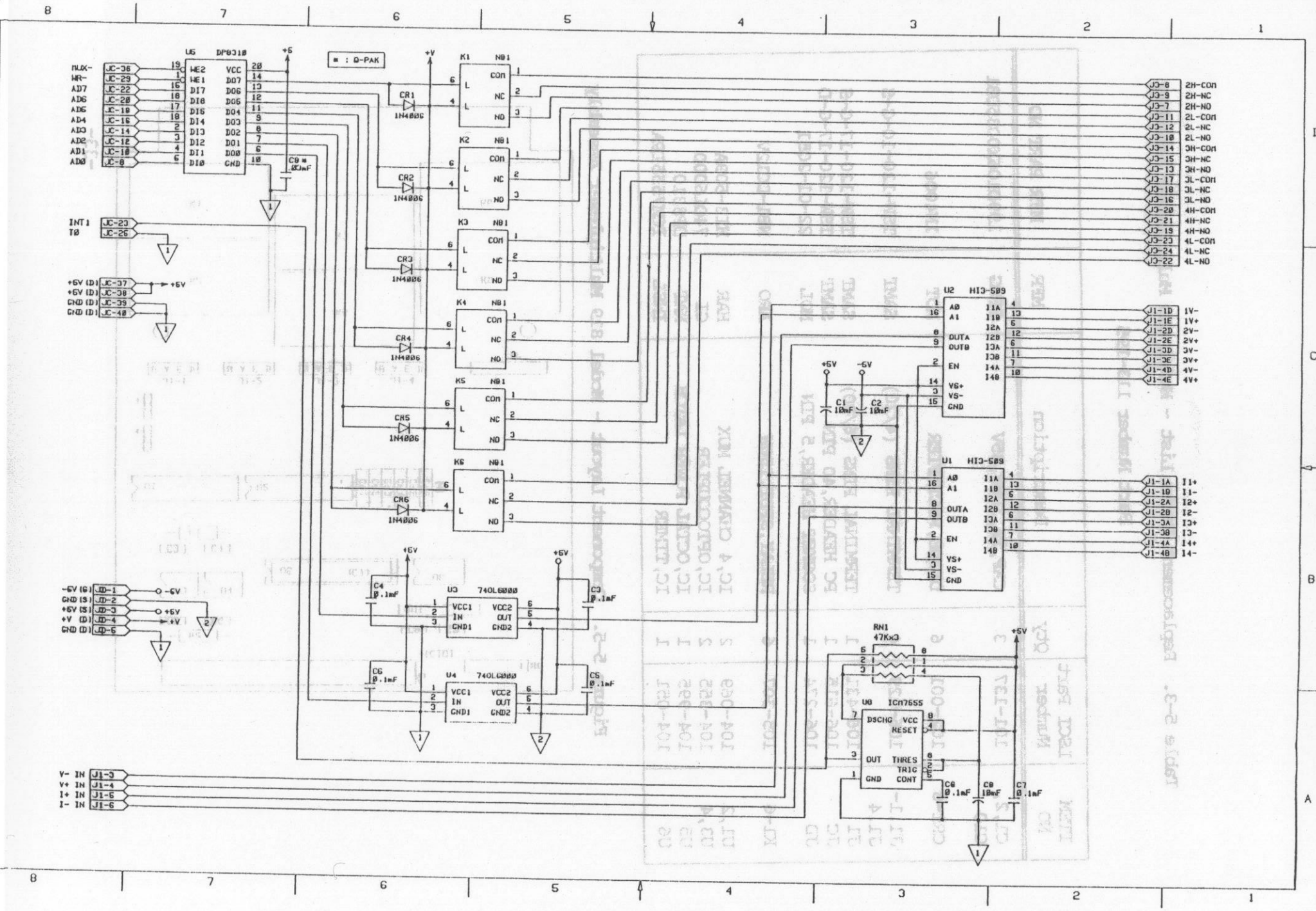


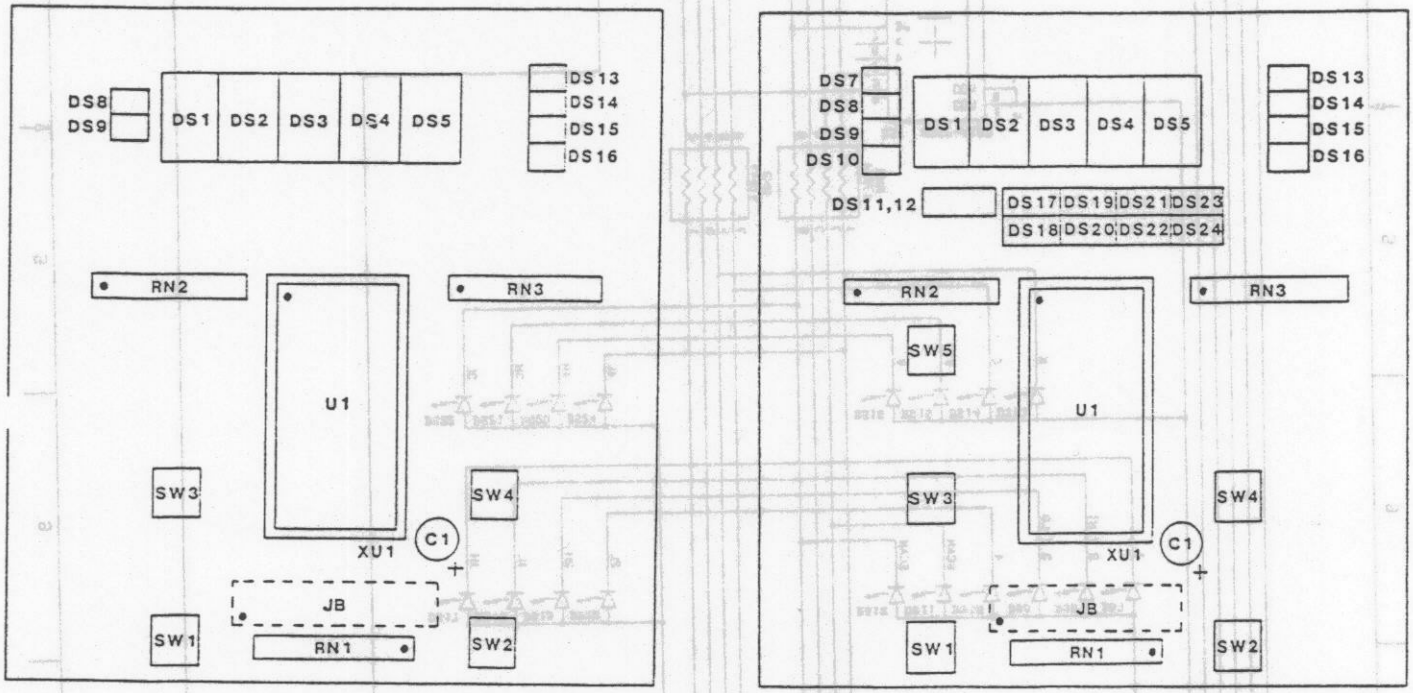
Figure 7-3. Schematic - Model 810 Mux Board

Table 5-4. Replacement Parts List - Model 818/819 Front Panel Assembly

Part Number 113-193

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
C1	101-137	1	CAP,TA,10MF,35V	SPRG	199D106X0035DB1
H1	105-676	4/5	KEY TOPS,LIGHT GRAY	LSCI	105-676
JB	106-607	1	SOCKET HEADER,20 PIN	SAMT	SSQ-110-01-G-D
S1-5	105-651	4/5	SWITCHES	ALPS	KEF10901
U1	104-062	1	IC,DISPLAY DRIVER	NAT	ICM7218

Figure 5-7. Component Layouts - Models 818 and 819 Display Boards



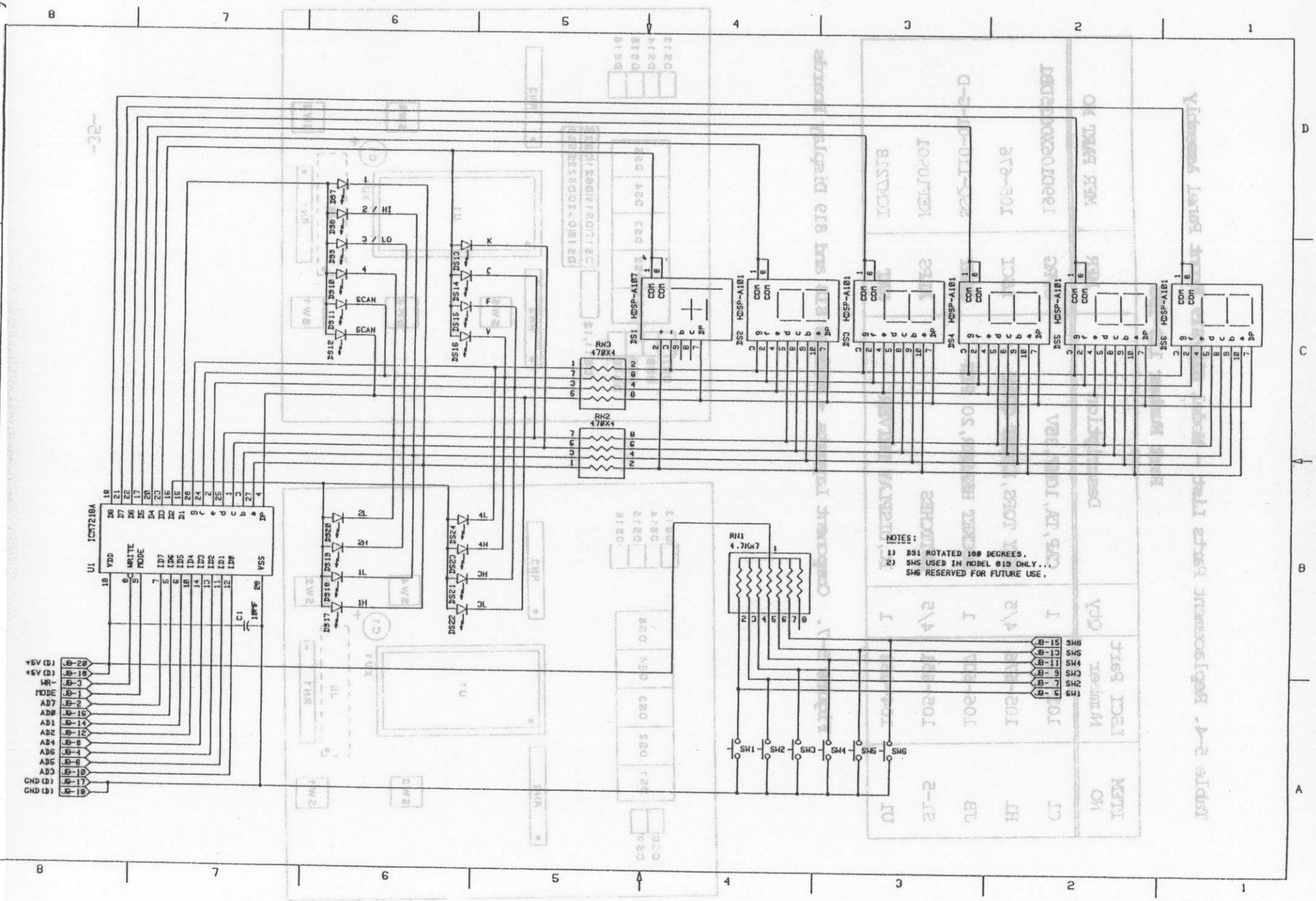
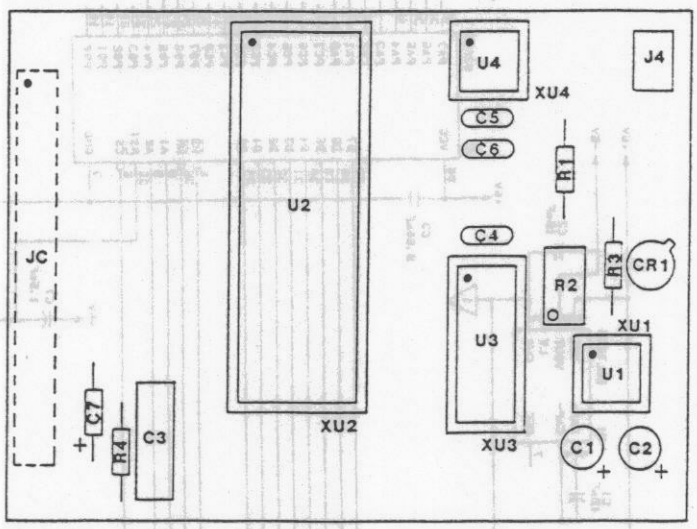


Figure 5 Schematic - Model 818/819 Display Board

Table 5-5. Replacement Parts List - Model 818-IA Analog Output Option LSCI Part Number 037

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
C1,2	101-137	2	CAP,TA,10MF,35V	SPRG	199D106X0035D51
CR1	102-040	1	VOLTAGE REFERENCE,1.22V	NAT	LM313H
JC	106-615	1	40 PIN PC HEADER (LA)	SAMT	TSW-120-17-G-D
	106-429	1	40 POS HEADER (MB)	RN	SBQ-40-P-D-100-TG
J4	106-013	1	7 PIN SOCKET	AML	126-198
	106-012	1	7 PIN PLUG	AML	126-195
U1	104-052	1	IC,VOLTAGE INVERTER	INSL	ICL7660CPA
U2	104-529	1	IC,PORT EXPANDER	INT	P82C55A-5
U3	104-430	1	IC,D/A CONVERTER	AD	AD7525LN
U4	104-001	1	IC,OP AMP	PMI	OP07EP

Figure MN/IA-1. Component Layout - Model 818-MN and 818-IA Options



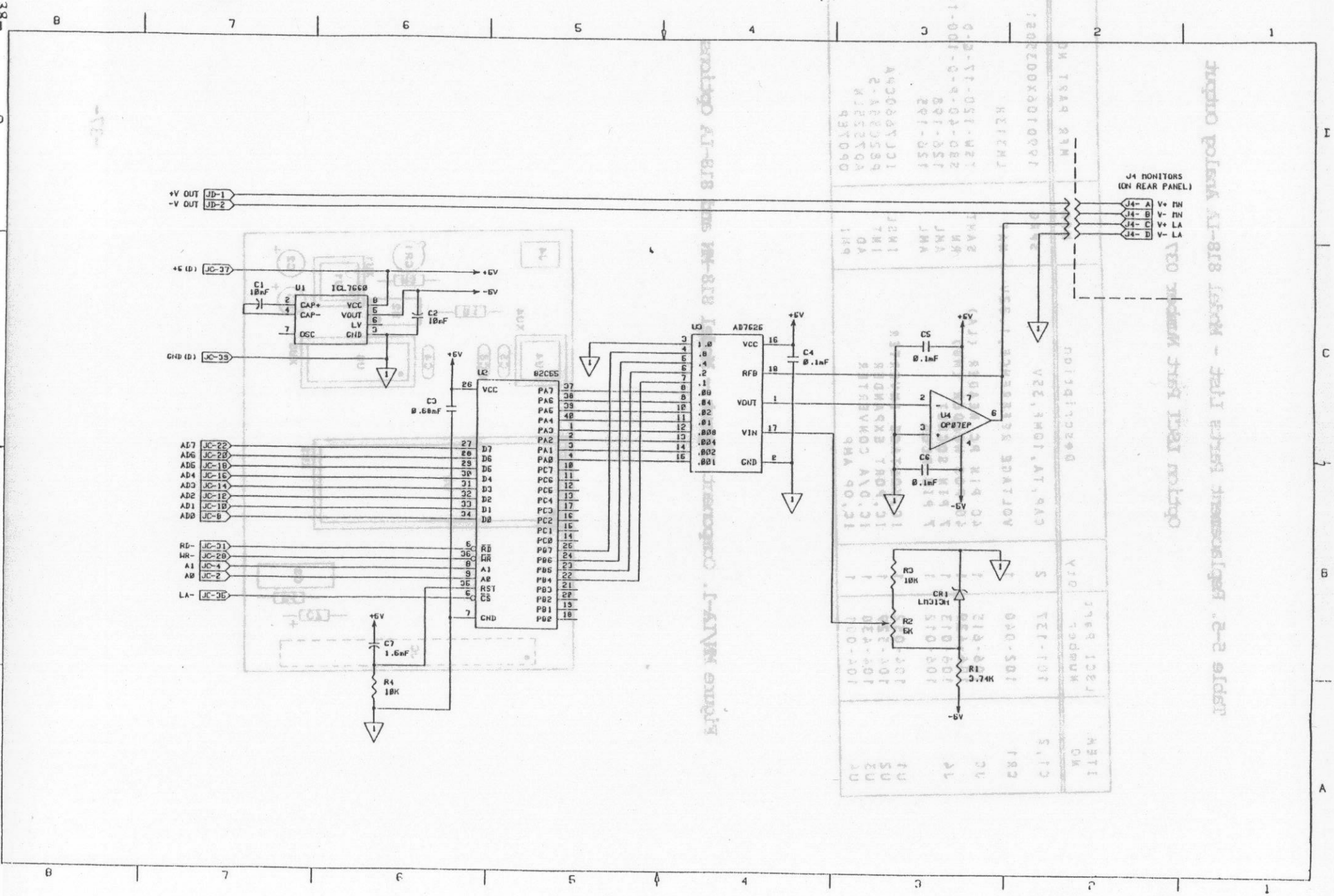


Figure 1. A-2 Schematic - Model 818-MN and 818-LA Options

Appendix A - Curve Information

Curve #0 - LSCI - DT-500DI-8B
Curve #1 - LSCI - DT-500DI-8A
Curve #2 - LSCI - DT-500DRC-D
Curve #3 - LSCI - DT-500DRC-E1
Curve #4 - CTI - Curve C
Curve #5 - LSCI - DT-500DI-8C
Curve #6 - LSCI - DT-470 Curve #10

Curve #0 - DT-500DI-8B Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
29	4.0	2.41773	19	29.0	1.11353	7	175.0	0.72353
	4.2	2.40475	18	30.0	1.10729		180.0	0.70936
	4.4	2.39217	17	32.0	1.09810		185.0	0.69532
	4.6	2.37946	16	34.0	1.09125		190.0	0.68125
	4.8	2.36668	15	36.0	1.08547		195.0	0.66713
	5.0	2.35378		38.0	1.08038		200.0	0.65302
	5.5	2.32126	14	40.0	1.07549		205.0	0.63889
	6.0	2.28869		45.0	1.06400		210.0	0.62475
	6.5	2.25643	13	50.0	1.05273		215.0	0.61066
	7.0	2.22480		55.0	1.04123	6	220.0	0.59646
	7.5	2.19395	12	60.0	1.02954		225.0	0.58262
28	8.0	2.16053		65.0	1.01748		230.0	0.56877
	8.5	2.13552	11	70.0	1.00528		235.0	0.55504
	9.0	2.10809		75.0	0.99263	5	240.0	0.54136
	9.5	2.08197		77.4	0.98666		245.0	0.52801
	10.0	2.05687		80.0	0.97988		250.0	0.51469
	11.0	2.00852	10	85.0	0.96711	4	255.0	0.50155
	12.0	1.96003		90.0	0.95397		260.0	0.48815
	13.0	1.90579		95.0	0.94086		265.0	0.47486
27	14.0	1.85614		100.0	0.92767		270.0	0.46148
	15.0	1.80479		105.0	0.91443		275.0	0.44800
26	16.0	1.74703	9	110.0	0.90124	3	280.0	0.43451
	17.0	1.67479		115.0	0.88776		285.0	0.42064
	18.0	1.60665		120.0	0.87434		290.0	0.40675
	19.0	1.53675		125.0	0.86087		295.0	0.39274
	20.0	1.46370		130.0	0.84735	2	300.0	0.37875
	21.0	1.38832		135.0	0.83377		305.0	0.36436
25	22.0	1.31868	8	140.0	0.82032		310.0	0.35002
	23.0	1.26476		145.0	0.80647		315.0	0.33559
24	24.0	1.21712		150.0	0.79274		320.0	0.32109
23	25.0	1.17857		155.0	0.77896		325.0	0.30656
22	26.0	1.15106		160.0	0.76513	1	330.0	0.29222
21	27.0	1.13317		165.0	0.75125			
20	28.0	1.12169		170.0	0.73733			

Curve #1 - DT-500DI-8A Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
30	4.0	2.46386		55.0	1.03951	4	265.0	0.46292
	4.2	2.44821	11	60.0	1.02744		270.0	0.44925
	4.4	2.43188		65.0	1.01475		275.0	0.43559
	4.6	2.41500		70.0	1.00193		280.0	0.42178
	4.8	2.39781	10	75.0	0.98892	3	285.0	0.40797
29	5.0	2.37578		77.4	0.98264		290.0	0.39375
	5.5	2.33823		80.0	0.97557		295.0	0.37951
	6.0	2.29906		85.0	0.96216		300.0	0.36515
	6.5	2.26440		90.0	0.94877	2	305.0	0.35078
28	7.0	2.23248	9	95.0	0.93535		310.0	0.33599
	7.5	2.20480		100.0	0.92166		315.0	0.32121
	8.0	2.17716		105.0	0.90798		320.0	0.30643
	8.5	2.14994		110.0	0.89426		325.0	0.29159
27	9.0	2.12245		115.0	0.88052	1	330.0	0.27665
	9.5	2.10065		120.0	0.86676			
	10.0	2.07844		125.0	0.85298			
	11.0	2.03712	8	130.0	0.83936			
	12.0	1.99736		135.0	0.82531			
	13.0	1.95641		140.0	0.81142			
26	14.0	1.91202		145.0	0.79749			
	15.0	1.85236		150.0	0.78351			
	16.0	1.79177		155.0	0.76950			
	17.0	1.73193		160.0	0.75544			
25	18.0	1.66870		165.0	0.74135			
	19.0	1.59215	7	170.0	0.72739			
	20.0	1.51169		175.0	0.71308			
	21.0	1.43234		180.0	0.69891			
24	22.0	1.34993		185.0	0.68469			
23	23.0	1.28434		190.0	0.67043			
22	24.0	1.23212		195.0	0.65615			
21	25.0	1.18995		200.0	0.64185			
20	26.0	1.16027		205.0	0.62754			
19	27.0	1.14015		210.0	0.61333			
18	28.0	1.12689	6	215.0	0.59901			
17	29.0	1.11741		220.0	0.58502			
16	30.0	1.11007		225.0	0.57099			
15	32.0	1.09942		230.0	0.55715			
14	34.0	1.09178	5	235.0	0.54327			
13	36.0	1.08559		240.0	0.52983			
12	38.0	1.07992		245.0	0.51639			
	40.0	1.07502		250.0	0.50302			
	45.0	1.06307		255.0	0.48965			
	50.0	1.05136		260.0	0.47625			

Curve #2 - DT-500DRC-D Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
	1.4	2.5984		22.0	1.3006		190.0	0.67931
	1.5	2.5958	23	23.0	1.2507		195.0	0.65518
	1.6	2.5932		24.0	1.2114		200.0	0.65105
	1.7	2.5906	22	25.0	1.1720		205.0	0.63693
	1.8	2.5880	21	26.0	1.1486		210.0	0.62280
	1.9	2.5854	20	27.0	1.1308		215.0	0.60867
30	2.0	2.5828	19	28.0	1.1190	8	220.0	0.59455
	2.2	2.5735	18	29.0	1.1116		225.0	0.58080
	2.4	2.5643	17	30.0	1.1058		230.0	0.56707
	2.6	2.5551	16	32.0	1.0970		235.0	0.55334
	2.8	2.5458	15	34.0	1.0902	7	240.0	0.53960
29	3.0	2.5366		36.0	1.0850		245.0	0.52649
	3.2	2.5226		38.0	1.0798		250.0	0.51337
	3.4	2.5036	14	40.0	1.0746		255.0	0.50026
	3.6	2.4946		45.0	1.0633		260.0	0.48714
	3.8	2.4807		50.0	1.0520	6	265.0	0.47403
	4.0	2.4667	13	55.0	1.0407		270.0	0.46057
	4.2	2.4527		60.0	1.0287		275.0	0.44711
	4.4	2.4387		65.0	1.0166		280.0	0.43365
	4.6	2.4247	12	70.0	1.0046	5	285.0	0.42019
	4.8	2.4108		75.0	0.99172		290.0	0.40613
	5.0	2.3968		80.0	0.97890		295.0	0.39208
	5.5	2.3618		85.0	0.96609		300.0	0.37802
	6.0	2.3269	11	90.0	0.95327	4	305.0	0.36397
	6.5	2.2919		95.0	0.93987		310.0	0.34940
	7.0	2.2570		100.0	0.92647		315.0	0.33482
	7.5	2.2220		105.0	0.91307		320.0	0.32025
	8.0	2.1871		110.0	0.89966		325.0	0.30568
	8.5	2.1521		115.0	0.88626		330.0	0.29111
28	9.0	2.1172		120.0	0.87286		335.0	0.27654
	9.5	2.0909		125.0	0.85946		340.0	0.26197
	10.0	2.0646	10	130.0	0.84606	3	345.0	0.24739
	11.5	2.0119		135.0	0.83228		350.0	0.23325
	12.0	1.9592		140.0	0.81850		355.0	0.21911
27	13.0	1.9066		145.0	0.80472		360.0	0.20497
	14.0	1.8338		150.0	0.79094	2	365.0	0.19083
26	15.0	1.7610		155.0	0.77716		370.0	0.17774
	16.0	1.6984		160.0	0.76338		375.0	0.16464
25	17.0	1.6359		165.0	0.74961	1	380.0	0.15155
	18.0	1.5646	9	170.0	0.73582			
	19.0	1.4932		175.0	0.72170			
	20.0	1.4219		180.0	0.70757			
24	21.0	1.3505		185.0	0.69344			

Curve #3 - DT-500DRC-E1 Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
30	1.4	2.6591		22.0	1.3317		185.0	0.6918
	1.5	2.6567		23.0	1.2837		190.0	0.6777
	1.6	2.6542		24.0	1.2357		195.0	0.6635
	1.7	2.6518	21	25.0	1.1877		200.0	0.6493
	1.8	2.6494	20	26.0	1.1559		205.0	0.6351
	1.9	2.6470	19	27.0	1.1365		210.0	0.6210
29	2.0	2.6446	18	28.0	1.1239		215.0	0.6068
	2.2	2.6355	17	29.0	1.1150	6	220.0	0.5926
	2.4	2.6265	16	30.0	1.1080		225.0	0.5789
	2.6	2.6175	15	32.0	1.0981		230.0	0.5651
	2.8	2.6084	14	34.0	1.0909		235.0	0.5514
28	3.0	2.5994	13	36.0	1.0848		240.0	0.5377
	3.2	2.5868		38.0	1.0797		245.0	0.5246
	3.4	2.5742	12	40.0	1.0746		250.0	0.5115
	3.6	2.5616		45.0	1.0630		255.0	0.4984
	3.8	2.5490		50.0	1.0515		260.0	0.4853
27	4.0	2.5364		55.0	1.0399	4	265.0	0.4722
	4.2	2.5221	11	60.0	1.0284		270.0	0.4588
	4.4	2.5077		65.0	1.0159		275.0	0.4454
	4.6	2.4934		70.0	1.0035		280.0	0.4320
	4.8	2.4791		75.0	0.9911	3	285.0	0.4186
	5.0	2.4648		77.35	0.9849		290.0	0.4045
	5.5	2.4290		80.0	0.9780		295.0	0.3904
	6.0	2.3932		85.0	0.9649		300.0	0.3763
	6.5	2.3574		90.0	0.9518	2	305.0	0.3622
	7.0	2.3216		95.0	0.9388		310.0	0.3476
	7.5	2.2858	9	100.0	0.9257		315.0	0.3330
	8.0	2.2500		105.0	0.9122		320.0	0.3184
	8.5	2.2142		110.0	0.8988		325.0	0.3038
26	9.0	2.1784		115.0	0.8853	1	330.0	0.2893
	9.5	2.1516		120.0	0.8718			
	10.0	2.1247		125.0	0.8584			
	11.0	2.0708	8	130.0	0.8449			
	12.0	2.0170		135.0	0.8311			
25	13.0	1.9632		140.0	0.8173			
	14.0	1.9011		145.0	0.8035			
	15.0	1.8390		150.0	0.7896			
	16.0	1.7769		155.0	0.7758			
	17.0	1.7148		160.0	0.7620			
	18.0	1.6527		165.0	0.7482			
	19.0	1.5724	7	170.0	0.7344			
	20.0	1.4922		175.0	0.7202			
	21.0	1.4120		180.0	0.7060			

Curve #4 - CTI Diode Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
29	10.0	1.4000		105.0	0.8907		300.0	0.3510
28	11.0	1.3850	14	110.0	0.8769	2	305.0	0.3382
27	12.0	1.3656	13	115.0	0.8625		310.0	0.3243
	13.0	1.3400		120.0	0.8500		315.0	0.3106
26	14.0	1.3161	12	125.0	0.8376	1	320.0	0.2968
	15.0	1.2750	11	130.0	0.8245			
	16.0	1.2350		135.0	0.8109			
	17.0	1.1910	10	140.0	0.7971			
25	18.0	1.1500		145.0	0.7828			
24	19.0	1.1290		150.0	0.7685			
23	20.0	1.1162		155.0	0.7543			
	21.0	1.1135		160.0	0.7400			
	22.0	1.1109	9	165.0	0.7255			
	23.0	1.1084		170.0	0.7114			
	24.0	1.1058		175.0	0.6972			
	25.0	1.1033		180.0	0.6830			
	26.0	1.1007		185.0	0.6690			
	27.0	1.0981		190.0	0.6545			
	28.0	1.0955	8	195.0	0.6408			
	29.0	1.0929		200.0	0.6270			
	30.0	1.0903		205.0	0.6133			
	32.0	1.0851		210.0	0.5995			
	34.0	1.0799		215.0	0.5858			
22	36.0	1.0747		220.0	0.5720			
	38.0	1.0693		225.0	0.5583			
	40.0	1.0640		230.0	0.5445			
	45.0	1.0505		235.0	0.5308			
	50.0	1.0370		240.0	0.5170			
	55.0	1.0235		245.0	0.5032			
21	60.0	1.0100	7	250.0	0.4896			
20	65.0	0.9958		255.0	0.4757			
	70.0	0.9822		260.0	0.4620			
	75.0	0.9690		265.0	0.4481			
19	77.4	0.9626	6	270.0	0.4341			
	80.0	0.9560		275.0	0.4197			
18	85.0	0.9440	5	280.0	0.4050			
17	90.0	0.9314	4	285.0	0.3911			
16	95.0	0.9184		290.0	0.3775			
15	100.0	0.9049	3	295.0	0.3640			

Curve #5 - DT-500DI-8C Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
29	4.0	2.6187	22	25.0	1.1900		145.0	0.8108
	4.2	2.6074	21	26.0	1.1602	7	150.0	0.7974
	4.4	2.5956	20	27.0	1.1402		155.0	0.7837
	4.6	2.5834	19	28.0	1.1269		160.0	0.7701
	4.8	2.5709	18	29.0	1.1173		165.0	0.7564
	5.0	2.5580	17	30.0	1.1100		170.0	0.7427
28	5.2	2.5484	16	31.0	1.1039		175.0	0.7289
	5.4	2.5312		32.0	1.0991	6	180.0	0.7152
	5.6	2.5173	15	33.0	1.0949		185.0	0.7013
	5.8	2.5033		34.0	1.0913		190.0	0.6874
	6.0	2.4890	14	35.0	1.0879		195.0	0.6734
	6.5	2.4524		36.0	1.0850		200.0	0.6595
	7.0	2.4151		37.0	1.0822		205.0	0.6455
	7.5	2.3773	13	38.0	1.0795		210.0	0.6315
	8.0	2.3394		39.0	1.0770		215.0	0.6176
27	8.5	2.2976		40.0	1.0746	5	220.0	0.6036
	9.0	2.2643		42.0	1.0697		225.0	0.5898
	9.5	2.2277	12	44.0	1.0649		230.0	0.5761
	10.0	2.1919		46.0	1.0603		235.0	0.5625
	10.5	2.1566		48.0	1.0558	4	240.0	0.5490
	11.0	2.1221		50.0	1.0512		245.0	0.5358
	11.5	2.0881		52.0	1.0467		250.0	0.5226
	12.0	2.0545		54.0	1.0421		255.0	0.4096
	12.5	2.0211		56.0	1.0376		260.0	0.4966
	13.0	1.9875		58.0	1.0330		265.0	0.4836
	13.5	1.9537	11	60.0	1.0285		270.0	0.4705
	14.0	1.9193		65.0	1.0168		275.0	0.4574
	14.5	1.8843		70.0	1.0049	3	280.0	0.4442
	15.0	1.8480	10	75.0	0.9930		285.0	0.4307
	15.5	1.8110		77.4	0.9870		290.0	0.4171
	16.0	1.7748		80.0	0.9805		295.0	0.4035
26	16.5	1.7441		85.0	0.9680	2	300.0	0.3898
	17.0	1.7047		90.0	0.9553		305.0	0.3758
	17.5	1.6702	9	95.0	0.9427		310.0	0.3618
	18.0	1.6361		100.0	0.9297		315.0	0.3477
	18.5	1.6022		105.0	0.9168		320.0	0.3336
	19.0	1.5676		110.0	0.9038		325.0	0.3194
	19.5	1.5316		115.0	0.8907	1	330.0	0.3054
	20.0	1.4950	8	120.0	0.8777			
	21.0	1.4218		125.0	0.8643			
25	22.0	1.3461		130.0	0.8510			
24	23.0	1.2840		135.0	0.8377			
23	24.0	1.2317		140.0	0.8243			

Curve #6 - DT-470 Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
29	1.4	1.69808		18.0	1.24928		185.0	0.78999
	1.5	1.69674		18.5	1.24053		190.0	0.77855
	1.6	1.69521		19.0	1.23184	8	195.0	0.76717
	1.7	1.69355		19.5	1.22314		200.0	0.75554
	1.8	1.69177	23	20.0	1.21555		205.0	0.74398
	1.9	1.68987		21.0	1.19645		210.0	0.73238
28	2.0	1.68912		22.0	1.17705		215.0	0.72075
	2.1	1.68574		23.0	1.15558		220.0	0.70908
	2.2	1.68352	22	24.0	1.13598		225.0	0.69737
	2.3	1.68121	21	25.0	1.12463	7	230.0	0.68580
	2.4	1.67880	20	26.0	1.11896		235.0	0.67387
	2.5	1.67632	19	27.0	1.11517		240.0	0.66208
	2.6	1.67376	18	28.0	1.11202		245.0	0.65026
	2.7	1.67114		29.0	1.10945		250.0	0.63841
	2.8	1.66845		30.0	1.10702		255.0	0.62654
	2.9	1.66571	17	31.0	1.10465		260.0	0.61465
	3.0	1.66292		32.0	1.10263		265.0	0.60273
	3.1	1.66009		33.0	1.10060		270.0	0.59080
	3.2	1.65721		34.0	1.09864		275.0	0.57886
	3.3	1.65430		35.0	1.09675	6	280.0	0.56707
	3.4	1.65134	16	36.0	1.09477		285.0	0.55492
	3.5	1.64833		37.0	1.09309		290.0	0.54294
	3.6	1.64529		38.0	1.09131		295.0	0.53093
	3.7	1.64219		39.0	1.08955		300.0	0.51892
27	3.8	1.64112		40.0	1.08781		305.0	0.50689
	3.9	1.63587		42.0	1.08436		310.0	0.49484
	4.0	1.63263	15	44.0	1.08105		315.0	0.48278
	4.2	1.62602		46.0	1.07748		320.0	0.47069
	4.4	1.61920		48.0	1.07402		325.0	0.45858
	4.6	1.61220		50.0	1.07053		330.0	0.44647
	4.8	1.60506		52.0	1.06700		335.0	0.43435
	5.0	1.59782		54.0	1.06346	5	340.0	0.42238
	5.2	1.59047		56.0	1.05988		345.0	0.41003
	5.4	1.58303		58.0	1.05629		350.0	0.39783
	5.6	1.57551	14	60.0	1.05277		355.0	0.38561
	5.8	1.56792		65.0	1.04353		360.0	0.37337
	6.0	1.56027		70.0	1.03425		365.0	0.36110
	6.5	1.54097		75.0	1.02482		370.0	0.34881
	7.0	1.52166	13	77.4	1.02044		375.0	0.33650
	7.5	1.50272		80.0	1.01525		380.0	0.32416
	8.0	1.48443		85.0	1.00552		385.0	0.31180
	8.5	1.46700		90.0	0.99565	4	390.0	0.29958
26	9.0	1.44850	12	95.0	0.98574		395.0	0.28700
	9.5	1.43488		100.0	0.97550		400.0	0.27456
	10.0	1.42013		105.0	0.96524		405.0	0.26211
	10.5	1.40615		110.0	0.95487		410.0	0.24963
	11.0	1.39287	11	115.0	0.94455		415.0	0.23714
	11.5	1.38021		120.0	0.93383		420.0	0.22463
25	12.0	1.36687		125.0	0.92317		425.0	0.21212
	12.5	1.35647		130.0	0.91243		430.0	0.19961
	13.0	1.34530		135.0	0.90161	3	435.0	0.18696
	13.5	1.33453	10	140.0	0.89082		440.0	0.17464
	14.0	1.32412		145.0	0.87976		445.0	0.16221
	14.5	1.31403		150.0	0.86873		450.0	0.14985
	15.0	1.30422		155.0	0.85764		455.0	0.13759
24	15.5	1.29340		160.0	0.84650	2	460.0	0.12536
	16.0	1.28527	9	165.0	0.83541		465.0	0.11356
	16.5	1.27607		170.0	0.82404		470.0	0.10191
	17.0	1.26702		175.0	0.81274	1	475.0	0.09032
	17.5	1.25810		180.0	0.80138			

Curve #6 - DT-470 Voltage-Temperature Characteristics

BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage	BP#	Temp. (K)	PROM Voltage
29	1.4	1.69808		18.0	1.24928		185.0	0.78999
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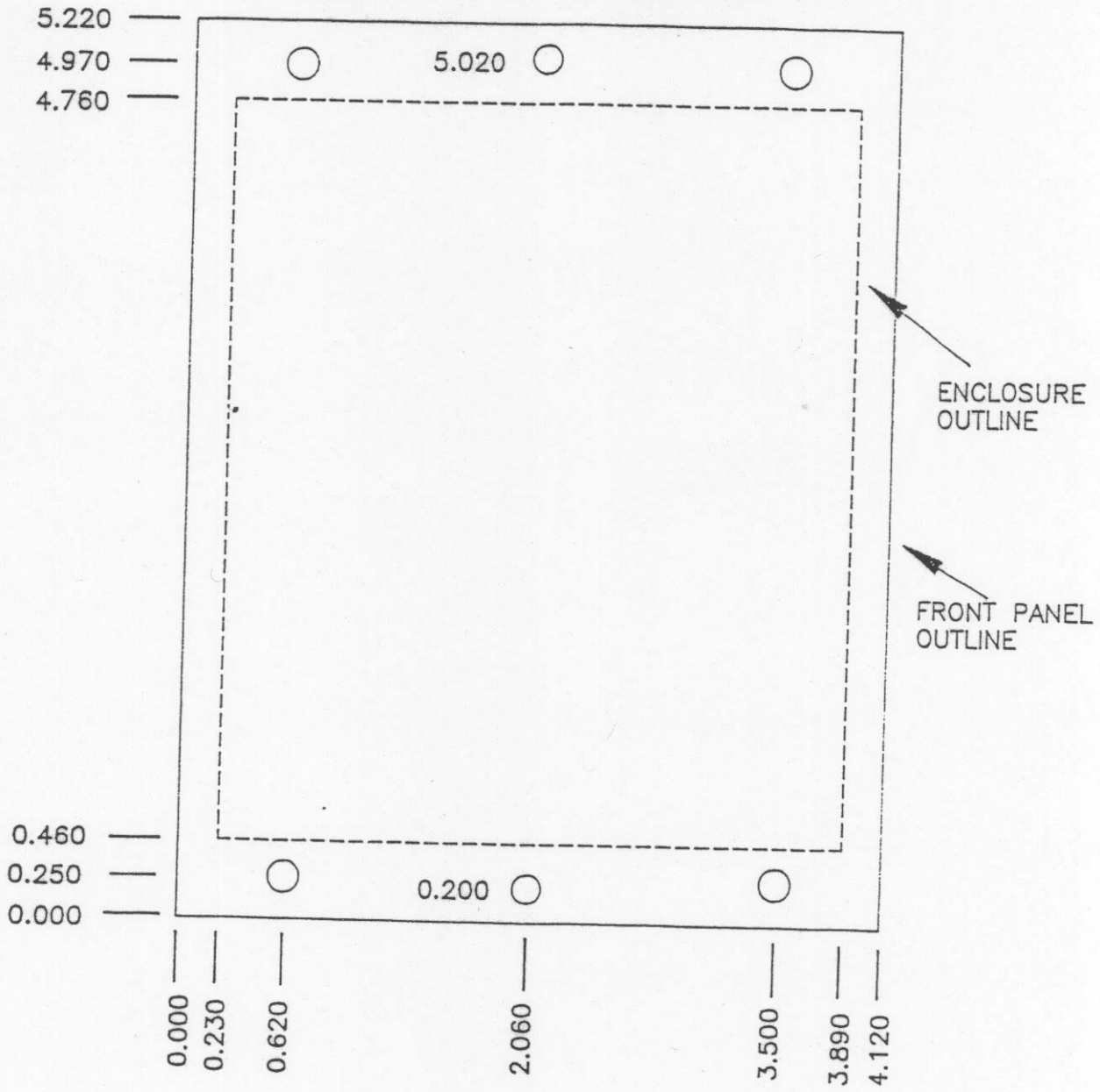
	1.6	1.69521		19.0	1.23184	8	195.0	0.76717
	1.7	1.69355		19.5	1.22314		200.0	0.75584
	1.8	1.69177	23	20.0	1.21555		205.0	0.74398
	1.9	1.68997		21.0	1.19645		210.0	0.73238
28	2.0	1.68912		22.0	1.17705		215.0	0.72075
	2.1	1.68574		23.0	1.15558		220.0	0.70908
	2.2	1.68352	22	24.0	1.13598		225.0	0.69737
	2.3	1.68121	21	25.0	1.12463	7	230.0	0.68580
	2.4	1.67840	20	26.0	1.11398		235.0	0.67387
	2.5	1.67632	19	27.0	1.11517		240.0	0.66208
	2.6	1.67376	18	28.0	1.11202		245.0	0.65026
	2.7	1.67114		29.0	1.10945		250.0	0.63841
	2.8	1.66845		30.0	1.10702		255.0	0.62654
	2.9	1.66571	17	31.0	1.10465		260.0	0.61465
	3.0	1.66292		32.0	1.10263		265.0	0.60273
	3.1	1.66009		33.0	1.10060		270.0	0.59080
	3.2	1.65721		34.0	1.09864		275.0	0.57886
	3.3	1.65430		35.0	1.09675	6	280.0	0.56707
	3.4	1.65134	16	36.0	1.09477		285.0	0.55492
	3.5	1.64833		37.0	1.09309		290.0	0.54294
	3.6	1.64529		38.0	1.09121		295.0	0.53093
	3.7	1.64219		39.0	1.08955		300.0	0.51892
27	3.8	1.64112		40.0	1.08781		305.0	0.50689
	3.9	1.63847		42.0	1.08436		310.0	0.49484
	4.0	1.63563	15	44.0	1.08105		315.0	0.48278
	4.2	1.63602		46.0	1.07748		320.0	0.47069
	4.4	1.61920		48.0	1.07402		325.0	0.45858
	4.6	1.61220		50.0	1.07053		330.0	0.44647
	4.8	1.60506		52.0	1.06700		335.0	0.43435
	5.0	1.59782		54.0	1.06346	5	340.0	0.42228
	5.2	1.59047		56.0	1.05988		345.0	0.41003
	5.4	1.58303		58.0	1.05629		350.0	0.39783
	5.6	1.57551	14	60.0	1.05271		355.0	0.38561
	5.8	1.56792		65.0	1.04352		360.0	0.37337
	6.0	1.56027		70.0	1.03425		365.0	0.36110
	6.5	1.54097		75.0	1.02482		370.0	0.34881
	7.0	1.52166	13	77.4	1.02044		375.0	0.33650
	7.5	1.50272		80.0	1.01525		380.0	0.32416
	8.0	1.48443		85.0	1.00552		385.0	0.31180
	8.5	1.46700		90.0	0.99565	4	390.0	0.29958
26	9.0	1.44850	12	95.0	0.98574		395.0	0.28700
	9.5	1.43488		100.0	0.97590		400.0	0.27456
	10.0	1.42013		105.0	0.96624		405.0	0.26211
	10.5	1.40615		110.0	0.95687		410.0	0.24963
	11.0	1.39287	11	115.0	0.94455		415.0	0.23714
	11.5	1.38021		120.0	0.93383		420.0	0.22463
25	12.0	1.36697		125.0	0.92317		425.0	0.21212
	12.5	1.35417		130.0	0.91243		430.0	0.19961
	13.0	1.34230		135.0	0.90161	3	435.0	0.18699
	13.5	1.33153	10	140.0	0.89082		440.0	0.17454
	14.0	1.32412		145.0	0.87976		445.0	0.16221
	14.5	1.31403		150.0	0.86872		450.0	0.14985
	15.0	1.30422		155.0	0.85764		455.0	0.13759
24	15.5	1.29340		160.0	0.84650	2	460.0	0.12538
	16.0	1.28327	9	165.0	0.83541		465.0	0.11326
	16.5	1.27607		170.0	0.82404		470.0	0.10191
	17.0	1.26702		175.0	0.81274	1	475.0	0.09002
	17.5	1.25810		180.0	0.80138			

APPENDIX B

INSTALLATION OF THE 818/819

The 818/819 mounts one 818/819 in a 1/4 panel EIA rack space. Refer to Figure B-1 on the next page for the overall dimensions of a unit with the 818/819 installed. Use the following procedure to install a 818/819 Mounting Adaptor:

Figure B-1. 818/819 Mounting Detail

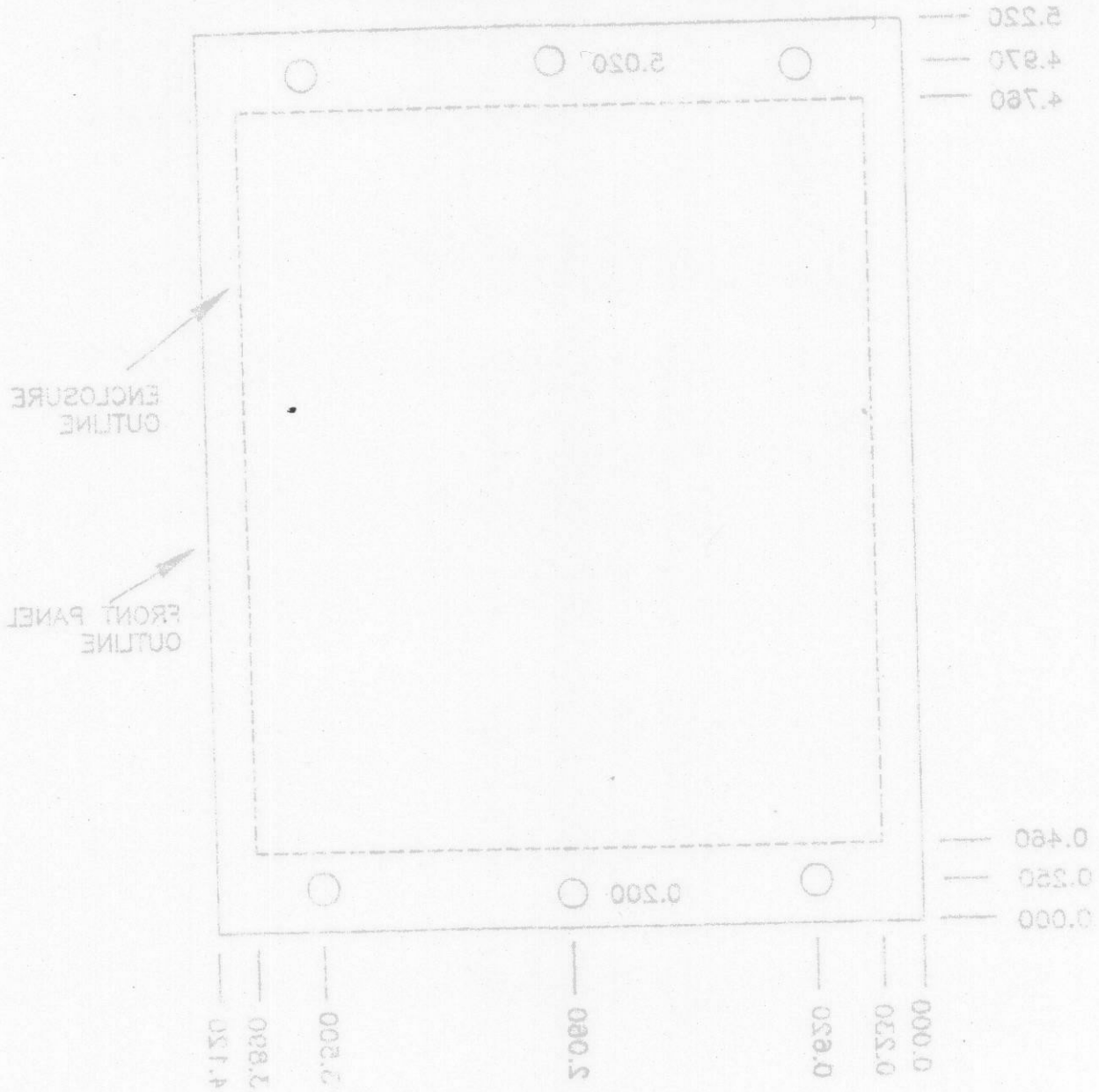


APPENDIX B

INSTALLATION OF THE 818/819

The 818/819 mounts one 818/819 in a 1/4 panel EIA rack space. Refer to Figure B-1 on the next page for the overall dimensions of a unit with the 818/819 installed. Use the following procedure to install a 818/819 Mounting Adaptor:

Figure B-1. 818/819 Mounting Detail



APPENDIX C
SAMPLE RS232 COMMUNICATION PROGRAM

WRITTEN IN QUICK BASIC

```
1:          OPEN "coml:300,o,7,1,RS" FOR RANDOM AS #1 LEN = 256
2:    L1:   INPUT "ENTER COMMAND"; A$
3:          PRINT #1, A$ + CHR$ (13) + CHR$ (10);
4:          LINE INPUT #1, B$
5:          PRINT B$
6:          GOTO L1
```

Line numbers 1 through 6 are only for reference to this text.
Line 1: Defines the COM1 port for input/output at 300 baud, odd parity, 7 data bits, and 1 stop bit. The (LEN) value selects the maximum length of the input/output string in ASCII characters.

Line 2: Asks the user for the command and enters it into the variable (A$).

Line 3: This line is responsible for sending the command to the 818/819. The CHR$(13) is a Carriage Return and the CHR$(10) is a Line Feed. The semi-colon at the end is to suppress the automatic Carriage Return.

Line 4: This line retrieves the response of the 818/819, if the 818/819 does not respond, the program will stop and wait for a response. The response is stored in variable B$.

Line 5: This line prints the response of the 818/819 on the screen.

Line 6: This line causes a jump back to line 2, in effect, starting the program over.

To stop the program, or if the program does not receive a response from the 818/819, it will be necessary to press and hold the Control (CTRL) key and the Break on the computer Key board.

APPENDIX C

SAMPLE RS232 COMMUNICATION PROGRAM

WRITTEN IN QUICK BASIC

```
1:        OPEN "com1:300,o,7,1,RS" FOR RANDOM AS #1 LEN = 256
2:   L1:  INPUT "ENTER COMMAND"; A$
3:        PRINT #1, A$ + CHR$ (13) + CHR$ (10);
4:        LINE INPUT #1, B$
5:        PRINT B$
6:        GOTO L1
```

Line numbers 1 through 6 are only for reference to this text.

Line 1: Defines the COM1 port for input/output at 300 baud, odd parity, 7 data bits, and 1 stop bit. The (LEN) value selects the maximum length of the input/output string in ASCII characters.

Line 2: Asks the user for the command and enters it into the variable (A$).

Line 3: This line is responsible for sending the command to the 818/819. The CHR$(13) is a Carriage Return and the CHR$(10) is a Line Feed. The semi-colon at the end is to suppress the automatic Carriage Return.

Line 4: This line retrieves the response of the 818/819, if the 818/819 does not respond, the program will stop and wait for a response. The response is stored in variable B$.

Line 5: This line prints the response of the 818/819 on the screen.

Line 6: This line causes a jump back to line 2, in effect, restarting the program over.

To stop the program, or if the program does not receive a response from the 818/819, it will be necessary to press and hold the Control (CTRL) key and the Break on the computer key board.