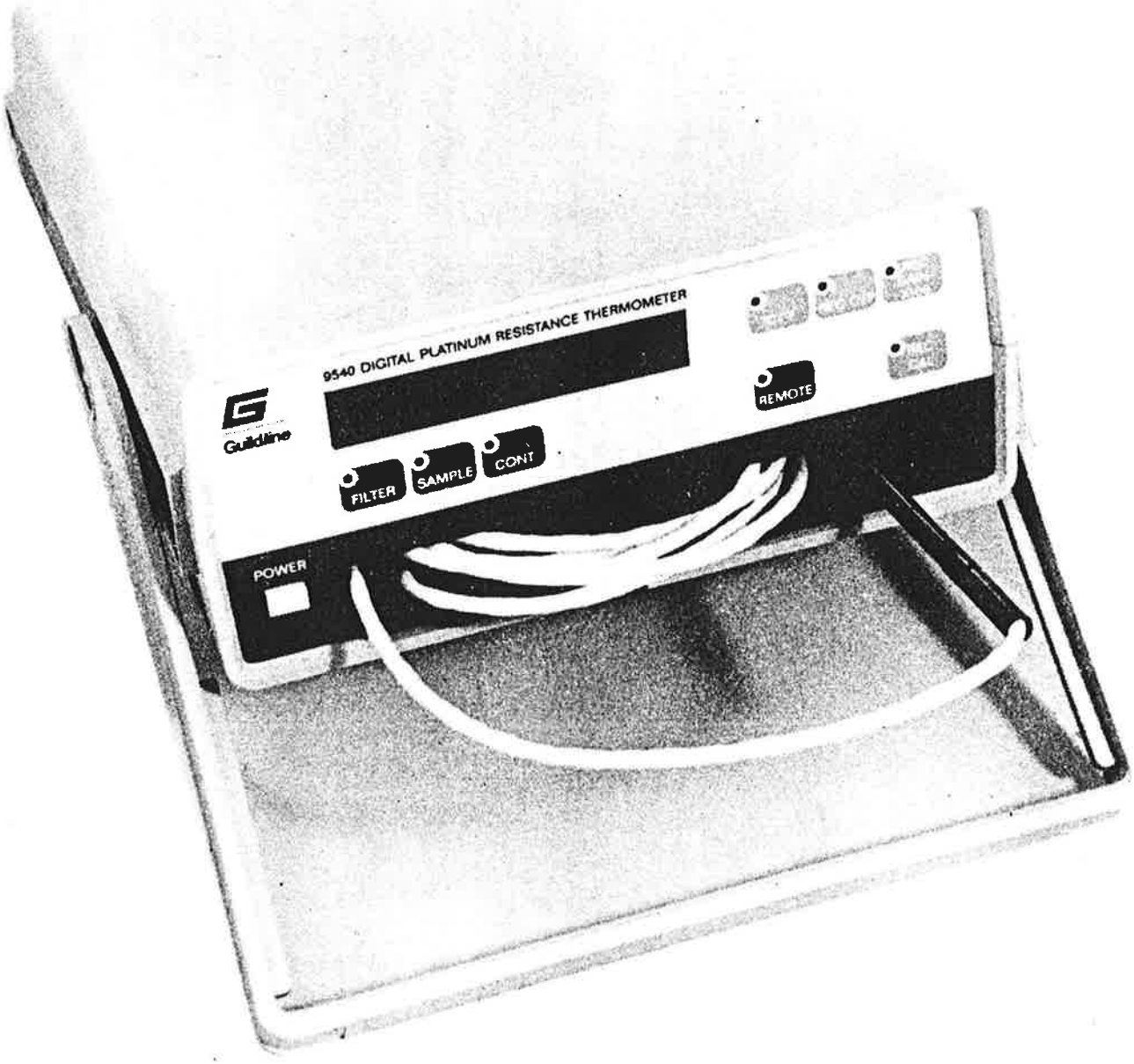
9540



PRECISION DIGITAL THERMOMETER

A D D E N D U M

Manual Number: TM9540-A-01

Details: Page 2-1, Temperature Table

RANGE	RESOLUTION °C or °F	24HRS. @23°C+/-1°C	90DAYS @23°C+/-1°C	1YEAR @23°C+/-1°C
+180°C to +240°C (+356°F to +464°F)	0.001	0.015	0.03	0.05
-40°C to +180°C (-40°F to +356°F)	0.001	0.01	0.015	0.03
-40°C (-40°F)	0.001	0.01	0.015	0.03
-41°C to -100°C (-41°F to -148°F)	0.001	0.01 +0.002/DEG	0.015 +0.002/DEG	0.03 +0.002/DEG
-100°C (-148°F)	0.001	0.1	0.115	0.13
-101°C to -200°C (-149°F to -328°F)	0.001	0.1 +0.02/DEG	0.115 +0.02/DEG	0.13 +0.02/DEG

TABLE OF CONTENTS

		Page
SECTION 1	GENERAL INFORMATION	1-1
1.1	Scope	1-1
SECTION 2	SPECIFICATIONS	2-1
SECTION 3	THEORY OF OPERATION	3-1
3.1	General	3-1
3.2	Functional Description	3-1
3.3	Circuit Description	3-3
3.3.1	Power Supplies	3-3
3.3.2	Front End Amplifier	3-3
3.3.3	Clock Circuits	3-6
3.3.4	Analog to Digital Conversion	3-6
3.3.5	Microprocessor Circuit	3-8
3.3.6	Keyboard Interface	3-9
3.3.7	Bus Interface	3-10
3.3.8	Digital to Analog Conversion	3-10
SECTION 4	SHOP MAINTENANCE	4-1
4.1	Introduction	4-1
4.2	Necessary Equipment	4-1
4.2.1	Calibration, Performance Verification	4-1
4.2.2	Troubleshooting	4-1
4.3	Performance Verification	4-2
4.3.1	Introduction	4-2
4.3.2	Performance Verification Power Up	4-2
4.3.3	Performance Verification Power Supplies	4-4
4.3.4	Performance Verification Ice Point	4-5
4.3.5	Performance Verification 164°C Point	4-6
4.4	Calibration Procedure	4-6
4.4.1	Introduction	4-6
4.4.2	Disassembly	4-7
4.4.3	Calibration Ice Point	4-7
4.4.4	Calibration 164°C Point	4-7
4.4.5	Reassembly	4-8
4.5	Troubleshooting	4-8
4.5.1	Introduction	4-8
4.5.2	Power Up	4-9
4.5.3	Power Supply Check	4-9
4.5.4	Clock Circuits	4-10
4.5.5	Front End	4-10
4.5.6	Front Panel	4-12
4.5.7	Microprocessor	4-13
4.5.8	GPIB	4-14
4.5.9	D/A	4-15

FIGURES

		Page
Figure 3-1	Functional Description	3-2
3-2	Functional Layout	3-4
3-3	100 Ω Reference	3-7
3-4	Dechopper Output Filter	3-7
4-1	PRT Copper Holding Block	4-3
4-2	CLK 1, CLK 2, CLK 3, CLK 4.	4-11

PARTS LISTS

18122.01.02	GENERAL ASSEMBLY
18108.01.02	MAIN PCB
18115.01.02	DISPLAY PCB
18125.01.01	CASE ASSEMBLY
18127.01.01	RACK ADAPTOR
18123.01.01	FRONT PANEL ASSEMBLY
18124.01.01	BACK PANEL ASSEMBLY

DRAWINGS

18115.01.02	DISPLAY PCB ASSEMBLY
18122.01.04	DIGITAL PLATINUM RESISTANCE THERMOMETER
18108.01.02	MAIN PCB ASSEMBLY

SECTION 1

1.1 Scope

This Service Manual for the Guildline Instruments Model 9540 Digital Platinum Resistance Thermometer contains specifications, theory of operation, calibration and troubleshooting information. Together with the Operator's Manual, qualified electronics repair and calibration personnel may use this manual to maintain and troubleshoot the Model 9540.

Chapter 2
Specifications

Specifications

TEMPERATURE

Accuracy: GUARANTEED PERFORMANCE including supplied probe.

Range	Resolution deg °C or °F	Limits of Error ± °C or °F		
		24 hrs. @ 23°C ± 1°C	90 days @ 23°C ± 5°C	1 Year @ 23°C ± 5°C
−200°C to −40°C −328°F to −40°F	0.001	0.015	0.03	0.05
−40°C to +180°C −40°F to +356°F	0.001	0.01	0.015	0.03
+180°C to +240°C +356°F to +464°F	0.001	0.015	0.03	0.05

Total guaranteed performance is worst case. It assumes all contributing errors are maximum and occur at the same time and in the same direction. Contributing errors include calibration uncertainty which is referred to flowing water at the rate of 1 m/s, repeatability, stability, temperature coefficient, linearization plus sensor and electronics drift and probe self heating.

Temperature coefficient: . . . . . < ±0.0005 deg. C./deg. C.
< ±0.0009 deg. F./deg. F.

Repeatability: . . . . . ±2 least significant digits

Warm up time: . . . . . 30 seconds to full rated accuracy

Time constant: . . . . . 5 seconds

Self Heating: . . . . . < 0.015 deg. C. at 23 deg. C. in flowing water at 1 m/s

Filter: . . . . . I0 sec. digital filter

Speed: . . . . . 1.5 sec. per reading filter out

General

Power Supply:

voltage (switch selected):	95 to 130V or 190 to 260V
frequency:	50, 60, or 400 Hz
consumption:	< 10VA

Protection:

power supply:	fused line 100 mA slo blo

Environment:

Temperature, working:	0 to 50 deg. C.
storage:	−30 deg. to 70 deg. C.
Maximum operating humidity (non condensing):	70% at 40 deg. C.
Shock and Vibration:	1 g in 3 planes, resonance search 5 Hz to 200 Hz

Dimensions:

Height:	88 mm (3.46 in.)
Width (including handle):	228 mm (8.98 in.)
Depth:	278 mm (10.94 in.)
Weight:	3.0 kg (6.6 lbs.)

Sensor Dimensions:

Length:	210 mm (8.25 in.)
Diameter:	3 mm (0.1 in.)
Immersion depth:	50 mm (2 in.) minimum
Length of sensor cable:	2 m (6.5 ft.)
Sensor incapsulation:	Stainless steel

INTERFACE — built in as standard

Protocol and connection: IEEE 488 (1978)

Provides full talker/listener facilities and remote control of all functions.

Subset: SH1, AH1, T5, TE0, L3, LE0, SR1, RL1, PP2, DC1, C0.

SECTION 3
THEORY OF OPERATION

3.1 General

The Model 9540 Precision Digital Thermometer is designed as a portable bench instrument, with rack option available, capable of measuring temperature in the range -200°C to +240°C (-392°F to +464°F) using a 100 Ω platinum sensing element. The sensor connects in series with a 100 Ω standard resistance. Measurement of temperature is a function of comparing the voltage across the sensor to the voltage across the standard resistance, digitizing the voltage difference, linearizing it and converting it to a numerical output.

3.2 Functional Description (Fig. 3-1)

A constant current is supplied to the sensor in series with the standard resistance. The voltage difference, which is stored on a high quality capacitor, is amplified and digitized by a 5-1/2 digit analog to digital converter. When addressed the output of the A/D converter is passed along to the microprocessor.

The variance of a platinum resistance thermometer with temperature can be accurately characterized by the equation

$$Rt/Ro = 1 + at + bt^2$$

where Ro is the ice point resistance of the sensor (i.e. at 0°C).

Rt is the resistance of the sensor at the temperature t

t is the temperature in degrees C

and

a,b are coefficients of the sensor

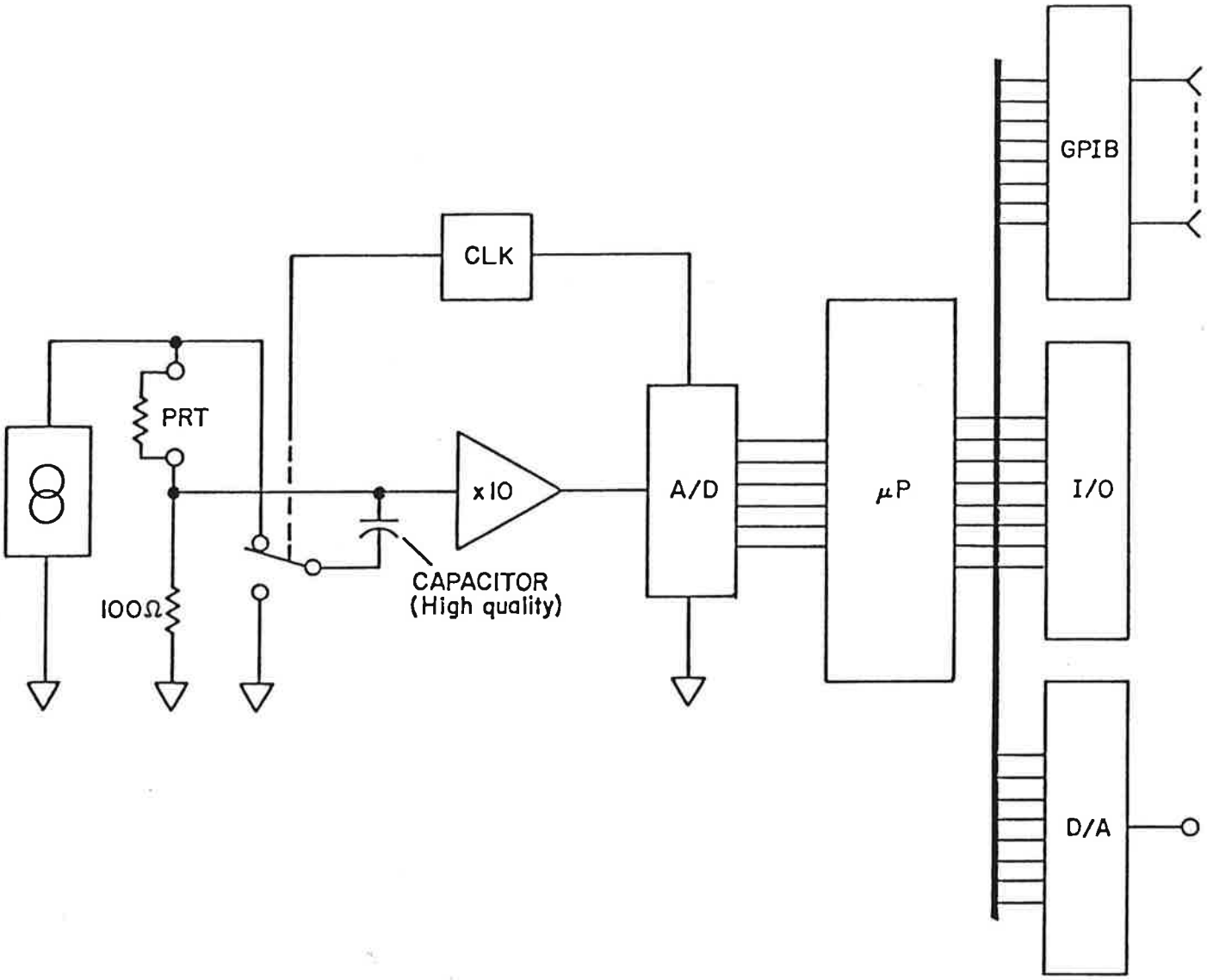


Fig. 3-1 FUNCTIONAL DESCRIPTION

The microprocessor linearizes the output curve according to these coefficients (which are built into the firmware) and the linearized output is displayed.

3.3 Circuit Description (Fig. 3.2)

3.3.1 Power Supply

The analog circuitry is driven from an isolated ±12 volt supply. The logic circuitry is driven almost exclusively from the +5 volt line with a -5 volt supply added for the A/D converter and some of the CMOS logic.

The circuit is designed such that supply voltages need not be critical. As such, conventional three terminal regulators are quite adequate in all four supplies. Zener diode protection adds to that provided by the regulators and an overvoltage crowbar circuit is added to protect the logic on the +5 volt line.

3.3.2 Front End Amplifier

The front end amplifier is basically a resistance difference to voltage converter. The circuit operates by comparing the voltage drop across the temperature sensor with a reference voltage across a stable resistance network. This technique is an adaptation of the Isolating Potential Comparator concept developed by T.M. Dauphinee at the National Research Council of Canada.

The constant current through the sensor is set to 2 mA, as determined by the resistive network at the input to the front end amplifier. This amplifier (A2) is a low noise, low offset voltage and low drift operational amplifier. By incorporating the sensor and reference resistance into the feedback path of this amplifier, the identical current is utilized in the input resistor as well as the sensor and reference resistors.

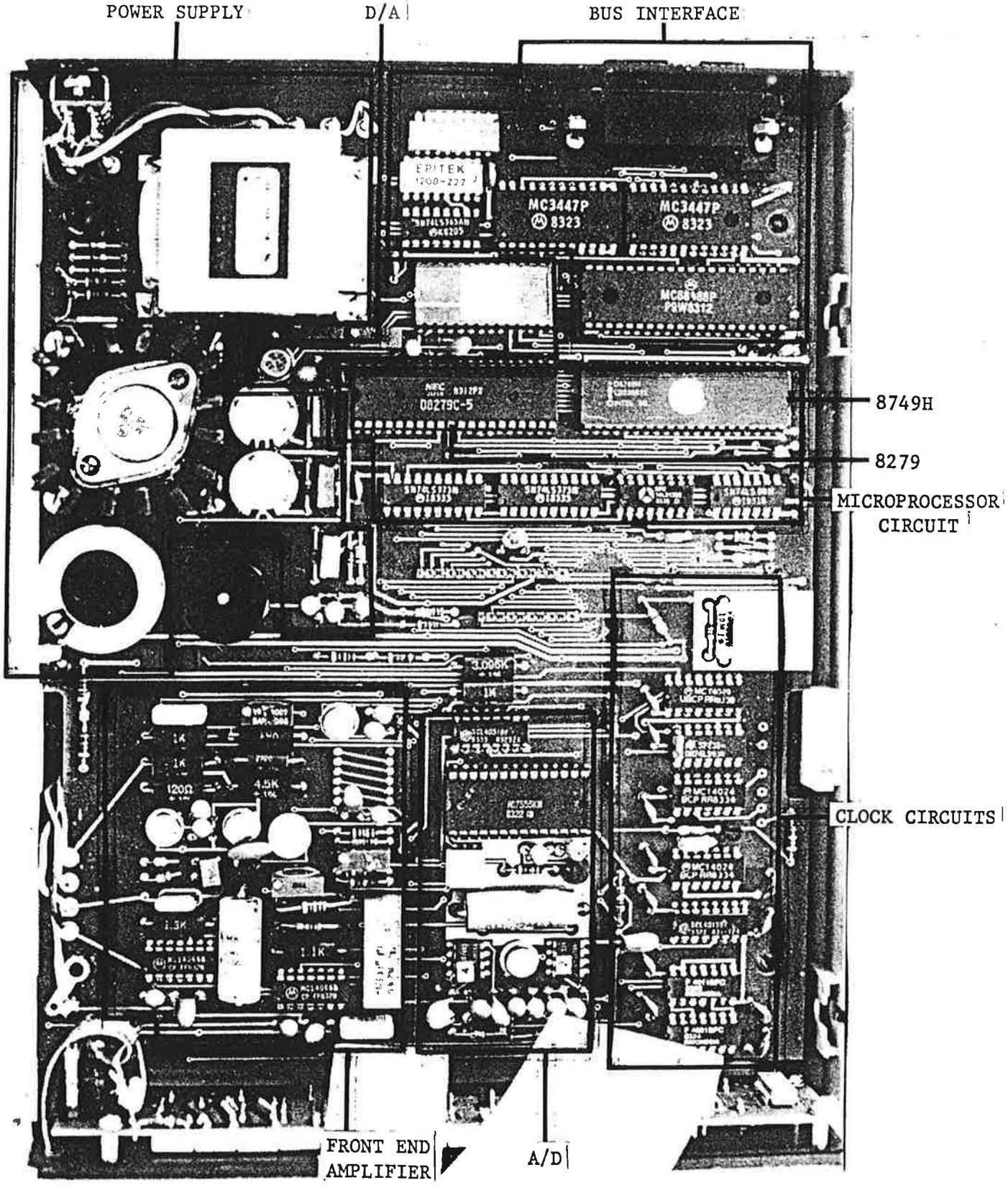


Fig. 3-2 FUNCTIONAL LAYOUT

During the calibration procedure the reference resistance is set to the ice point resistance of the sensor. Accuracy is achieved using a parallel resistance/potentiometer network which includes a stable potentiometer adjustable over ±0.25% of the span of the nominal 100 Ω sensor (Fig. 3.3).

The isolating potential comparator circuit employs a low loss, low leakage capacitor (C49) to compare the voltages. The capacitor is initially switched across the reference resistance, during which time the amplifier, implemented in a non-inverting mode, is tied to the virtual earth point at the summing junction of the current source amplifier. In the first cycle, the capacitor is charged to the voltage across the reference and in the next cycle the capacitor is put in series opposition between the sensor and the input to the charge amplifier, effectively subtracting the sensor potential. The voltage thus presented to the gain stage amplifier (A7) is the difference between the voltage across the sensor and the voltage across the reference.

The FET switches controlling this "flying capacitor" arrangement are driven from a four phase clock generator set up in a break-before-make fashion such that there is a period of no overlap between the opening of one switch and the closing of the next. During this period of no overlap, the amplifier input is held up with a 4700 pF capacitor (C46).

Utilizing the AC chopper mode in the isolating potential comparator circuit eliminates the problem of dc offsets in the front end. A true differential comparison is made with no error due to common mode voltages. The gain of the overall front end is approximately 10.

The chopped signal from the gain stage amplifier is coupled via a nonpolarized 6.8 μF capacitor to two further FET switches. These are controlled by the clock in order to sample the signal in the middle of each half cycle. During one half cycle the free end of the capacitor is switched to ground by switch U23.

When the circuit reverses in the second half of the cycle the free end is switched to the output filter (C48, R22) which stores the peak value of the ac signal, from the gain stage amplifier, as an effective dc level. It is this voltage that the analog to digital converter measures.

3.3.3 Clock Circuits

The oscillator which provides the clock source for the entire instrument is based on a 4.0960 MHz crystal. The microprocessor is clocked directly from the oscillator output while the A/D converter is driven from a 1.0240 MHz signal derived from this. The four phase clock (ref Fig. 4-2) controlling the chopper circuitry in the front end amplifier is generated by the divider logic (U15-19).

The frequency of the chopper is brought down to 500 Hz by two 4024 chips (U17,18) and offset to varying degrees by reclocking this with a synchronous 64 kHz signal using a shift register (U19). Clocks 2 and 3 control the flying capacitor while clocks 1 and 4 dechop the output of the gain stage amplifier and load up the output filter (ref. Fig. 3-4).

3.3.4 Analog to Digital Conversion

The analog to digital converter (U9) is a 5-1/2 digit, 200000 count device linear to five of the least significant bits. The conversion time, which determines the cycle time between readings at the display, is 1.2 seconds,±0.2 seconds.

As is customary in high performance quantization circuitry, the analog and digital grounds have been kept separate except at a single point. Throughout the front end amplifier section the analog ground is set up as a star ground (i.e. returning to a single point) to keep ground noise problems to a minimum. This starground is centered at the analog ground pin of the A/D converter.

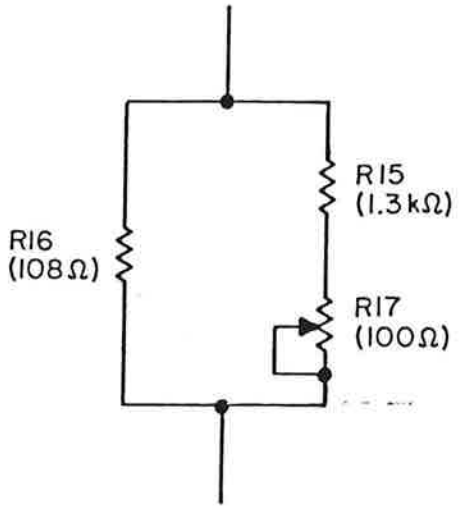


Fig. 3-3 100 Ω Reference

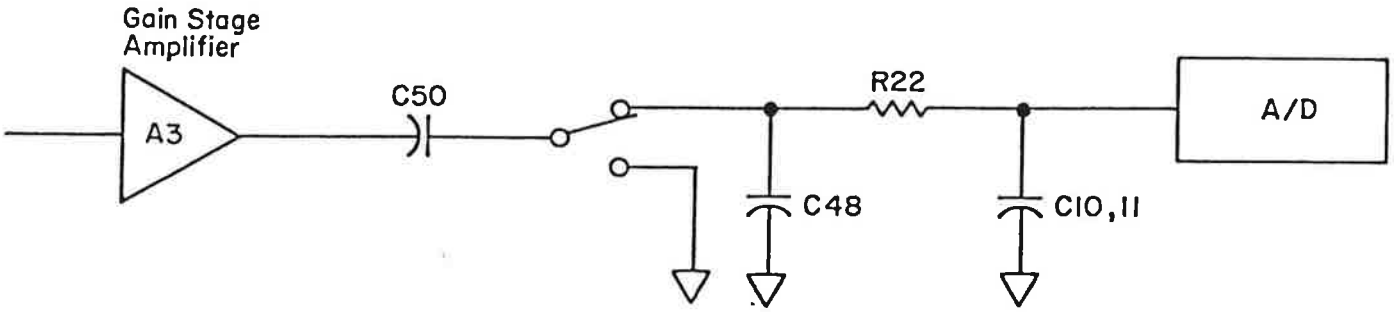


Fig. 3-4 Dechopper Output Filter

The integrating capacitor used (C60) is a teflon type having very low leakage and dielectric absorption characteristics. To further minimize noise injection, the outside foil of the capacitor is fixed to the integrating amplifier output, not the summing junction input.

3.3.5 Microprocessor Circuit

The digital output of the A/D converter is the quantized representation of the CALLENDAR-VAN DUSEN equation:

$$(W-1) = at + bt^2 + ct^3(t-100) \quad (1)$$

where $W = Rt/Ro$

Ro is the ice point resistance of the thermometer sensor
Rt is the resistance of the sensor at the temperature t
a,b,c are coefficients of the sensor.

By definition, the coefficient c is non zero only for values of temperatures less than 0°C and even then these third order effects are so small as to be well inside the stated accuracy specifications of the instrument. With that knowledge, the linearization of (1) reduces to the inversion of a quadratic:

$$t = \frac{\sqrt{A^2-4B(1-W)} - A}{2B}$$

This linearization is performed using the microprocessor, an INTEL 8749H (U1) single chip device.

Except for the input from the A/D converter, which has its own input port, all of the I/O devices are memory mapped. A decoder (U25) routes the control signals necessary to enable the requisite devices.

Control of the A/D converter is initiated by software. P14 of the 8749H micropcessor sets DMC (display multiplier clock) high. The micro then checks DAV (data valid) to see if a new A/D conversion is ready to be transferred. If DAV is not set, indicating that a new conversion has not been completed, the micro scans through its mainline program polling the instrumentation bus and keyboard.

If DAV is set high, indicating that a new conversion is complete, the micro again toggles DMC and the A/D input data is transferred into data memory.

A 10 μF capacitor (C56) on the reset pin of the 8749H ensures that the reset pin remains low while Vcc is brought high upon power up. This permits the external logic to stabilize before the microprocessor assumes control.

3.3.6 Front Panel Interface

The front panel interface is handled by an INTEL 8279 general purpose keyboard interface (U2) which reads the keyboard and writes to the display. It provides an automatic refresh to the display since this is only called up once in every cycle of the A/D converter, approximately every 1.2 s. An octal latch (U13) is used in the drive circuit of the front panel pushbutton indicator LEDS.

3.3.7 Bus Interface

The interface to the instrumentation bus is carried out by a Motorola MC68488 General Purpose Interface Bus (GPIB) chip (U3). In tandem with the bus transceivers (U4, U5), the GPIB chip performs the basic talker/listener functions via the back panel adapter. This connector conforms to the IEEE-488 1978 standard.

When initialized the GPIB chip addresses an 8 bit tri-state buffer (U11) as an internal register in order to put the GPIB address, selected on the back panel switches, onto the data bus.

3.3.8 Digital to Analog Conversion

The use of a twelve bit digital to analog converter rather than merely tailoring the analog signal from the front end permits additional flexibility in the output range capability of the instrument. Full scale output, which is ±10 volts, is selectable from the front panel for a full scale output of either ±200° or ±2°. The resolution thereby becomes 5.0 V/100 deg. or 5.0 V/1 deg. on the X100 sensitivity range.

SECTION 4
SHOP MAINTENANCE

4.1 Introduction

This section covers performance verification, calibration and troubleshooting of the Model 9540. Performance verification requires external standards which are more accurate than the Model 9540. Calibration covers adjustments which also require external standards more accurate than the Model 9540.

This section also covers the list of necessary equipment which is required for performance verification, calibration and troubleshooting.

4.2 Necessary Equipment

The list of necessary equipment is broken down under two headings, calibration, performance verification and troubleshooting.

4.2.1 Calibration, Performance Verification

Guildline Model 9975
Primary Standard PRT
High Temperature Fluid Bath
Triple Point Cell or Ice Bath (Guildline Engineering Bulletin No. 14).
PRT Copper Holding Block

4.2.2 Troubleshooting

DVM 0.01% accuracy
Oscilloscope 1 mV resolution
Frequency Counter 1/2 Hz to 10MHz range
Variable 0 to 15 Vdc power supply (current limited to 0.5 A).

4.3 Performance Verification

4.3.1 Introduction

The following tests are designed to verify the overall operation of the Model 9540 Precision Digital Thermometer. These checks are useful as a verification of the specifications, in preventive maintenance or as an aid in troubleshooting. Should the instrument fail these performance verification checks, calibration or corrective maintenance will be required.

Performance verification checks are performed at the Power Up level and accuracy checks at 0°C. For temperatures other than 0°C it is recommended that the set up as shown in Fig 4-1 be used where applicable.

4.3.2 Performance Verification Power Up

The Model 9540 has a hidden key located between the REMOTE key and the RECCAL key. When depressed it allows the user to verify the power supply voltages directly on the front panel display. This state of self check is only accessable during POWER UP when 8's are being scrolled across the display.

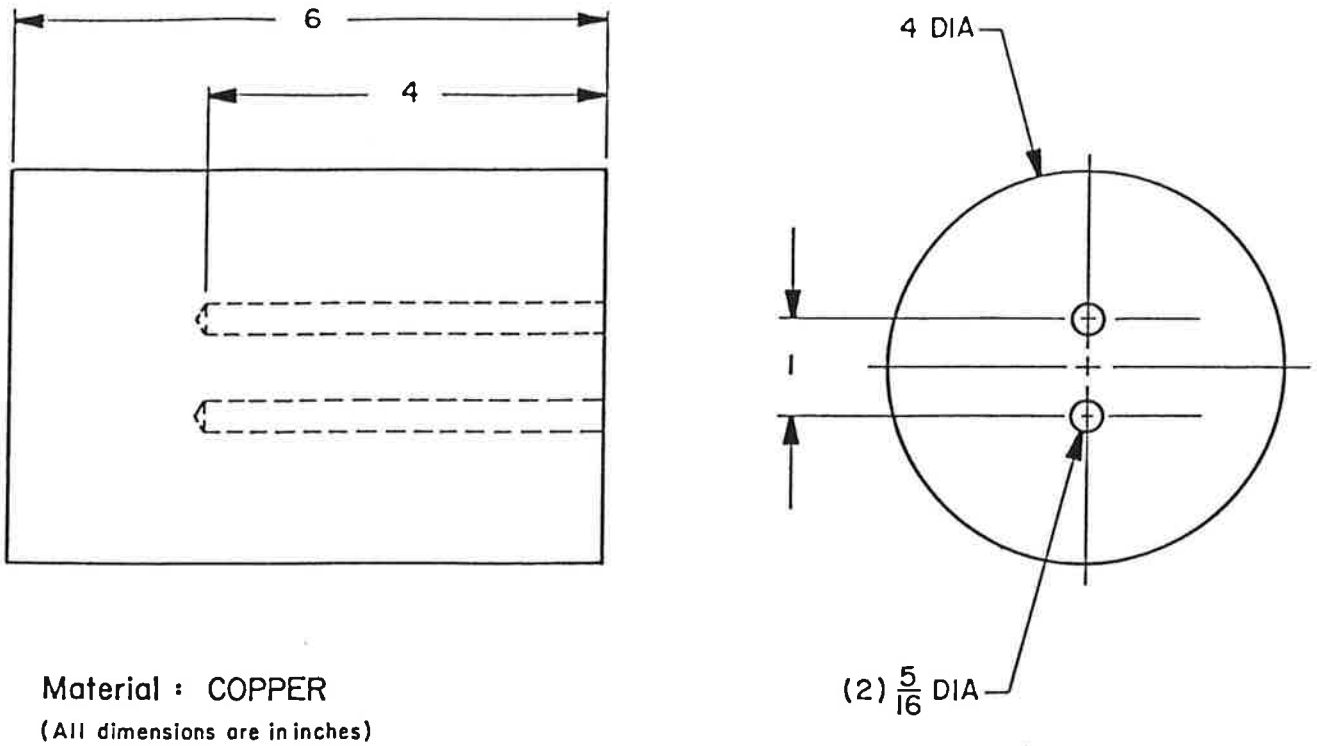
1) Depress the power to OFF.

2) Depress the power to ON.

3) Depress the hidden SELF CHECK key ensuring that it is only depressed once.

4) Observe that the display finishes scrolling 8's across the display, then displays 488 and the GPIB address switch setting.

5) Next observe that the display indicates a negative reading.
NOTE: This reading is only negative for positive temperatures.



Material : COPPER

(All dimensions are in inches)

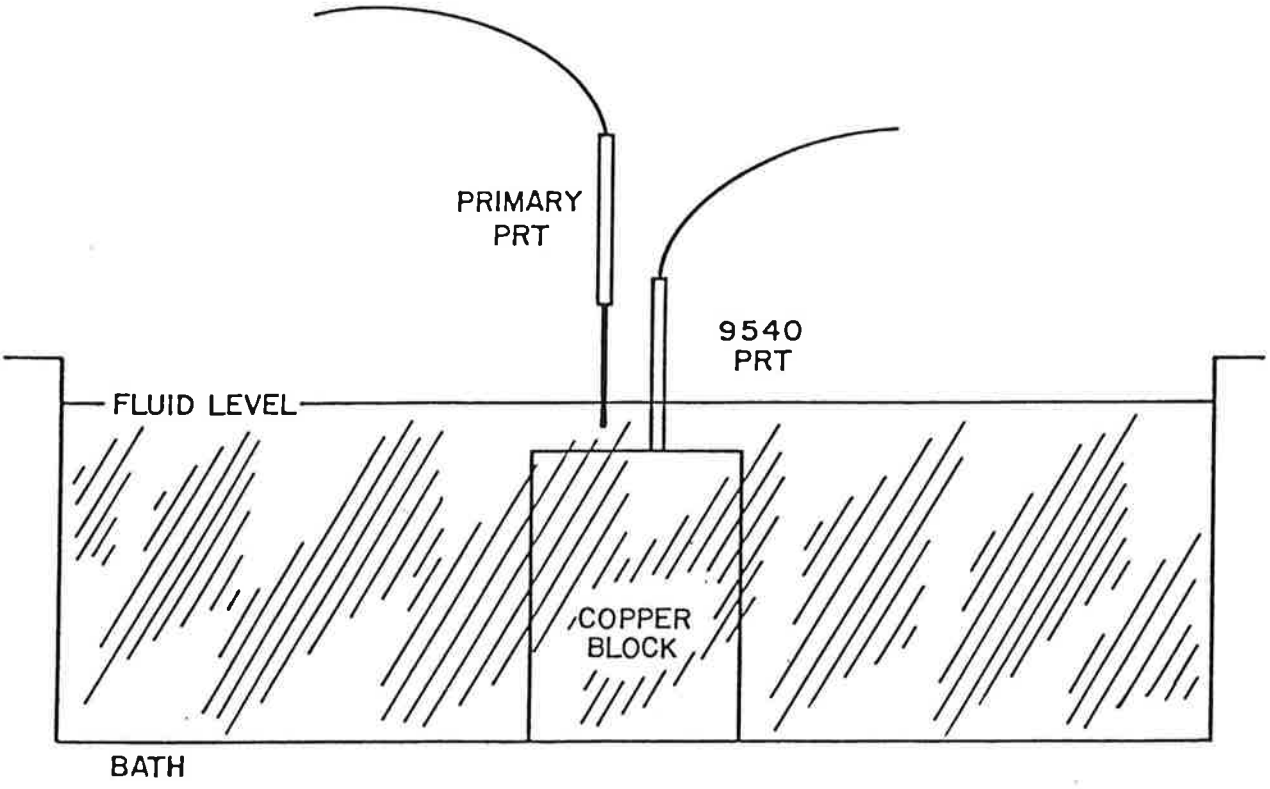


Fig. 4-1 PRT Copper Holding Block

4.3.3 Performance Verification Power Supplies

This procedure is manually incremented thru by depressing any one of the front panel keys and observing the readings in between key depressals. The routine starts by checking the supplies as shown below. Note that all readings are referenced in terms of percentage.

1) Depress any one of the front panel keys.

2) +5 V Check
   Observe that the display indicates +100 ±5%.

3) Repeat step 1

4) -5 V Check
   Observe that the display indicates -100 ±5%.

5) Repeat step 1.

6) +12 V Check
   Observe that the display indicates +100 ±5%.

7) Repeat step 1

8) -12 V Check
   Observe that the display indicates -100 ±5%.

9) Repeat step 1

10) Vref Check
    Observe that the display indicates +100 ±.005%

11) Repeat step 1.

12) Observe that the display indicates a temperature reading indicating the degree sign and a C.

13) This routine is now complete. Should the instrument fail any of the above performance checks then corrective maintenance and calibration will be required.

4.3.4 Performance Verification Ice Point

The most desirable ice point accuracy can be established with the triple point cell for water. If a triple point cell is not available then an ice bath as described in Engineering Bulletin No. 14 will suffice.

4.3.4.1 Procedure

During the course of testing allow from 20 to 30 seconds stabilization of instrument readings following power up or placement of probe in respective baths.

1) Prepare an ice bath as described in Engineering Bulletin No. 14.

2) Verify by means of the Model 9975 and primary PRT that actual temperature of ice point reference is 0°C ±1 mK.

3) Clean Model 9540 PRT prior to insertion using mild detergent wash, two tap water rinses and one distilled water rinse.

4) Immerse probe in center of ice bath.

5) Note instrument reading and check that it is within limits (90 day spec).

6) Should the instrument fail the above test then calibration will be required.

4.3.5 Performance Verification 164°C Point

CAUTION: CARE MUST BE EXERCISED AT THE FOLLOWING EXTREME TEMPERATURES TO AVOID PERSONAL INJURY.

The use of the fluid bath preheated to 164°C ±1°C is required here. The temperature of the bath should be monitored with the Model 9975 and primary PRT.

4.3.5.1 Procedure

1) Immerse Model 9540 PRT into copper block (see dwg. 4-1).

2) Note instrument reading and check that it is within the specified limits (90 days).

4.4 Calibration Procedure

4.4.1 Introduction

Although factory adjusted to meet the guaranteed performance specifications, the instrument may require adjustment of calibration settings occasionally. There are two possible reasons to justify recalibration. One is electronic drift, the other is a need to optimize instrument performance.

The recalibration procedure is a modified version of the performance verification (section 4.3.4 and 4.3.5) procedures. It is only necessary to calibrate the instrument at two settings, 0°C and +164°C.

4.4.2 Disassembly

1) Ensure that the instrument line chord is disconnected.

2) Remove handle.

3) Remove 4 screws from bottom of unit.

4) Remove top cover.

5) Disassembly is complete. Replace line chord and turn power ON.

4.4.3 Calibration Ice Point

Procedure

1) Refer to section 4.3.4.1 Performance Verification Ice Point, and incorporate the following.

2) Step 5
Note instrument reading and check that it is within the specified limits ±2 mK. If not adjust R17 such that the display indicates 0 ±2 mK.

3) Ice point calibration is now complete.

4.4.4 Calibration 164°C

Procedure

1) Refer to section 4.3.5.1 Performance Verification 164°C point, and incorporate the following.

2) Step 2.

Note instrument reading and check that it is within the specified limits ±10 mK. If not adjust R20 such that the display indicates the calculated temperature as per Model 9975 and primary PRT ±10 mK.

3) The unit is now calibrated.

4.4.5 Reassembly

1) Ensure that the instrument line cord is disconnected.

2) Replace top cover.

3) Turn instrument over (top cover down) and install 4 screws and washers.

4) Replace handle and line cord.

5) Assembly is now complete.

4.5 Troubleshooting

4.5.1 Introduction

The following information is provided to help localize faults to within sub-assemblies or discrete components. To do any troubleshooting at this level the unit requires disassembly so as to access one or more of the PCB's (2 PCB's only). Disassembly and reassembly are covered in sections 4.4.2 and 4.4.5 respectively. Before disassembling the unit perform the Performance Verification, sections 4.3.2 and 4.3.3 to help isolate the problem.

4.5.2 Power Up

If the unit shows no reaction to being plugged into the wall socket and turned on, then

1) check the fuse (0.2 Amp)
2) Ensure that the line chord is inserted properly and that the front panel power switch is depressed. If the unit comes up with isolated segments lighting up weakly, then check the line voltage selector switch on the rear of the instrument.

4.5.3 Power Supply Check

With the top lid removed and the instrument turned on, connect an oscilloscope and dvm to the following test points and observe the following voltages.

TP	VDC	TOL	VAC	NOTE
TP1	+12	±1	500 mV	
TP2	+23	±2	250 mV	
TP3	-23	±2	250 mV	
TP4	+12	±.5	2 mV	
TP5	-12	±.5	2 mV	adjust R3
TP6	+4.096	±0.009	2 mV	
TP7	-5	±.5	5 mV	
TP8	+5	±.5	5 mV	

Note: All tolerances are with respect to 120 Vac ±3 V line supply.

4.5.4 Clock Circuits

These checks are necessary should the following conditions occur.

1) Should the display come up with all 6 digits reading zero upon power up and stay that way.

2) Should the displayed temperature be well out of tolerance.

Connect a Frequency Counter or Oscilloscope to the following points and observe the following waveforms.

TP9	4.0960 MHz
U9 Pin 12	1.024 MHz (with blanks)
U2 Pin 3	1.024 MHz
U1 Pin 2	4.096 MHz

Using the oscilloscope verify the following waveforms of CLK 1, CLK 2, CLK 3, CLK 4 (See Figure 4-2).

4.5.5 Front End

If neither R17 or R20 have enough range to allow the settings at 0 °C or +164°C respectively then it is probable that the fault lies in the front end or the A/D section. The following procedure should be carried out.

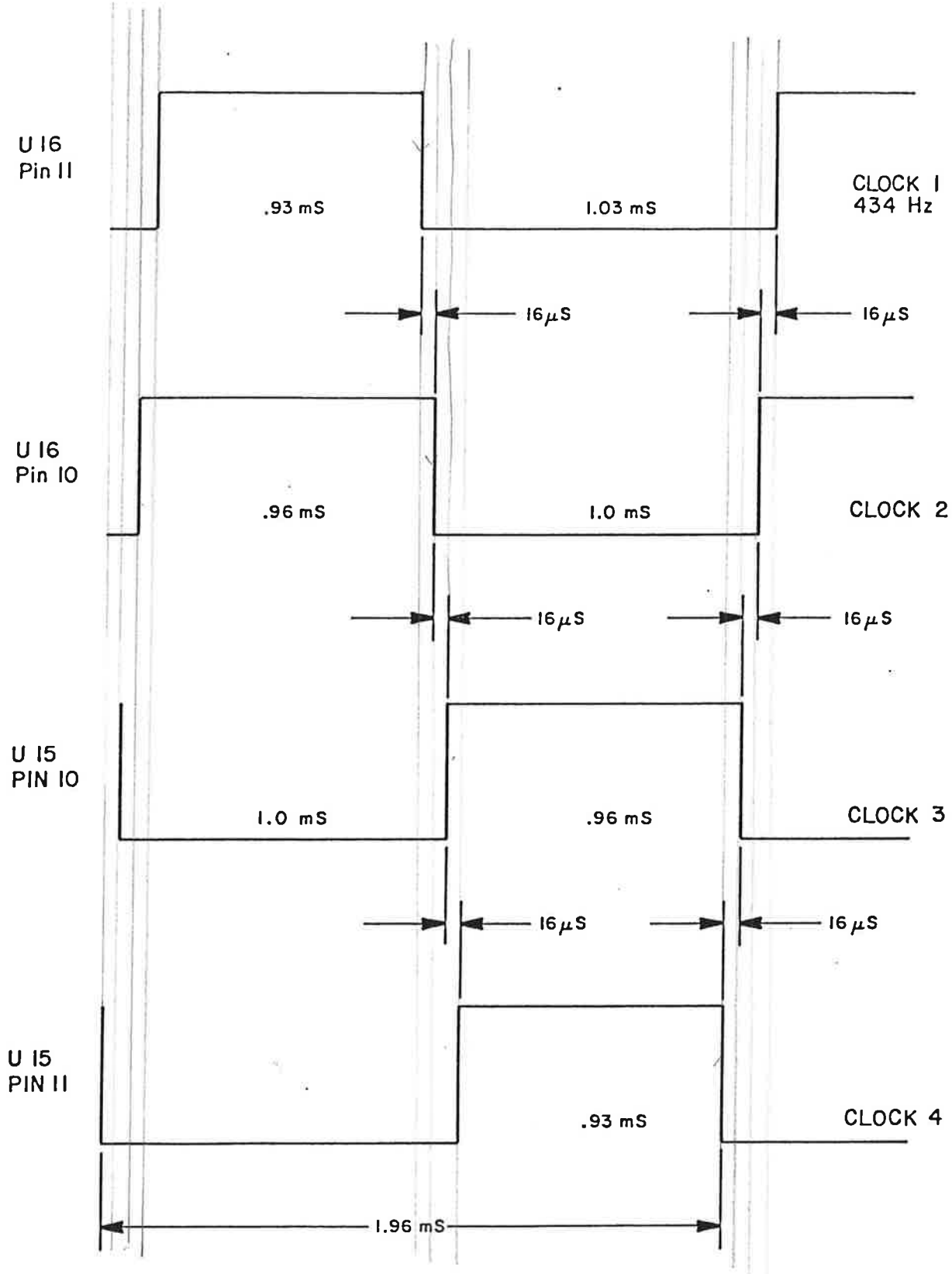


Fig. 4-2 CLK 1, CLK 2, CLK 3, CLK 4.
AMPLITUDE ±5 V

Perform section 4.3.2 Performance Verification Power Up and add the following.

6) Depress the OP/CAL switch (SW4) on PCB 18108 to C2.

7) Observe that the display indicates a positive reading in the range 4.800.

8) Adjust R27 such that the display indicates 4.800 ±5 LSD.

9) If this cannot be done the problem lies in the A/D section.

10) Depress the OP/CAL switch to C1.

11) Place the Model 9540 PRT in an ice bath.

12) Observe that the display indicates 0.000 ±10 last digits.

13) If a steady overrange condition exists then it is quite likely that the probe is open circuit.

14) If not, the problem lies in the front end. Check the following:-

The PRT
A1, A2, U22, U23.

4.5.6 Front Panel

The front panel is easy to troubleshoot as the microprocessor starts by scrolling 8's across the display and lighting up all 8 switch indicators. After the display test routine the front panel displays 488 and the address of the GPIB address switch.

While the display indicates 488 and the address, the 8 switch indicating LED's are set to the following.

FILTER	OFF
SAMPLE	OFF
CONTINUOUS	ON
REMOTE	OFF
RECCAL	ON
C/F	ON
REC O/P	OFF
REC GAIN	OFF

The display is then updated to display temperature.

If, upon Power Up, the display comes on showing all 0's and remains there then the problem is with either the U2, U201, or U202. Verify that the connector J1 is positioned properly.

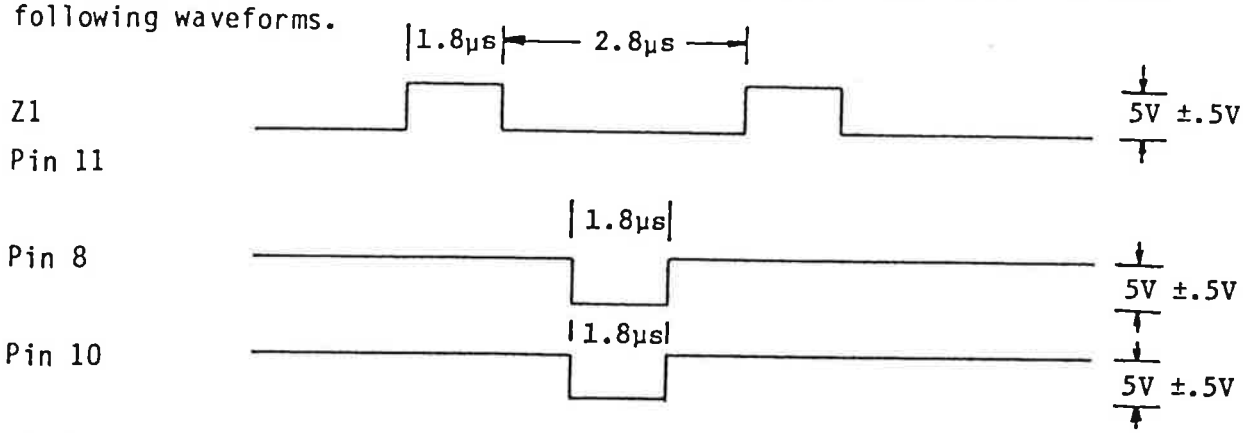
If the switch indicator LED's do not initialize as stated above, then check U13 or the individual LED's.

4.5.7 Microprocessor

If none of the displays change and all of the switch indicator LED's remain on, then the fault lies in the microprocessor.

Check to see if the microprocssor is actually running.

Connect an oscilloscope to the following points and observe the following waveforms.



If the above waveforms are correct, then it is probable that the fault lies in the EPROM software.

4.5.8 GPIB

Set the GPIB address switch on the rear of the instrument to address 8. Ensure that the talk/listen switch, located on the rear panel, is in the talk/listen mode. Depress the Power switch OFF and then ON again. Observe that the 8's are scrolled across the display and then 488 and 08. If 08 does not appear the fault lies in either the 68488 (U3) or the 74LS365 (U11).

If 08 does appear then do the following:-

1) Send the universal command DCL, device clear. The thermometer should cycle thru its power up routine.

2) If not, check U3, U4, U5.

3) Next send an addressed command such as SDC which is selected device clear. This time the thermometer will only respond if the address on the back panel switches matches the device address sent by the controller.

4) If not, replace U3, U4, U5.

4.5.9 D/A

Troubleshooting the D/A is best done with the unit set to RECCAL. The Rec O/P terminals should correspond as follows:-

RECCAL	REC O/P TERMINALS	NOTES
Power ON	0 V out	
Depress once	0 V out	set point
Depress once	-10 V out	adjust R34
Depress once	+10 V out	adjust R35
Depress once	0 V out	

If the above conditions are not met, then replace U8 or A4.

REV D ECN No 1923

Appr [illegible] Date 83.12.20

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18122.01.02 Sht 1 of 1

Title GENERAL ASSEMBLY

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	1	18115.01.02	Display PCB			
S	1	18108.01.02	Main PCB Test & Calibration			Guildline
S	1	18123.01.01	Front Panel Assembly			Guildline
S	1	18124.01.01	Back Panel Assembly			
S	1	18125.01.01 F	Case Assembly			
S	1	330-00098	PRT			
S	2	099-04005	Fuse		17939-4150-1/4-7-3-96-139AW-K-D1/8-3	YSI
A	3 ft	996-00188	Coax Wire	F1	GMA-2/10	Buss
F	2"	990-28003	#28 Red Hook-up Wire		RG188AU	
F	2"	990-28004	#28 Green Hook-up Wire			
F	2"	990-28002	#28 Black Hook-up Wire			
S	1	250-04030	Line Cord			
S	1	18114.01.19	Serial No Label		86537000	Panel Comp
F	4	812-03864	Bolts			
F	4	841-01328	Lockwasher, Split		4-40 x 1/4"	
S	1	18129.01.19A	Power Receptacle Label		#4	
S	1	18126.01.12	I.C. Modified for 9540			
S	1	200-30231	I.C. Digital	U1	8749H	Intel
S	1	200-30600	I.C. Digital	U2	P8279-5	NEC
S	1	200-25710	I.C. Digital	U3	MC68488P	Motorola
S	1	200-10160	I.C. Digital	U8	AD567JD	Analog
S	2sets	18119.01.19A	Decals	U9	AD7555KN	Analog
S	4	018-02200	Feet			
S	1	225-02090	Shorting Bar		420310260	Solartron
F	4	812-04700	Screw		1863	H.H. Smith
F	4	839-06628	Washer		409601720	Solartron
					411129020	Solartron

REV H ECN No 1934

Appr [illegible] Date 84.02.07

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18108.01.02 Sht 1 of 3

Title MAIN PCB

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	1	18108.01.07 D	Printed Circuit Board			
S	2	200-30165	IC Digital	U4,U5	MC3447P	
S	2	200-25851	IC Digital	U10,U13	74HC373N	
S	1	200-25801	IC Digital	U11	74HC365N	
S	1	200-25362	IC Digital	U14	74HC00N	
S	1	200-25086	IC Digital	U16	CD4001BCN	National
S	2	200-25197	IC Digital	U17,U18	74HC4024N	
S	1	200-25152	IC Digital	U19	CD4015BCN	National
S	1	200-25596	IC Digital	U20	7493	
S	1	200-25261	IC Digital	U21	74HC4049N	
S	2	200-25316	IC Digital	U22,U23	CD4066BCN	National
S	1	200-43200	Crystal 4.096 MHz 50 Hz	Y1	MM-18N	Monitor Prod
S	1	200-25293	IC Digital	U24	CD4051BC	National
S	1	059-87025	Connector	J2	22032101	Molex
S	1	059-87030	Connector	J1	22032151	Molex
S	3	200-40165	IC Linear	A1,A3,A4	OP07CJ	PMI
S	2	200-40268	IC Linear	A5,A6	LM301AN	National
S	1	200-65133	IC Linear	VR1	LM309K	National
S	1	200-65155	IC Linear	VR2	LM320T-5	National
S	1	200-65210	IC Linear	VR3	LM340T-12	National
S	1	200-65160	IC Linear	VR4	LM320T-12	National
S	1	075-33100	IC Linear	VR5	S2008LS3	Teccor
S	1	200-45495	IC Linear	VR6	LM399AH	National
S	1	075-03179	Diode	CR1	MDA108A	Motorola
S	8	075-28186	Diode	CR2-CR9	1N4003	
S	2	075-61300	Diode	VR11,VR10	1N4735A	
S	2	075-61305	Diode	VR12,VR13	1N4744A	
S	1	075-61034	Diode	VR16	1N750A	
S	2	075-46142	Diode	CR16,CR17	1N459	
S	2	200-40176	IC Linear	A2,A7	OP07EJ	PMI

REV H Ec.. No 1934

Appr Date 83.02.06

BILL OF MATE..ALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18108.01.02 Sht 2 of 3

Title MAIN PCB

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	1	801-80400	Transistor	Q2	2N4402	
S	2	801-75500	Transistor	Q1,Q3	2N3903	
S	3	300-03030	Variable Resistor	R20,34,35	RV205-208-100	
S	1	300-03050	Variable Resistor	R27	RV205-208-500	
S	1	300-20050	Variable Resistor	R17	RV1240W-100	Vishay
S	1	799-11076	Resistor	R33	1208-222J	Epitek
S	1	158-01160	Heatsink		680-1.25 A	IRC
S	1	150-09072	Hardware Mounting Kit		4725	Keystone
S	1	782-01335	Resistor	R1	8E16D 4.5 kΩ	G.R.
S	1	782-01540	Resistor	R2	8E16D 16.5 kΩ	G.R.
S	1	781-00122	Resistor	R19	8E16D 20 Ω	G.R.
S	3	782-01173	Resistor	R5,R6,R45	8E16D 1 kΩ	G.R.
S	1	782-00250	Resistor	R7	8E16D 120 Ω	G.R.
S	1	781-01085	Resistor	R44	8E16A 3096 Ω	G.R.
S	1	782-01227	Resistor	R15	8E16D 1.3 kΩ	G.R.
S	1	702-00108	Resistor	R16	HP202C/108 Ω 0.1%	Vishay
S	1	782-01184	Resistor	R18	8E16D 1.1 kΩ	G.R.
S	1	782-01460	Resistor	R21	8E16D 9661.7 Ω	G.R.
F	1	707-00370	Resistor	R22	RL07S331J	
F	1	707-00447	Resistor	R23	RL07S102J	
F	2	707-00304	Resistor	R24,R37	RL07S101J	
F	1	707-00711	Resistor	R25	RL07S333J	
F	1	760-00760	Resistor	R26	RN60D2002F	
F	3	707-00612	Resistor	R28,R29,R39	RL07S103J	
F	1	760-01350	Resistor	R30	RN60D7503F	
F	1	765-03500	Resistor	R31	RN65D1005F	
F	1	707-00557	Resistor	R32	RL07S472J	
F	2	707-00623	Resistor	R49,R50	RL07S123J	
F	2	707-00656	Resistor	R42,R47	RL07S223J	
F	2	707-00480	Resistor	R41,R46	RL07S202J	
S	1	038-54000	Capacitor	C1	LP472S025E1P3	Emhart
S	2	038-74000	Capacitor	C2,C3	035-90031	Philips
S	28	041-01269	Capacitor	C4-21,C30,C51-56	TAG10/35	ITT
				C58,43,44		
S	21	049-10125	Capacitor	C22-29,C31-42,45	UK25-103	Centralab

REV H ECN No 1934

Appr Date 84.02.06

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18108.01.02 Sht 3 of 3

Title MAIN PCB

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	2	037-01011	Capacitor	C47,48	C344CHA100k	Phillips
S	1	046-01391	Capacitor	C49	B32120-E9475M	Siemens
S	1	043-00450	Capacitor	C60	D11B224KXW	Comp Research
F	2	049-00315	Capacitor	C61,62	DD300	Centralab
S	1	037-22310	Capacitor	C50	MKC1862-56806	ERO
S	1	530-00043	Transformer	T1	DMPC-Y-12	Signal
S	1	012-00024	Transformer Bracket		24-BR	Signal
S	1	430-11075	Switch	S3	76PSB08S	Grayhill
S	1	059-49180	Connector	P4	552791-1	AMP
S	1	152-43056	Panel Mount Kit		552633-4	AMP
S	1	430-11058	Switch	S4	76SD01	Grayhill
F	3	707-00520	Resistor	R48,R51,R36	RL07S302J	
S	1	086-30800	Audio Indicator	DS1	A1-254	Projects Unltd
S	2	410-01028	Socket		703-4228-01-04-10	Cambion
S	3	410-01040	Socket		703-4240-01-04-10	Cambion
F	11	604-06131	Pins	WT1-WT11	1558-02.01	Cambion
S	5	150-08052	Spacers		TO5-8L	Jermyn
S	1	200-25678	IC Digital	U25	74HC138	
F	1	049-10010	Capacitor	C57	DD102	Centralab
F	3	707-00810	Resistor	R38,40,43	RL07S104J	
S	1	200-25108	IC Digital	U15	CD4011BCN	National
S	1	782-01462	Resistor	R4	8E16D 10 kΩ	G.R.
S	1	150-01045	Pillar		CBS-12N	Richco
S	1	043-00850	Capacitor	C46	SXK247	Mallory
S	1	300-03070	Variable Resistor	R3	RV205-208-2K	

REV C ECN No 1601

Appr [illegible] Date 84.01.31

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18115.01.02 Sht 1 of 1

Title DISPLAY PCB

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	1	18115.01.07	Printed Circuit Board Rev A			
S	1	200-25512	IC Digital	U202	DM74LS47N	National
S	1	799-11011	Resistor	R201	1407-151G	Epitek
S	9	080-78000	Display	CR209....217	MAN4610A	Fairchild
S	8	075-25101	Diode, LED	CR201...208	HP-5082-4790	H.P.
S	1	059-00158	Connector	P2	FP10AC7	Ansley
S	1	059-00188	Connector	P1	FP15AC7	Ansley
S	9	801-80400	Transistors	Q201...209	2N4402	
S	2	200-25678	IC Digital	U201, U203	74HC138	
F	1	707-00337	Resistor	R203	RL07S221J	
S	1	752-00231	Resistor	R202	CR52 TOL5 10	Philips
S	1	152-12050	Connector	J3	22-03-2081	Molex

REV F ECO 1923

Appr Date 84.06.18

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18125.01.01 Sheet 1 of 1

Title CASE ASSEMBLY

Model Number STOCK

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
M	1	020-15142	Chassis (18111.01.12B)			
F	2	150-05200	Cable Tie Mount		1444-15	Hammond
B	1	18125.01.13	Case Assembly - Fabricated Parts		ABMS-A	Panduit
M	1	020-15000	Case Top, Metalized(18110.01.12B,18128.01.12D)			
M	1	020-15148	Case Bottom Metalized(18110.01.12B,18128.01.12D)		71502026A	Solartron
F	1	114-02156	Grommet		71502025B	Solartron
F	4	870-02216	Pop Rivet, medium, open end, domed head, Alum		2156	Ont. Rubber
F	A/R	925-44373	RTV (clear)		4063F06	Supplies Cda
F	2	150-05024	Cable Tie			
M	1	121-63650	Handle (18128.01.12D)		PLT 1.51-M	
					71502003B	Solartron

REV B EC. No 1893

Appr [illegible] Date 84.01.05

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18127.01.01 Sht 1 of 1

Title **Rack Adaptor**

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
M	1	021-30250	Rack Adaptor (18135.01.12B)		71501	Solartron
A	1	18127.01.23	Installation Instructions			

REV C ECN No 1601

Appr [illegible] Date 83.12.12

BILL OF MATERIALS
GUILDLINE INSTRUMENTS LTD

Bill No. 18123.01.01 Sht 1 of 1

Title FRONT PANEL ASSEMBLY

Model Number STOCK

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	2	280-05200	Pins		.3" x 1/16" spring	H&W Perrin
S	1	280-05240	Ball Plunger		W19	Reid
S	1	18116.01.10	Front Panel			Duralith
S	1	18117.01.10	Door			Duralith
S	1	430-10650	Switch		1XD10FSCWHT2UEEL	Schadow
S	1	154-05150	Switch Mount		0003-00	Schadow
S	2	150-02023	Spacer		1107-4-A-0	RAF
F	2	812-03864	Bolts		4-40 x 1/4"	
F	A/R	-	Locktite			
F	A/R	925-31057	5 Minute Epoxy			
S	1	18130.01.19A	Impact Warning Label			
F	1	814-73832	Set Screw		6-32 x 3/8, st. Cone pt.	
S	1	154-05550	Switch Cap		7637-2	C & K

REV E ECN No 1922

Appr [signature] Date 84.10.16

BILL OF MATERIALS

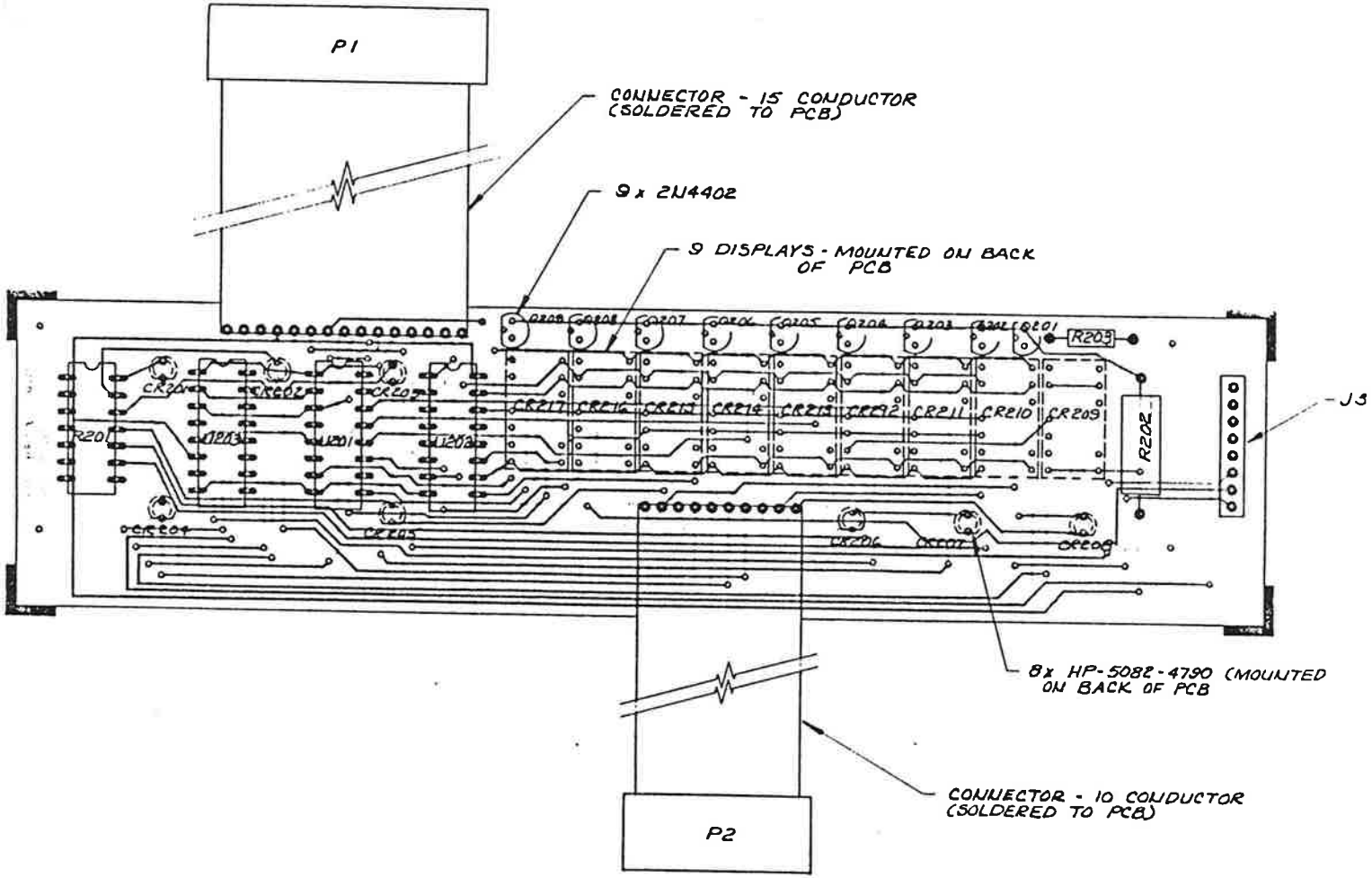
GUILDLINE INSTRUMENTS LTD.

Bill No. 18124.01.01 Sht 1 of 1

Title BACK PANEL ASSEMBLY

Model Number 9540

Code	Qty	Stock Number	Description	Cct Reference	Mfr Part Number	Mfr
S	1	340-04200	Receptacle		42R31-1-1-1-1	Power Dynamics
S	1	430-12012	Switch	S2	46256LFR	Switchcraft
S	2	225-04904	Terminal		108-0904-001	Johnson
S	1	225-04903	Terminal		108-0903-001	Johnson
S	1	18109.01.10C	Back Panel			DTI Precision
F	2	812-03864	Machine Screw		4-40x1/4" R.H.	
F	4	825-38143	Nut		4-40	
F	2	812-03947	Machine Screw		4-40 x 3/8" F.H.	
F	4	841-01328	Washer		#4 split L/W	
F	1	604-03436	Solder Tag			



GUILDLINE INSTRUMENTS LTD. SMITHS FALLS ONT. CANADA		STOCK
LM	DISPLAY PCB ASSEMBLY	
84/01/31		
2:1	1st	18115 01.02 A

REV D ECN 1924

TEMP PROBE

C2 P2 P1 C1

VR6 R2 16.5kΩ R1 4.53kΩ R3 25Ω R4 10kΩ R5 1kΩ R6 1kΩ R7 120Ω R15 1.3kΩ R16 108Ω R17 100Ω R18 1kΩ R20 100Ω R21 9758Ω R22 330Ω

A1 A2 A7

C8 C9 C47 C48 C49 C50 C53 C54 C46 4700pF C51 C52 C12 C13

U22 U23

TP6

+12V -12V +5V -5V

R47 22kΩ R46 2kΩ R42 22kΩ R41 2kΩ R49 12kΩ R48 3kΩ R50 12kΩ R51 3kΩ R44 3096Ω R45 1kΩ

U24

S3 R33 220Ω C38 0.01µF U11 TALK ONLY

R38 100kΩ R40 25kΩ CR16 CR17 R37 100Ω

U1 P27 P26 P25 P13 P12 P11 P10 P14 P15 P16 P17 P24 RESET XTAL1 RD WR ALE DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0

CR9 C56 10µF

U14 TP9 DS1 Q3 2N3903 J1-14 J2-9 J2-10

S4 R32 4.7kΩ U21 Q2 2N4402

U3 ASB T/R1 T/R2 R/W IB0 IB2 IB4 IB6 DAV DAC EOI IFC IB1 IB3 IB5 IB7 SRQ RFD ATN REN

U5 DATA SIDE U4 DATA SIDE GPIB DIO1 DIO3 DIO5 DIO7 DAV NDAC EOI IFC DIO2 DIO4 DIO6 DIO8 SRQ NRFD ATN REN

U10 U2 CLK

U16 U15 U19 U18 U17 U21 U20 U9 U25

CLK 1 CLK 2 CLK 3 CLK 4

C45 C25 C27 C57 0.001µF C29 C24 C31 C32 C22 C26 C28 C23 C14 10µF C15 10µF C10 10µF C11 10µF C58 10µF C30 10µF C55 10µF C60 0.22µF C20 10µF C21 10µF C16 10µF C18 10µF C19 10µF C17 10µF C41 C40

Q1 2N3903 R25 33kΩ 10kΩ

1.024 MHz 4.096 MHz 1.024 MHz

R43 100kΩ R30 750kΩ R26 20kΩ R27 500Ω R28 10kΩ R29 10kΩ

A5 A3 A6 A4

VR1 VR10 R24 100Ω VR5 R23 1kΩ C1 4700µF C4 0.1µF

VR3 VR12 C2 1000µF C5 0.1µF

VR4 VR13 C3 1000µF C6 0.1µF

VR2 VR11 C7 0.1µF

CR4 CR2 CR3 CR1 CR5 CR6 CR7 CR8 R31 10MΩ Y1

TP1 TP2 TP3 TP4 TP5 TP7 TP8

T1 S2 S1 F1

R34 100Ω R35 100Ω U8 (ADD 000 to 007) C43 0.1µF C44 0.1µF

ANALOG OUT

FRONT PANEL

REC /CAL FILTER REC GAIN x100 REMOTE SAMPLE C/F REC O/P CONT

J3- J1-8 J1-9 J1-10

J1- J3-1 J3-2 J3-3 U1-34 U1-35 U1-33 N/U

U203 U201 U202 R202 10Ω R203 220Ω Q201 Q202 Q208 Q209 (8x) 2N4402

CR 209 CR 210 to CR 215 CR 216 CR 217

J2- FILTER SAM CONT REC O/P REC CAL REC SENS C/F REMOTE

R201 150Ω CR 208 CR 207 CR 206 CR 202 CR 204 CR 201 CR 203 CR 205

Q201

N ON L204 ONLY

GUILDLINE INSTRUMENTS LTD. SMITHS FALLS ONT CANADA		9540
L.M.	DIGITAL PLATINUM RESISTANCE THERMOMETER	
84.04.03		
NONE	1 of 1	18122-01-04 0

REV D ECN 1924

FRONT PANEL

TEMP PROBE

VREF CAL

OP-07 CJ

4.096V

0°CAL

MRL

164°C CAL

OP07EJ

MRC 1852 63V

AD7555

PME 6510 4.096 MHz

4.096 MHz

1.024 MHz

50HZ

4024

4051

4015

AD567JD

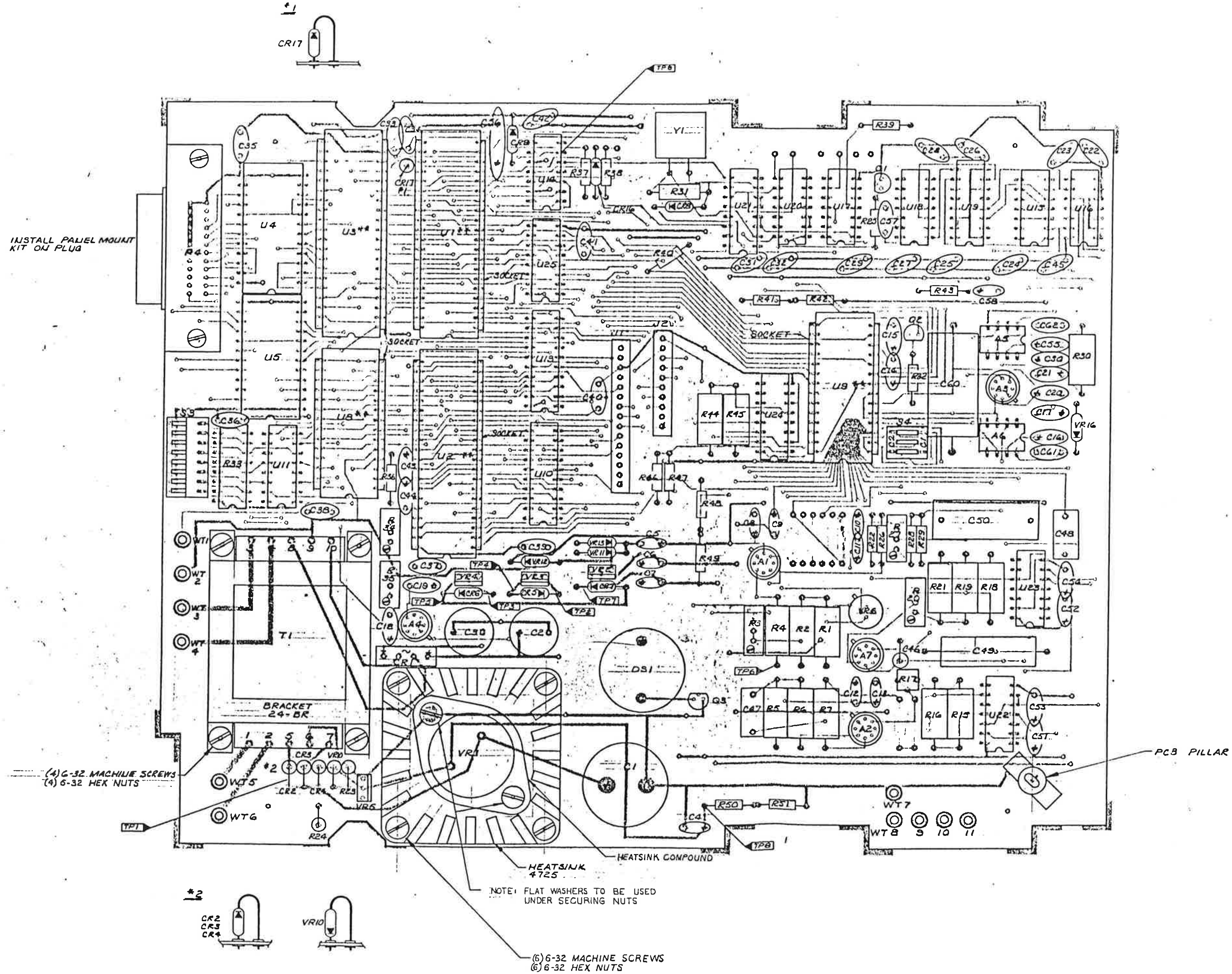
OP07

ANALOG OUT

N ON L204 ONLY

GUILDLINE INSTRUMENTS LTD. SMITHS FALLS ONT CANADA		9540
L.M.	DIGITAL PLATINUM RESISTANCE THERMOMETER	
84.04.03		
NONE	1 of 1	18122-01-04 D

REV B ECN 1601
REV C ECN 1923
REV D ECN 1934



** NOTE: U1, U2, U3, U8, U9 - INSTALL SOCKETS ONLY ; I.C.s WILL BE INSTALLED DURING TEST AND CALIBRATION.

GUILDLINE INSTRUMENTS LTD. SMITHS FALLS ONT CANADA	9540
L.M	MAIN PCB ASSEMBLY
84 02 02	
2:1	1 of 1 — 18108-01-02 D