OPERATING AND
INSTRUCTION MANUAL
FOR
MODEL DRC-6

GENERAL INFORMATION

1.1 Introduction

This manual provides the necessary information to install, operate and maintain the Model DRC-6 Digital Thermometer.

1.2 Description

The DRC-6 Digital Thermometer is a completely self-contained temperature indicator with a built-in reference junction that automatically displays the temperature of an attached platinum resistance thermometer (PRT) to a resolution of one tenth degree.

The standard unit provides non-isolated parallel and serial BCD outputs.

1.3 Specifications

1.3.1 Electrical Specifications

Full Scale Range	399.9 K
Number of Digits	4
Resolution	0.1 K
Repeatability	±0.1 K for 30 min. at constant temperature
Linearization	Fully digital with 31 segment approximation
Input Impedance	100 megohms
Warmup Time	Rated accuracy ±0.1 K within 5 minutes after power is applied; rated accuracy after 20 minutes
Input Power	Dual-primary; 115V/230V ±10% selection by jumper; 50-60 Hz; 10 watts

1.3.1   (CONTINUED)

Common-Mode Rejection
Ratio, DC to 60 Hz

CMRR to Digital Ground:	none
CMRR to Power Ground:	140 db with 300V isolation
Normal-Mode Noise Rejection	45 db at 50 to 60 Hz with standard settling time
Settling Time	2 seconds to within 0.1 K after a full-scale step input

Reading Rates

Internal Control Mode	From $\frac{1}{2}$/sec to 60 per/sec programmable by external resistor
External Control Mode	0 to 60 readings/second
Maximum Normal Mode Signal	135 mVRms
Sensor Excitation	2 mA
Sensor Input	4 wire
BCD Outputs	Parallel and serial, I.C. compatible
Display	0.6" high numerals, glow discharge type with polarized view screen

1.3.2   Mechanical Specifications

Dimensions	13.2 cm (5.2") wide x 6.4 cm (2.5") high x 16.5 cm (6.5") deep
Weight	1.8 Kg (4 pounds)

1.3.3   Operating Environment

Temperature 0° to 45°C

Relative Humidity   0 to 75%, non-condensing.
                                             Humidity-sealed boards
                                             available for 90% RH

1.3.4   Temperature Specifications

Sensor Type   Platinum - 100 ohms at
                                             273.16 K (0°C)

Sensor Model   PT-101, 102, or 103

Useful Range   4.0-400.0 K

Conformity Range   50.0-400.0 K

Linearization Conformity*   0.2 K

Maximum Digitizing Error
(8 hrs. at 25°C)   0.1 K ±0.03% R

Maximum Digitizing Error
(90 days at 15-35°C)   0.2 K ±0.06% R

*To DIN 43760   = 0.003850 ohms per ohm per $^{\circ}$C

1.3.5   Reference Junction Error

The signal conditioner error for 10-40°C ambient is less than
±0.08 K ±0.05% of reading in a 24 hour period.

RECEIVING AND INSTALLATION

2.1   Unpacking and Inspection

Your Model DRC-6 Digital Thermometer has been carefully inspected
and tested before shipment. Unpack the meter and perform a visual
inspection to assure that no damage has occurred during shipment
or handling. These meters are factory sealed units. The only
controls that may require periodic adjustment are accessible through
the rear panel. Because extensive damage could result from attempts
to measure circuit parameters or to trouble-shoot the meter by
non-factory personnel, the warranty is automatically voided if the
unit has been removed from its case.

2.2   Installation-Mechanical

The figure below illustrates the required panel cut-out to accept
the Model DRC-6 allowing the clamping brackets to grip the front panel
bezel to the rack panel.

2.43

.03 R max.
4 places

5.03
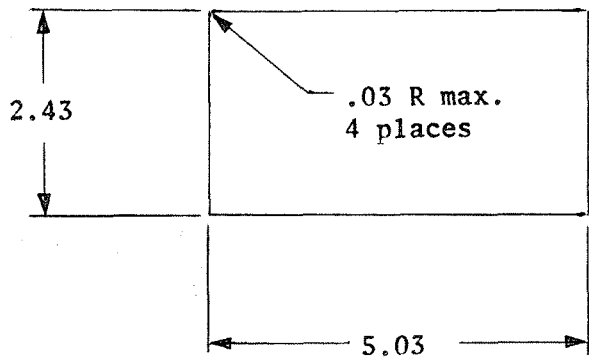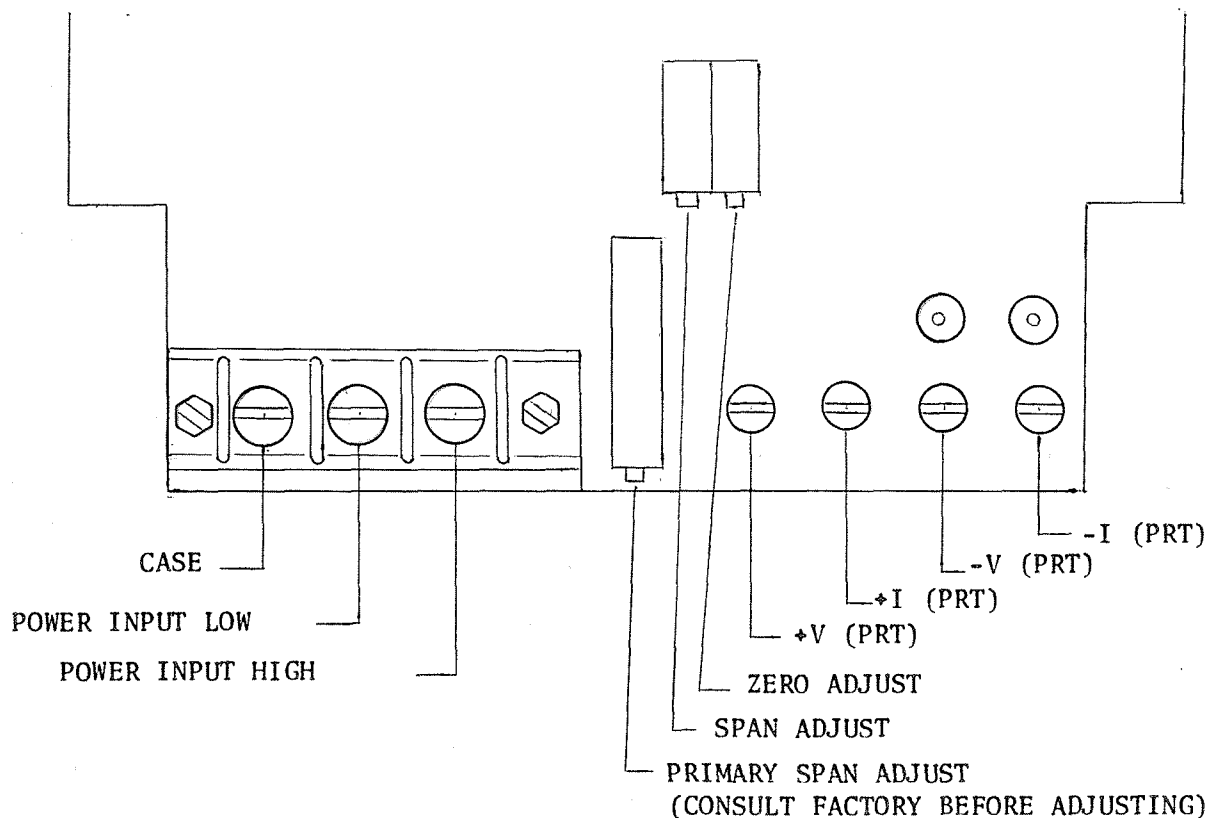
OPERATING INSTRUCTIONS

3.1   Wiring

All wiring to the Model DRC-6 is accomplished from the rear of
the unit (see drawing A-052-001).
Power wiring is to a barrier strip and the PRT wiring to
connecting terminal lugs. All controls and digital connections
are via an edge card connector.

NOTE: To enable continuous readings, jumper J1-M to J1-10.

3.1.1   Power Wiring

The standard unit operates from a 115V ±10%, 50 to 400 Hz power
source. Operation from 230V is available as an option and is
accomplished via internal jumper connections.

The unit should be connected to the power source with a three wire
cable terminated at the barrier strip. The third wire provides
safe grounding of the case and should be attached to earth ground
at the power source.

CASE

POWER INPUT LOW

POWER INPUT HIGH

ZERO ADJUST

SPAN ADJUST

PRIMARY SPAN ADJUST
(CONSULT FACTORY BEFORE ADJUSTING)

+V (PRT)

+I (PRT)

-V (PRT)

-I (PRT)

3.1.2 EXTERNAL CONTROL WIRING

The following is a list of the digital input/output connections for the Model DRC-6.

PIN	FUNCTION	PIN	FUNCTION
1	4.0^o	A	0.1^o
2	8.0^o	B	0.2^o
3	10.0^o	C	0.4^o
4	20.0^o	D	0.8^o
5	40.0^o	E	1.0^o
6	80.0^o	F	2.0^o
7	DATA READY ENABLE	H	DATA READY
8	TRANSFER	J	READY
9	100.0^o	K	200.0^o
10	HOLD	L	SERIAL BCD OUTPUT
11	SPARE	M	DIGITAL GND
12	NEGATIVE POLARITY	N	READ RATE
13	POSITIVE POLARITY	P	ERROR OR NEGATIVE POLARITY
14	ERROR (NEG TRUE)	R	RELAY DRIVE
15	RELAY CONTACT OUT	S	RELAY CONTACT OUT

3.1.3   Platinum Resistance Thermometer Wiring

The PRT input wires are attached directly to the DRC-6 via terminal lugs as illustrated in figure below. An optional 2-lead configuration option is provided by shorting Hi to Lo and L1 to L2 and connecting PRT between Hi and L2.

FIGURE 3.1

3.2   External Control Signals

The following paragraphs describe the control signals and their functions. All signals are available at the rear of the unit. All input/output levels are compatible with DTL and TTL logic.

Input Signal Requirements:

    False: 0 to +.5V, sink 1.6ma

    True: +2.4 to +5.5V, source .1ma

3.2   (CONTINUED)

Output Signal Specifications:

    False: 0 to +.5V, sink 3.2ma

    True: +2.4 to +5.5V, source .2ma

3.2.1   DATA READY (OUT)

The DATA READY signal goes true (high) upon completion of a
measurement, and remains true until the next measurement is started.
During this time, the BCD outputs constitute a valid reading available
for use by an external device. the DATA READY signal normally remains
true for at least 6 ms, and may be held true indefinitely by keeping
the HOLD input true.

3.2.2   HOLD (IN)

Measurements may be externally controlled as desired by use of the
HOLD input. While the HOLD input is maintained false (low),
measurements occur at the externally-programmed reading rate (0.5 to
60 per second). While it is true, the last measurement is held in
memory. An internal storage element allows control by pulses or
transitions.

3.2.3   READ RATE (IN)

This input provides a means for adjusting the reading rate from
approximately 0.5 per second to 60 per second by connection of a
resistor between pin N (READ RATE) and pin M (GND). Leaving the
READ RATE input open results in a reading rate of 0.5/sec or
less, while a short results in a 60/sec rate.

An approximate value of programming resistor for intermediate reading
rates may be determined from the formula:

$$R = \frac{5000}{N-0.5} \text{ Kilohms}$$

Where N is the desired readings per second.

The HOLD input must be grounded for the reading rate to be enabled.

3.2.4   BCD Outputs

The digital outputs consist of the parallel BCD equivalent of the displayed temperature including magnitude, positive or negative polarity, ERROR (low for either overrange or open input) and an output representing the logic combination of ERROR or NEGATIVE POLARITY.

In addition, a serial BCD output is provided. If isolated parallel BCD outputs are desired, the serial BCD output may be applied to a separate package containing isolating transformers. The SERIAL BCD OUTPUT may be accumulated and transferred to storage elements by means of a TRANSFER pulse which also generates the reset to prepare the BCD accumulator for the next reading. The POSITIVE POLARITY and NEGATIVE POLARITY outputs are timed to be accepted with the BCD data.

3.2.5   Relay Output (Optional)

A form A relay contact and driver are provided which may be actuated by any of the digital BCD outputs. Selection is achieved by jumpering on the rear connector from Pin R to the selected BCD output. The relay provides an isolated contact closure on pins 15 and S.

THEORY OF OPERATION

The Model DRC-6 Digital Thermometer with internal reference junction accepts the resistance output of a platinum resistance thermometer (PRT) and provides a digital display of the equivalent temperature. Since the resistance generated by a PRT is a non-linear function of temperature, the analog-to-digital converter circuit in the Model DRC-6 is made non-linear to match the PRT curve. The curve is approximated by 31 straight line segments to reduce the conformity error to less than the standard PRT error.

A digital linearization technique (see figure 4.1) is used incorporating a Binary-Frequency-Generator (BFG) controlled by a Read-Only-Memory (ROM). The output of the BFG serves as the clock source for the modified analog-to-digital converter. The 6 bit binary coded digital input to the BFG is derived from six of the eight parallel outputs of the ROM. The remaining two bits are used to select one of three available segment lengths for a particular PRT type.

The five bit segment counter is advanced at intervals of tenths of degrees determined by the ROM and derived from the display counter. Each segment is represented by one 8 bit word in the ROM. Segments corresponding to temperatures occur in different sections of the ROM and are selected by a polarity indicating logic level.

An internal reference junction provides the interface between the PRT resistance and input amplifier. The input circuit is a fixed gain chopper amplifier to ensure drift free operation with time and temperature. There is a three pole 5 Hz filter for high noise rejection.

The signal conditioner for the PRT is a multi-current source (see figure 3.1 on page 8) which provides 2 mA (I_1) for the PRT and a second 2 mA source (I_2) for a balanced bridge configuration. An amplifier compensates for any lead resistance in lead #4 or any change with temperature of lead resistance up to a maximum lead resistance of 100 ohms. The output of the signal conditioner is a voltage which is directly proportional to the sensor resistance and hence its temperature. Changes in lead #1 resistance are not seen by the input amplifier and cause no error. Leads #2 and #3 do not carry current and do not cause any error due to lead resistance variation.
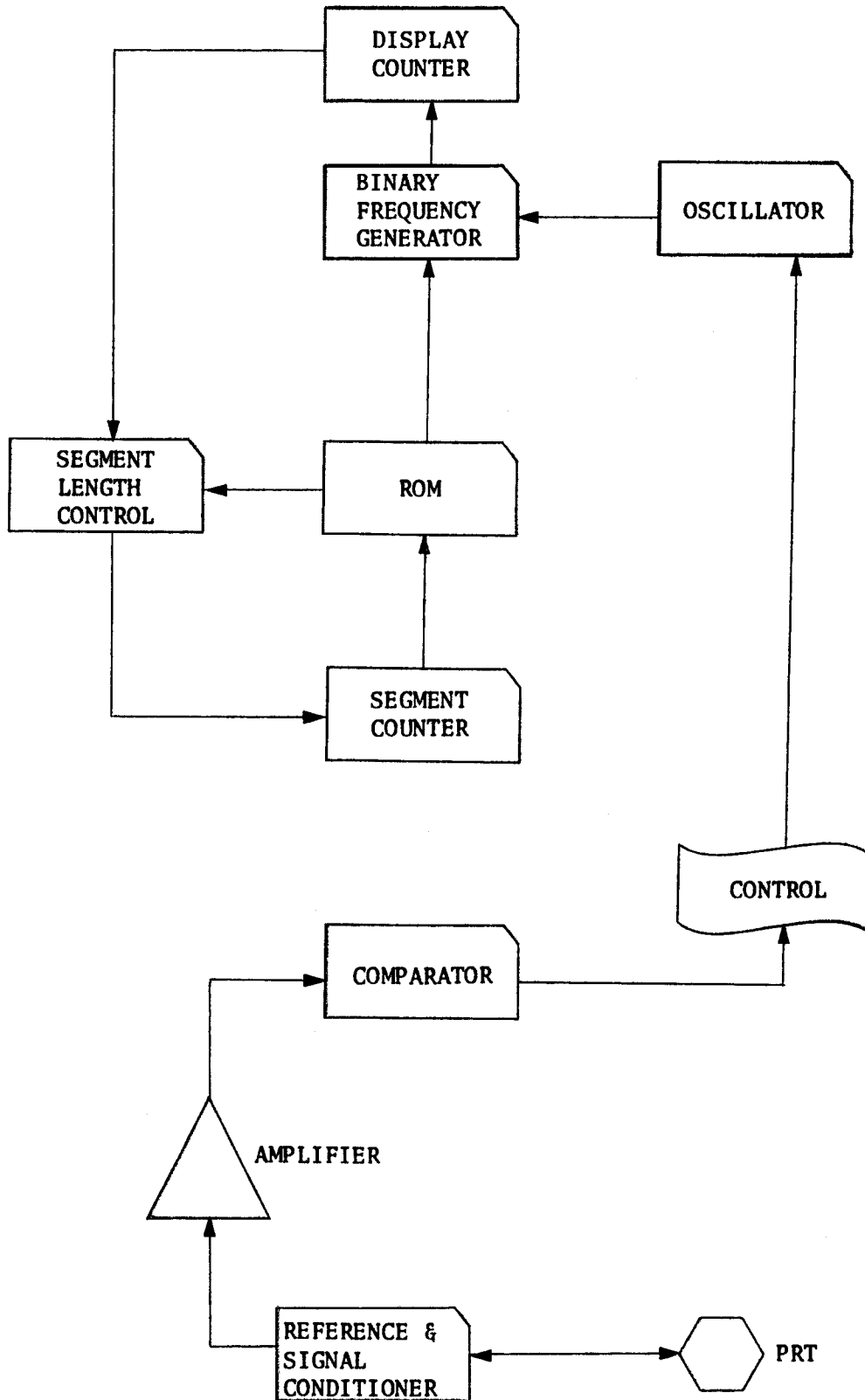
DISPLAY
COUNTER

BINARY
FREQUENCY
GENERATOR

OSCILLATOR

SEGMENT
LENGTH
CONTROL

ROM

SEGMENT
COUNTER

CONTROL

COMPARATOR

AMPLIFIER

REFERENCE &
SIGNAL
CONDITIONER

PRT

FIGURE 4.1   BLOCK DIAGRAM OF MODEL DRC-6

CALIBRATION PROCEDURE

5.1   EQUIPMENT REQUIRED

    1. A variable resistance source of 0 to 1000 ohms with resolution of 0.01 ohms and accuracy of 0.01%.

    2. Test cables as indicated in figure 5.1.

    3. An ice bath with better than 0.2 degree stability.

5.2   Procedure

5.2   INITIAL CALIBRATION

    1. Connect test cables between variable resistance source and Model DRC-6 terminals labeled HI and L2. Connect a jumper between terminals labeled HI and LO and a second jumper between terminals L1 and L2.

    2. Set span adjust and zero adjust potentiometers (see figure 5.2) to center scale.

    3. Adjust variable resistance source to read 0.00 ohms.

    4. Observe and record reading.

    5. Adjust resistance source to 141.10 ohms and note and record readout.

    6. If the difference between readings observed in step 4 and 5 is not 380.0 K, adjust SPAN adjust potentiometer until the readout difference is 380.0 K when dialing in the resistance provided in step 4 and 5.

    7. Adjust resistance source for 0.00 ohms and observe a reading of 10.6 K. If unit does not display 10.6 K, then adjust ZERO adjust potentiometer until a reading of 10.6 K appears.

    8. Adjust resistance source to 141.10 ohms to check that unit is displaying 390.6 K.

5.3 CALIBRATION PROCEDURE WITH A PRT
AND A KNOWN TEMPERATURE

1. Connect a PRT sensor as illustrated in figure 5.1.

2. Stabilize PRT in a 273 K bath (ice bath) and adjust
   ZERO adjust potentiometer for 273.2 K indication.

3. Stabilize PRT to a known temperature (such as LN_2)
   and adjust SPAN adjust potentiometer for required
   temperature indication.

   Note: This adjustment should be minor and performed
          after initial calibration in Section 5.2
          above. Errors should not be greater than
          accuracy of temperature source, PRT sensor
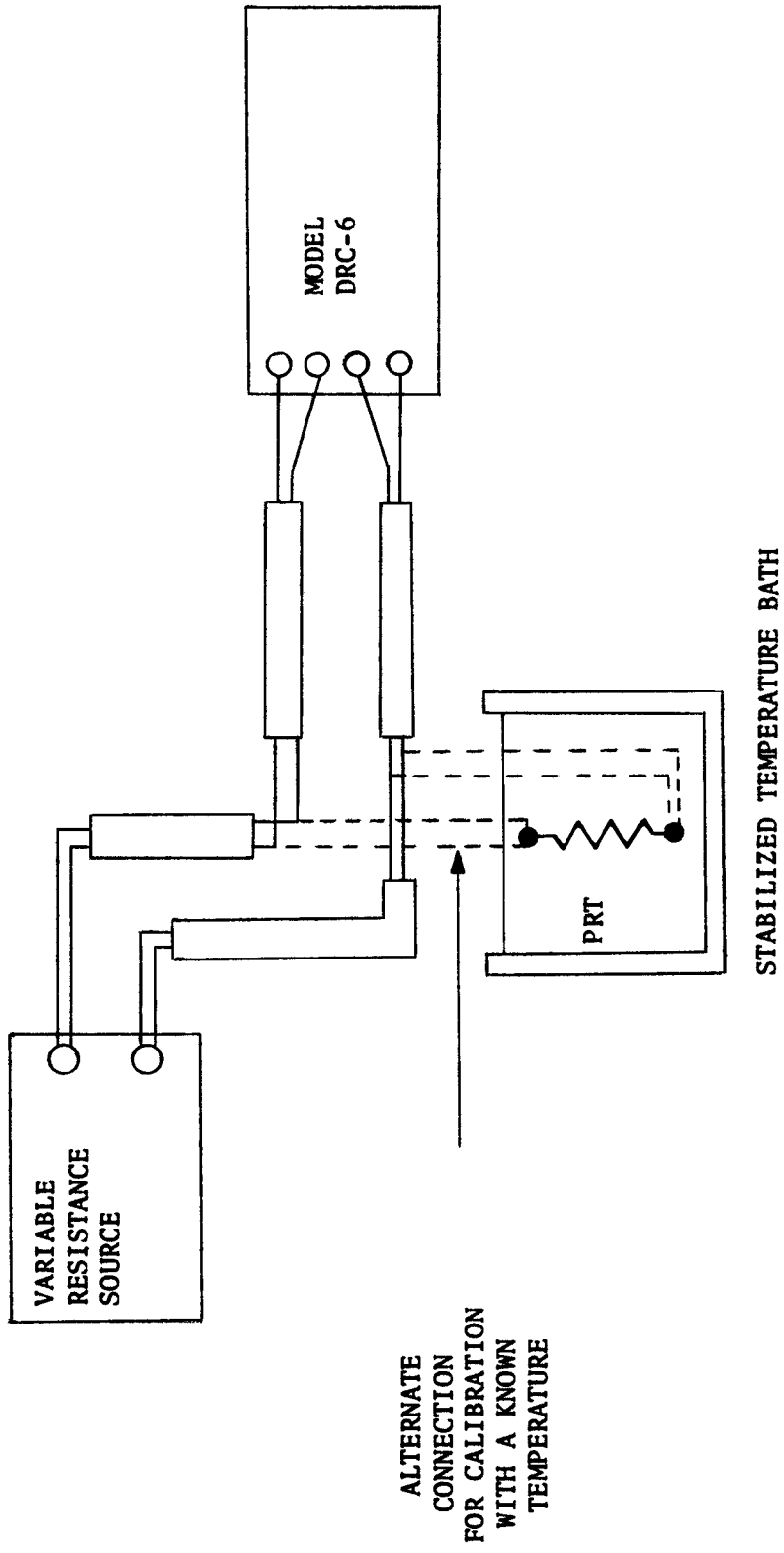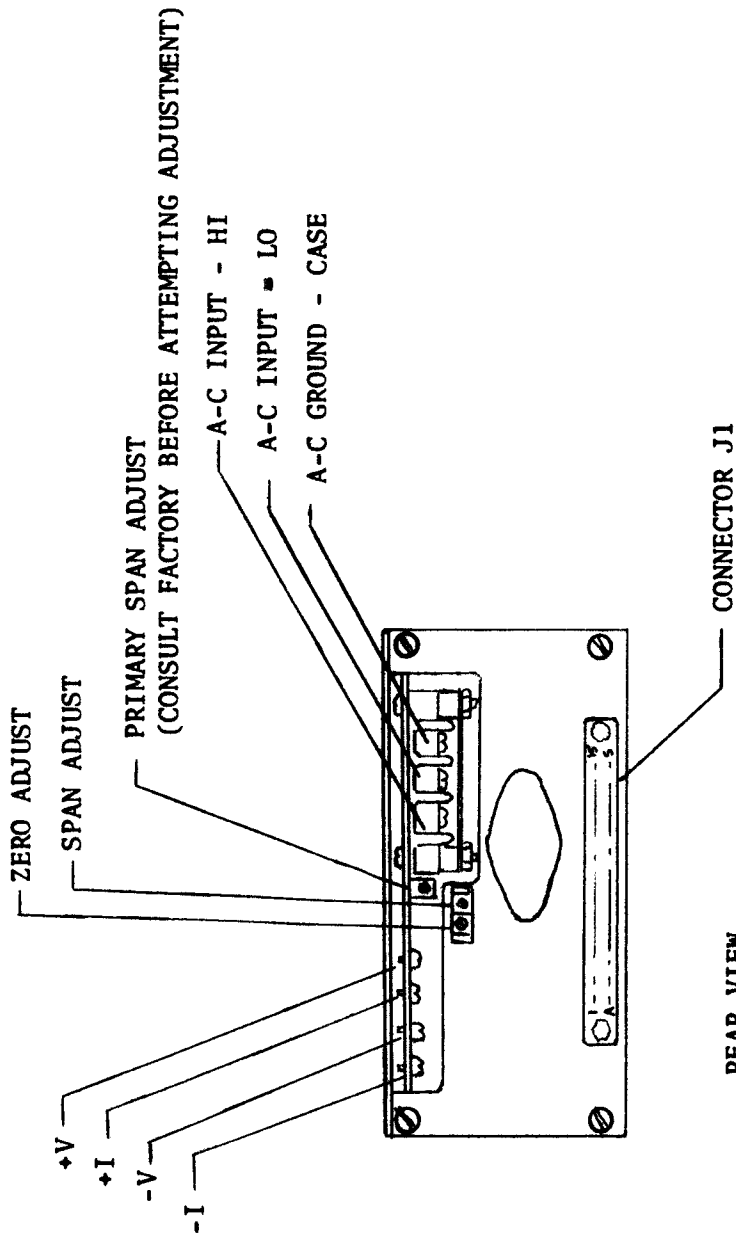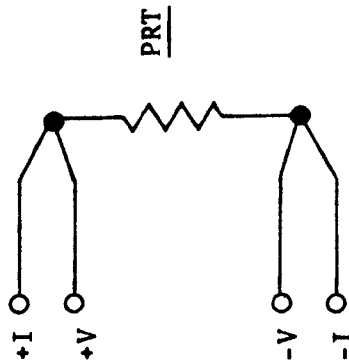   and ±0.1 K ±0.1% of reading.

MODEL
DRC-6

VARIABLE
RESISTANCE
SOURCE

PRT

STABILIZED TEMPERATURE BATH

ALTERNATE
CONNECTION
FOR CALIBRATION
WITH A KNOWN
TEMPERATURE

FIGURE 5.1 TEST CABLE SET-UP

15.

ZERO ADJUST

SPAN ADJUST

PRIMARY SPAN ADJUST
(CONSULT FACTORY BEFORE ATTEMPTING ADJUSTMENT)

A-C INPUT - HI

A-C INPUT - LO

A-C GROUND - CASE

CONNECTOR J1

+V
+I
-V
-I

REAR VIEW

PRT

+I
+V
-V
-I

LAKE SHORE CRYOTRONICS, INC.
Eden, New York 14057

SCALE:

DATE: 4/1/75

APPROVED BY:

DRAWN BY: JRB

REVISED

CONNECTIONS LOCATOR FOR MODEL DRC-6

FIGURE 5.2

DRAWING NUMBER
A-052-001