DP465

Digital Thermometer

Operator's Manual
M1198/0292

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An OMEGA Technologies Company

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1.0 INTRODUCTION

The OMEGA™ Model DP465 is an accurate, low-cost, reliable, linearizing thermocouple (T/C) meter with a 4 digit display range of −1999 to 9999. It can be switched to display linearized T/C junction temperature for types D, E, T, R, S, J or DIN J with exceptional proprietary linearization technique enables close conformity to the DIN and IPTS-68-based tables.

When in the calibration mode, the DP465 will read millivolts, in the range from −19.99 to 80.00 mV. This feature assists accurate temperature calibration of the meter itself.

The basic meter is contained on a single PC card mounted in a standard 1/8 DIN plastic case. On the back is a 6 position terminal block (TB1) that is made up of two smaller 3-pin terminal blocks. It is used to connect power and T/C inputs to the DP465. It also has a self contained cold-junction compensation detector.

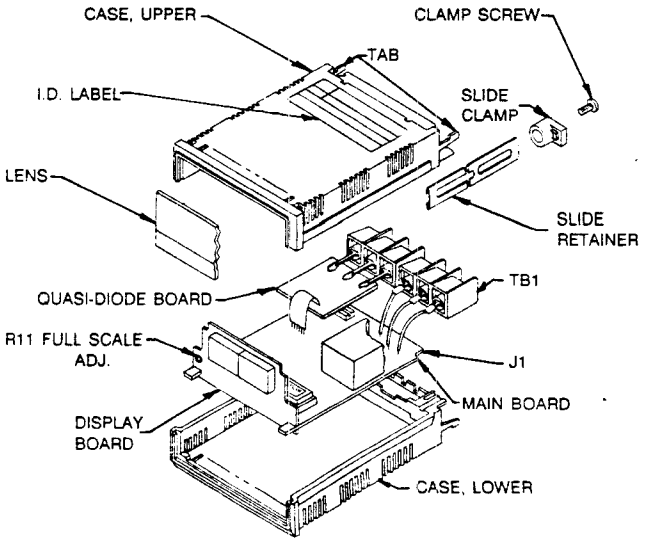


Figure 1-1 Exploded View of Model DP465

This illustration includes label placement, read from the rear.

Selection of T/C type, mV, °F/°C or cold-junction temperature output is obtained by means of a simple jumper/pin array behind the lens. This allows the user to select the millivolt range, Celsius or Fahrenheit display of the output of any one of the seven T/C types, or the cold-junction temperature value.

2.0 UNPACKING

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

Please find the following items in the box:

DP465 Panel Thermometer

PCB Edge Connector

3.0 SAFETY CONSIDERATIONS

This instrument complies with required safety regulations. To prevent electrical or fire hazard and ensure safe operation, please adhere to the following guidelines:

3.1 VISUAL INSPECTION: Do not attempt to operate the instrument if damage is found.

3.2 MOUNTING: Check the I.D. label on the top of the instrument for type of power (AC or DC) and the voltage level. Observe mounting instructions in Section 4.1.

3.3 POWER VOLTAGE: Verify that the instrument is connected for the power voltage rating that will be used. If not, make the required changes as called out in Section 5.5. This instrument is delivered with AC power set for 120 V unless ordered otherwise.

3.4 POWER WIRING: This instrument has no power-on switch; it will be in operation as soon as the power is connected.

Verify that the power cable has the proper ground (earth) wire and that this wire is properly connected to an adequate ground (earth) point. If the panel cutout is a metal enclosure, it must be grounded (earthed). The meter must be grounded (earthed) in accordance with the latest local safety regulations.

This instrument is protected according to Class I (Protective Earth) of the IEC (International Electrotechnical Commission) 348 and the VDE 0411 regulations. The power cable must contain a protective ground (earth) conductor which is not disconnected (open) either inside or outside the instrument. No extension cables without grounding (earthing) wires shall be used.

3.5 INPUT SIGNAL WIRING: Do not make signal wiring connections or changes when power is on. Make signal connections before power is applied. If connection changes are required, first disconnect the power.

3.6 RAIN OR MOISTURE: Do not expose the instrument to condensing moisture.

3.7 FUMES AND GASES: Do not operate the instrument in the presence of flammable gases or fumes; such an environment constitutes a definite safety hazard.

CAUTION
Meters are internally connected for either 120 or 240 V ac power, 5 V dc power, 9-32 V or 26-56 V isolated DC power. Check label on meter for proper supply voltage, and proceed accordingly.

4.0 INSTALLATION AND INITIAL HOOK-UP

The DP465 is a very versatile panel thermometer. It can be configured to work in a variety of modes. some of the configurations include: accepting several different types of thermocouples, the ability to read in degrees F or C, and overscale/underscale detection, just to name a few. Your DP465 has already been configured to your exact specifications at the factory.

You may proceed to install your new DP465 by following the directions that follow. However, if you wish to verify (or change) the configuration of your particular meter, please refer to Section 5.

4.1 PANEL MOUNTING INSTRUCTIONS

The unit is inserted from the front of the panel and held in place by two slide retainers. The panel thickness may be between 0.030 in. (0,75 mm) and 0.25 in (6,35 mm).

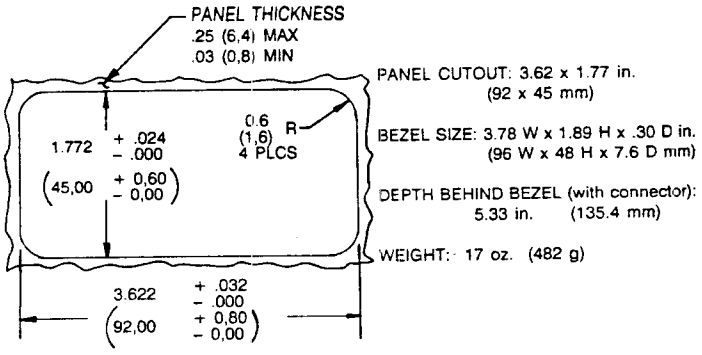


Figure 4-1 Panel Cutout and Dimensions

4.2 EQUIPMENT REQUIRED FOR HOOK-UP

A 120 V or 240 V, 50 to 60 Hz power source (3 watts), 5 V dc at 150 mA, 9 to 32 V dc, or 26 to 56 V dc (3.5 watts).

Three-wire AC power cord, or two-wire DC power cord.

Flat blade screwdriver (1/4" blade).

Piece of copper bus wire.

4.3 POWER REQUIREMENTS AND POWER CORD

The standard meter draws 3.5 watts from 120 V +10%, −15%, 50 to 60 Hz. A three-wire connection should be used to connect power to the meter; two conductors provide power to the meter and the third provides a ground for noise rejection protection.

4.4 POWER AND INPUT SIGNAL CONNECTIONS

Refer to Figure 4-2 when making connections.

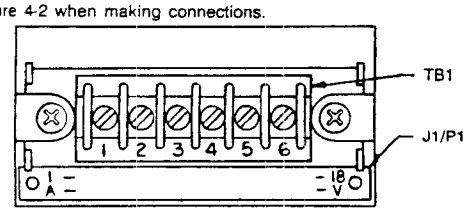


Figure 4-2 Rear View of the DP465 Thermometer

FOR AC POWER OPERATION: Refer to Table 4-1 when wiring Terminal Block TB1 as located on the back of the DP465 Thermometer. Please note that TB1-3 (AC GND) should be returned to earth ground to obtain the best noise immunity. Proper ground connections must be made to the meter for accurate readings.

For best results, a shielded T/C should be used. The shield is terminated at TB1-4. A shielded T/C must not have the shield connected at both the T/C end and the meter end. Signal Ground and Analog Ground are internally connected. Analog Ground and the digital In/Out signals are optically isolated.

TB1 Screw Terminal Number	DP465 Label Designation		Input Signal	Wire Color (USA)	Optional mV Input Connection
1	1	HI	AC HI	Black	--
2	2	NET	AC LO	White	--
3	3	GND	AC GND	Green	--
4	4		Shield	--	SIG GND
5	5		T/C − Lead	Red	− Input
6	6		T/C + Lead	Other Color	+ Input

Table 4-1 Wiring for AC Power Operation

FOR DC POWER OPERATION: Refer to Table 4-2 when wiring Terminal Block TB1 as located on the back of the DP465 Thermometer. Please note that TB1-3 (AC GND) should be returned to earth ground to obtain the best noise immunity. Proper ground connections must be made to the meter for accurate readings.

For best results, a shielded T/C should be used. The shield is terminated at TB1-4. A shielded T/C must not have the shield connected at both the T/C end and the meter end. Signal Ground and Analog Ground are internally connected. Analog Ground and the digital In/Out signals are optically isolated.

TB1 Screw Terminal Number	DP465 Label Designation	Input Signal	Optional mV Input Connection
1	--	N/C	--
2	2 POS	+ DC PWR	--
3	3 NEG	DC PWR RTN	--
4	4	Shield	SIG GND
5	5	T/C - Lead	- Input
6	6	T/C + Lead	+ Input

Table 4-2 Wiring for DC Power Operation

4.5 POWER-UP

Apply power and examine the display. After a momentary indication of 8.8.8.8, the readout will show ambient temperature in °C or °F, as applicable.

4.6 RS232 SERIAL ASCII OUTPUT CONNECTIONS

The DP465 comes standard with an RS232 Serial ASCII output. To connect to an IBM compatible computer, refer to Figure 4-3 and follow the wiring instructions below.

We have provided a sample program in BASIC for the COM 1 port on the computer.

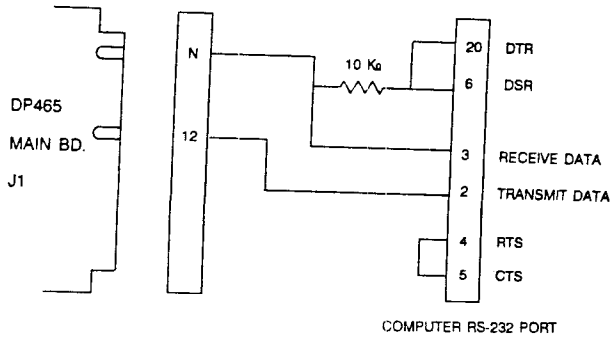


FIGURE 4-3 RS232 SERIAL ASCII WIRING

WIRING INSTRUCTIONS: The RS232 Serial ASCII output is available at the J1/P1 connection on the back of the DP465 meter (P1 connector provided). Refer to Figure 4-2 to locate P1. Wire the P1 connector to the computer as shown in Figure 4-3.

RS232 SERIAL ASCII OUTPUT SPECIFICS:

Baud Rate is:	1200 BAUD	1 Start Bit 7 Data Bits (ASCII) 1 Parity Bit (Odd) 2 Stop Bits

Each message consists of 9 ASCII characters:

1	+ or –
2 to 6	Numeric data, including floating DP (2EH)
7	Space (2OH)
8	C or F for temperature
9	Carriage return (0DH)

Leading zeros are blanked, except those immediately preceding the DP (decimal point).

Overflow	1	+
	2	Space
	3 to 6	4 'E's (45H)
	7 to 8	2 Spaces
	9	Carriage return
Underflow	1	--
	2 to 9	Same as Overflow

SAMPLE RS232 COMMUNICATIONS PROGRAM FOR IBM COMPUTER (BASIC):

```
10 CLS:KEY OFF
20 KEY 1, " "
30 LOCATE 25,30
40 PRINT "<<STRIKE F1 KEY TO EXIT>>"
50 LOCATE 1,1,1
60 ON KEY(1) GOSUB 170
70 KEY(1) ON
80 OPEN "COM1:1200,0,7,2,CS,DS" AS#1
130 IF LOC(1) < 1 GOTO 130
140 X$ = INPUT$(LOC(1),#1)
150 PRINT X$;
160 GOTO 130
170 CLOSE
180 CLS
190 END
```

5.0 DP465 RE-CONFIGURATION

As mentioned earlier, the DP465 Thermometer has been configured at the factory per the specifications at the time of ordering. The following information describes the steps taken to change the normal workings of the meter.

Regarding the information in 5.2 through 5.4, the DP465 is shipped with the jumpers set for "normal operation."

5.1 INPUT CONFIGURATION

The DP465 is capable of reading up to 7 different types of thermocouples, depending on the type of T/C for which it is configured. If one wants to change the type of thermocouple that the DP465 will read, it is a simple matter of re-configuring jumpers on the group of pins (S1) behind the lens. Figure 5-1 shows the location of the "forest of pins" and the jumpers to be changed.

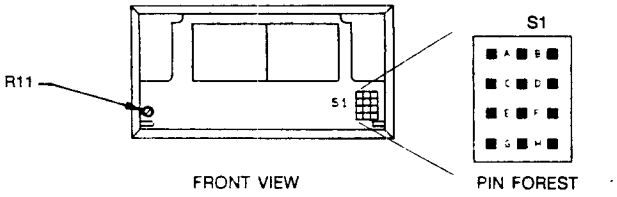


Figure 5-1 Jumper Placement for Input Selection

LENS REMOVAL: To expose the group of pins behind the DP465 lens, you will need a small jewelers screwdriver and a gentle touch. Position the screwdriver in the cutout found on the inside edge of the meter bezel (along the center of the lower edge of the lens). Gently wiggle the screwdriver until the lens pops out. (Replace by bowing the lens a bit and dropping it into place.)

RE-CONFIGURING THE INPUT TYPE: Using a small long-nose plier, change the thermocouple type according to Table 5-1 below. Grasp the sides of the small jumpers with the long-nose pliers and gently pull. Reposition the jumpers on the new pins to agree with the locations as described in Table 5-1.

Input Configuration	Jumper Placement S1
T (°F)	A, C, E, H
T (°C)	A, C, E, G
J (°F)	A, C, F, H
J (°C)	A, C, F, G
K (°F)	A, D, E, H
K (°C)	A, D, E, G
E (°F)	A, D, F, H
E (°C)	A, D, F, G
R (°F)	B, C, E, H
R (°C)	B, C, E, G
S (°F)	B, C, F, H
S (°C)	B, C, F, G
DIN J (°C)	B, D, F, G
CJ (°F)	B, D, E, H
CJ (°C)	B, D, E, G
Millivolts	B, D, F, H

Table 5-1 Input Configuration Table

NOTE: For sections 5.2, 5.3, and 5.4, refer to the PC board diagram in Figure 5-2 below for jumper locations. The DP465 must be removed from the panel in order to get at the jumpers discussed.

TO OPEN THE DP465 CASE: Disconnect all wires and remove meter from panel. Place on bench. Remove terminal block cover, phillips-head clamp screws, slide clamps and slide retainers (Figure 1-1). Lift off top cover to expose printed circuit boards.

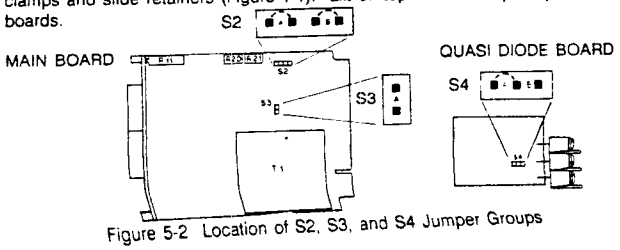


Figure 5-2 Location of S2, S3, and S4 Jumper Groups

5.2 OPEN-THERMOCOUPLE DETECTION

Model DP465 is shipped with jumpers placed at S4A, S2A and S2B.

When T/C is open, a jumper at:

S4A - Meter indicates overscale S4B - Meter indicates underscale

NOTE: Removal of S4 jumper will increase meter accuracy if maximum resistance of the T/C exceeds 250 ohms; however, there will not be open T/C detection with this modification.

The DP465 is shipped with the jumpers set for normal operation.

5.3 COLD-JUNCTION CONFIGURATION

S2A ON For normal operation Energizes internal cold-junction circuitry.

S2A OFF If external cold-junction is used.

5.4 ANALOG AND DIGITAL FILTERING

S2B ON For normal operation Connects analog input filter (33 kOhm x 10 μf) providing a normal mode rejection of 60 dB at 50/60 Hz.

S2B OFF Only for special tests.

S3 ON Disables the digital filtering by connecting the digital serial output to serial input. (This jumper is internal to the meter, see Figure 5-2.)

S3 OFF For normal operation Digital filtering enabled.

5.5 CONVERTING TO 240 V ac (OR TO 120 V ac)

CAUTION: Incorrect power can cause damage to your meter!

The DP465 can be re-configured to be powered by 240 V ac (assuming it is currently configured for 120 V ac), and vice versa. Some simple rewiring is done to the transformer per the instructions below.

1. Disconnect all wires from the meter. Remove from panel.
2. Disassemble the DP465 per the instructions located above Figure 5-2.
3. Observe Figure 5-3. Carefully lift the printed circuit board assembly out of the case. (Grasp it by the edges of the display board.) Place it on the bench, being careful not to damage anything.

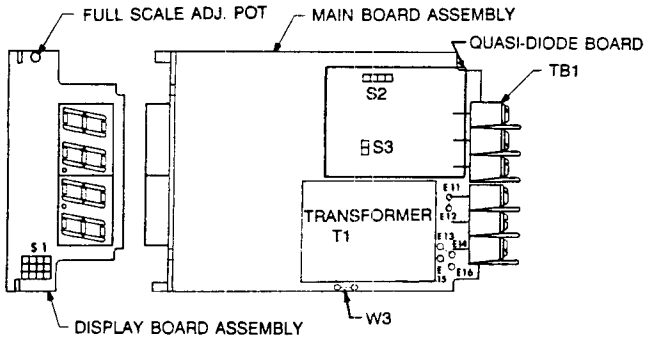


Figure 5-3 Main Board Assembly

4. Refer to the transformer in Figure 5-4. Remove jumpers W1 and W2 from the transformer. (Leave the jumper between pins 11 & 12 intact.)

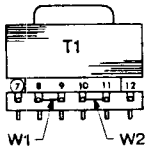


Figure 5-4 Transformer T1

5. Solder a jumper connecting the holes marked W3 on the Main Board Assembly. Refer to Figure 5-3 for the location. (The "W3" designation is somewhat hidden under the transformer.)

The meter is now wired for 240 V ac operation.

NOTE: To change the meter form 240 V ac operation to 120 V ac, reverse the above procedure.

6.0 CALIBRATION

6.1 CALIBRATION OF V REF, COLD-JUNCTION COMPENSATION AND FULL SCALE

Your model DP465 was calibrated at the factory with a precision voltage source. Frequent calibration is not necessary due to the stability and internal accuracy of the meter. When verification of calibration is necessary, the following procedure can be used.

The linearization algorithms use the millivolt and cold-junction values plus the S1 jumper configuration to determine the appropriate temperature display. Thus the millivolt and cold-junction displays are sufficient to determine the calibration of the meter. To expedite the calibration check, a 4PST switch can be connected to the S1 A, C, E, and G positions of the pin forest located behind the front lens. The meter will be unharmed if the operational modes are changed while it is operating. Results will be obtained more quickly if the digital filtering is disabled. (See Section 5.4.)

The V ref (meter internal voltage reference), is initially factory set to a value which results in a minimum temperature coefficient, i.e., V ref versus ambient temperature. This value is not the same for all meters. If the voltage reference must be replaced, return the meter to the factory. The V ref potentiometer (R20) is sealed after adjustment at the factory. If this seal is broken, the accuracy of V ref is questionable.

Potentiometer R21, the cold-junction reference adjustment, is also factory set and sealed. Proper operation can be checked, however, by simply configuring the meter for CJ temperature display (Section 5.1) and comparing the CJ temperature with the actual temperature of the terminal block. Note that the temperature of the block must be known with an accuracy commensurate with the Model DP465 specifications.

Full scale adjustment is controlled by potentiometer R11, located behind the lens (Figure 1-1), and is front panel accessible. Adjustment can be made by configuring the Model DP465 as a millivoltmeter (see Section 5.1). Verify that the unit indicates ± 0.00 mV with shorted inputs (TB1-5 and TB1-6). Then apply + 80.005 mV to TB1-6, referenced to Analog Ground (TB1-5), and then adjust R11 for a reading of + 80.00/80.01 mV. The 1/2 count is obtained when the display alternates between + 80.00 and + 80.01 mV.

If S4A is in place (Normal Position), approximately 50 nA will be flowing into the signal input terminal; therefore the input resistance of the calibration source can offset the reading.

Calibrating the meter for plus full scale should automatically insure calibration for minus full scale; however, minus full scale can be checked to verify proper operation of the meter. In this case, although -19.99 mV is the most negative display value, it is more convenient to check the meter at -19.90 mV, which will avoid a possible underscale condition. If Digital Filtering is OFF (S3), recovery from underscale will appear to be instantaneous, i.e., as soon as the input voltage is in range, the display will indicate in-range operation. If Digital Filtering is ON, recovery will take longer because the digital filtering is not automatically disengaged while the meter is in the overrange condition.

Note that for positive inputs, overrange does not occur in the mV mode until the display attempts to exceed 99.99 or until the overrange condition causes internal operation of the analog section of the meter to cease, whichever occurs at a lower value. The meter cannot display mV values more negative than -19.99, because the g-segment (center segment) of the leading display digit is used to indicate minus.

6.2 CALIBRATION VERIFICATION USING THERMOCOUPLES

The following procedure can be used to verify the calibration of the Model DP465 using T/Cs.

1. Connect test cables as shown in Figure 6-1.
2. Apply power and allow meter to warm up for ten minutes.
3. Apply zero volts from the Calibrated Voltage Source and verify readout of ± 0°C or 32°F.
4. Verify that the Model DP465 is operating within specification per the International Practical Temperature Scale, IPTS-68, as published in the NIST Monograph 125 Thermocouple Tables issued March 1974 (or DIN 43710), by applying the appropriate voltage to the input.

Note that this method only requires that the simulated measure junction temperature. The ice bath will zero the copper - T/C junctions for the copper wires which are connected to the Calibrated Voltage Source; however, the cold junction compensation detector of the Model DP465 must first be calibrated so the meter will properly compensate for the T/C junctions at the meter barrier block. For accurate results, T/C wires which have a known accuracy should be used.

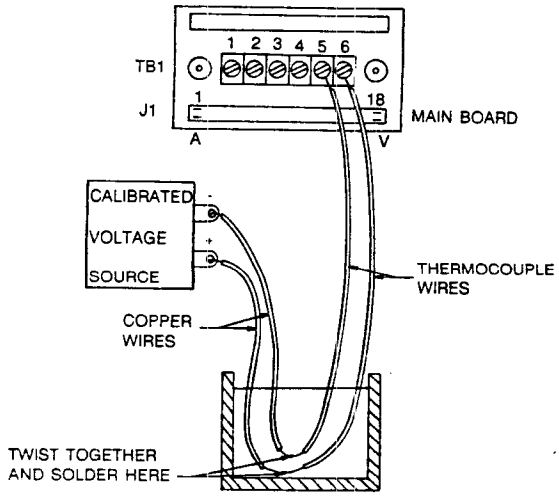


Figure 6-1 Ice Bath Calibration Setup

6.3 CONFORMITY VERIFICATION AFTER CALIBRATION

Even if the meter is not properly calibrated, the conformity can be verified for the indicated CJ temperature and millivolts displayed by the meter, then determine the temperature from the appropriate NIST (or DIN) table. The example below is for the J T/C, °C, configuration with the meter indicating CJ = 23.6°C and 41.09 mV (mV display). Note that in this procedure, only a stable millivolt source is required; neither T/C wires nor a separate millivoltmeter is required. This conformity verification demonstrates that, for given net MJ (measure junction) CJ voltage and CJ temperature meter display values, the correct MJ temperature result will be obtained when the meter is switched to the appropriate T/C configuration (using S1).

Millivolts displayed by meter:	41.09
Cold junction temperature displayed, °C	23.6
NIST value for 23.6°C:	1.2098 mV
NIST value for 750.2°C:	42.2960
NIST value for CJ = 23.6, MJ = 750.2:	41.0862 mV

(use linear interpolations of NIST values)

The expected meter display value is 750°C when switched to the J T/C mode.

Note that the meter display has a resolution of one degree in this case (J T/C). Noise in the millivolt source or a change in the cold junction value will cause variations.

The following is another example of how to check the conformity. This time the T T/C configuration, which has a display resolution of 0.1°, will be used. The object is to determine if the meter will display 390.3°C for values obtained from the NIST table.

STEP	MODE	DISPLAY	NIST VALUE
1.	CJ	23.6°C	934.9 μV
2.	MV	19.33/19.34 mV	19335.9 μV
3.	T T/C	390.3°C	20270.8 μV

In the above example, the Model DP465 was first configured to read CJ temperature in °C. A value of 23.6°C was displayed. Linear interpolation between the values for 23 and 24°C in the NIST table for the T T/C yields 934.9 μV. Likewise, 390.3°C yields 20270.8 μV which gives a net value of 19335.9 μV. The meter configuration was then changed to mV and a stable millivolt source was adjusted to obtain a display of 19.33/19.34 mV (alternating between 19.33 and 19.34 mV). This would be the voltage expected for "perfect" T T/Cs. Changing the mode to T T/C should then yield a display of 390.3°C.

After step 3, it is advisable to recheck the CJ value since, in a realistic situation, a change of 0.1°C (or more) ambient temperature could occur during the time interval required for the procedure. The procedure can be made more efficient by providing a 4PST switch connected to the pin-forest, plus a SPST switch connected to S3A. (See 5.3 for an alternative which avoids removing the meter case.) When the SPST switch is on, it simulates an external serial data source, thereby disabling the DP465 digital filtering.

7.0 MAIN BOARD J1 PIN ASSIGNMENTS

UPPER ROW PIN	UPPER ROW SIGNAL	LOWER ROW SIGNAL	LOWER ROW PIN
1	N/C	N/C	A
2	N/C	N/C	B
3	N/C	N/C	C
4	N/C	N/C	D
5	N/C	N/C	E
6	N/C	N/C	F
7	N/C	N/C	H
8	N/C	N/C	J
9	N/C	N/C	K
+ 10	Control output return	Control output	L +
+ 11	Serial input	Serial input return	M +
+ 12	Serial output return	Serial output	N +
+ 13	Buffer full	Buffer full return	P +
14	N/C	N/C	R
* 15	+ 5 V OUT	N/C	S
16	N/C	DIGITAL GND	T *
17	N/C	QD GND	U *
* 18	- 2.49 V ref OUT	QD Emitter	V *

\+ Optically isolated

* For these signals to be present on J1, a header, wired as shown in Figure 7-1, must be inserted into socket labeled XU7 (see Figure 10-1 for location). A 33 K, 1/4 W resistor is required from pin 3 to pin 14 on header to provide input filtering and protection. This header should be removed if connector isolation from the T/C common-mode voltage is required.

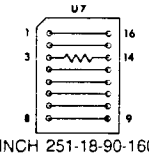


Figure 7-1 U7 Header

Connector Type: ELCO 00-6007-036-450-012; TRW/CINCH 251-18-90-160; SAE SCC18D/1-2

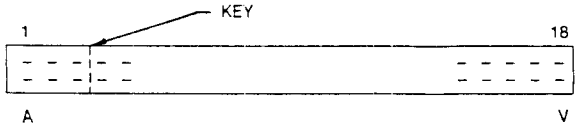


Figure 7-2 Rear View of J1 Connector Pin Orientation

8.0 RS232 SERIAL ASCII DETAILS

8.1 SERIAL DATA INPUT

The Serial Data-In bit stream must be synchronous with the Serial Data-Output bit stream as shown in Figure 8-1. Also the message format must be as specified in Section 4.6, e.g., it must be identical to the DP465 Serial Data-Output message format (9 ASCII characters). The Start Bit of the Serial Data-In should (ideally) start in the center of the Serial Data-Out Start Bit. In practice, the Serial Data-In Start Bit can have its leading edge occur within the center 90% of the Serial Data-Out Start Bit. Note that a host computer can return the same data (on a bit for bit basis) as is being transmitted by the DP465, but if the DP465 data is to be modified by the host for transmission to the DP465, the result cannot be returned any sooner than the next DP465 message.

The trailing edge of the DP465 Control Out can be used as an interrupt to the host computer to synchronize transmission to the DP465. Polling can also be used. The bit duration at 1200 baud is 833 μs, so if there is some delay, e.g., 100 μs, in the host response, the leading edge of the Control Out pulse could be used instead.

Note	Current into J1 Pin 11 (Serial-In)	Result at U10 Pin 34	DP465 Display	DP465 Serial Output
1	2 mA DC	Short to Ground	On Hold	Unfiltered Data
2	0 mA	Floating	Filtered Data	Filtered Data
3	2 mA/0 from Serial Data-Out	Receives Serial Data-Out	Unfiltered Data	Unfiltered Data
4	2 mA/0 from Intelligent Peripheral	Receives data from Intelligent Peripheral	Input Data	Unfiltered Data

Notes:

1. DP465 serial output continues, digital filter is disabled, display retains last reading before DC current was applied to diode of Serial Input optocoupler.
2. Assumes Jumper S3 is not installed. (See Section 5.4.)
3. Externally - can be implemented with circuit shown in Figure 5-2.
   Internally - Jumper S3 installed.
   2 mA/0 signifies bit stream of 2 mA current pulses.
4. Digital filtering is automatically disabled by the DP465 so the intelligent peripheral, e.g., host computer, can have complete control over the display.

Note also, if $\overline{\text{BUFFER FULL}}$ goes true (2 mA to P1 pin 13) while serial data is being outputted, the measurement being processed will be aborted and restarted.

8.2 DIGITAL SIGNALS

Normal use of the Model DP465 is with the optically isolated serial Output/Input provided at 1200 baud, giving the DP465 the ability to be interfaced with computers and systems equipment. The DP465 can also accept a synchronous, serial ASCII display value input in place of the internally generated value. A BUFFER FULL input (active low) allows the receiving device to halt the flow of data as needed. A CONTROL output is provided for convenience in certain applications.

SERIAL OUTPUT - open collector of opto-isolator (2 mA max)

CONTROL OUTPUT - open collector of opto-isolator (2 mA max)

SERIAL INPUT - LED input of opto-isolator (2 mA source required)

BUFFER FULL INPUT - LED input of opto-isolator (2 mA source required)

If BUFFER FULL or CONTROL OUT are not used, the connections for these signals can be left open.

SERIAL IN and SERIAL OUT can be left open for meter stand alone operation. With no jumper at S3 (the normal condition), the DP465 microcomputer will sense that there is no serial-out-to-serial-in data transfer and will send the meter generated data to the meter display automatically. If there is a serial-out-to-serial-in data transfer, it will also be sensed by the microcomputer and the digital filtering will be disabled. The host computer can then process the data as required. The return data to the DP465 can be any character string that satisfies the DP465 format. Refer to Section 4.6.

The timing of the return sequence to the DP465 is optimized if the return bits are delayed by 1/2 bit period (417 μs). An exact overlap, as achieved by using jumper S3, will work but the 1/2 bit delay provides the best margin of operation for pulse distortion and timing variations.

The CONTROL OUTPUT pulse trailing edge can be used to initiate the start of the return character serial bit stream (see Section 8.3).

8.3 CONTROL OUTPUT

The control output is a single pulse per serial character. The pulse starts 20 μs before the beginning of the start pulse of the character bit sequence and ends at the middle of the start pulse. The trailing edge of the control output pulse can be used to initiate the start of the return character serial bit stream.

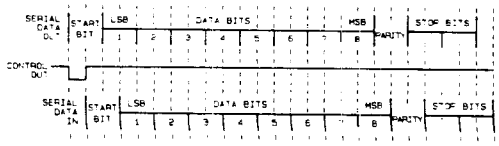


Figure 8-1 Serial I/O Timing Requirement

9.0 SPECIFICATIONS

INPUT RANGE AND CONFORMITY ERROR

Thermocouple Type	Meter Conformity Error °C ± 1/2 LSD	Temperature Range °C		Temperature Range °F	
J	0.1	-210	+760	-346	+1400
K	0.1	-205	+1372	-337	+2502
E	0.2	-205	+1000	-337	+1832
T	0.1	-199.9	+400.0	-199.9	+752.0
R	0.5	-50	+1741	-58	+3166
S	0.5	-50	+1767	-58	+3213
DIN J	0.3	-200	+775		

Voltage Range: -19.99 to +80.00 mV
Cold Junction Temperature Range: -40 to +257°F (-40 to +125°C)
Cold Junction Conformity Error: 0.03°C ± 1/2 LSD
Temperature Resolution: 1°C/1°F, except type T, which is 0.1°F/0.1°C

DP465 Meter Accuracy:
(meter conformity error) + (cold junction conformity error) + (1/2 LSD)
Warmup for rated accuracy: 10 min.

For the K and E T/Cs, when operating below -337°F (-205°C) the conformity error is up to twice that specified for warmer temperatures; however, operation of the meter in these areas is useful and repeatable.

Operation of the T/Cs a few degrees above the NIST table limits is possible on all T/Cs except type S. Conformity error is not defined in these areas, but meter operation is repeatable and the values are a reasonable extrapolation of the NIST polynomials.

THERMOCOUPLE RANGE LIMITS:

Thermocouple Type	Range Limits °C		°F	
J	-210	+763	-346	+1405
K	-240	+1378	-400	+2513
E	-240	+1001	-400	+1833
T	-199.9	+402.4	-199.9	+756.3
R	-50	+1800	-58	+3272
S	-50	+1767	-58	+3213
DIN J	-200	+775		

Exceeding range limits will result in underscale or overscale indications.
Voltage Range Limits: -19.99 mV +99.99 mV

The low temperature limit of the T T/C, −199.9°C or °F, is caused by the use of the center segment of the leading digit for a minus sign.

On the Voltage Range, the meter is calibrated at 80.00 mV, but overrrange does not occur until the display attempts to exceed 99.99 or until the input causes internal operation of the analog section of the meter to cease, whichever occurs at a lower value.

Span Tempco Standard:	0.006% R/deg from 0 to +55°C
T/C Reference Junction:	0.01 deg/deg from −40 to +125°C

NOTE: This is the T/C reference junction range allowed by the microcomputer. For reference junction operation outside the operating temperature range of the meter {32 to 131°F (0 to 55°C)}, a remote reference junction must be used.

POWER:

Input Voltage:	120 V ac +10% −15%	50/60/400 Hz	
	240 V ac +10% −15%	50/60/400 Hz	(Option C1)
	5 V dc ±5%		(Option C3A)
	9-32 V dc	Isolated	(Option C3B)
	26-56 V dc	Isolated	(Option C3D)
Input Power:	3.5 watts maximum		

PHYSICAL:

Weight	17 oz (480 g)
Case Material	94V-O UL-rated polycarbonate
DIN Case Size	
Bezel (WxHxTh)	3.78 x 1.89 x 0.24 in. (96 x 48 x 6 mm)
Depth behind bezel with connector	5.33 in. (135.4 mm)
Panel Cutout	3.62 x 1.77 in. (92 x 45 mm)

ENVIRONMENT:

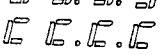
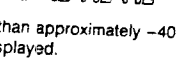
Rated Temperature	32 to 131°F	(0 to 55°C)
Operating Temperature	+4 to +131°F	(−20 to +55°C)
Storage Temperature	−40 to +150°F	(−40 to +170°C)
Humidity	Up to 95% at 104°F (40°C)	

CONVERSION TECHNIQUE:

This involves separate μC-controlled dual slope conversions of CJ (cold junction) voltage and T/C voltage. The CJ measurement is taken first and used as the starting point for the T/C measurement. Linearization is done by the μC.

ANALOG FILTERING:

Single Pole, Low Pass	T = 0.33 S (33K x 10μf)
Digital Filtering:	AVE(N + 1) = (7/8) AVE(N) + (1/8) SIG(N)
NMR at 50/60 Hz:	60 dB
CMR at 250 Ω Imbalance:	120 dB, AC Power to Signal Low

LEAD RESISTANCE:	250 Ω max for rated T/C meter accuracy
DISPLAY:	
Leading zero blanking:	Leading zeros are blanked, except those immediately preceding the decimal point.
Decimal Point Position	
Voltage Range	1 9.9 9
Cold Junction (°C/°F)	1 9 9.9
All Thermocouple Ranges except T	1 9 9 9 (no DP displayed)
Type T	1 9 9.9
Overscale Indication	
Underscale Indication	

If the input signal is less than approximately −40 mV, the integrator will not ramp up and an underrange is displayed.

10.0 DRAWINGS

NOTE: DIMENSIONS ARE IN MILLIMETERS ±0.25 MM
AND INCHES ARE IN ( ) ±0.01 IN

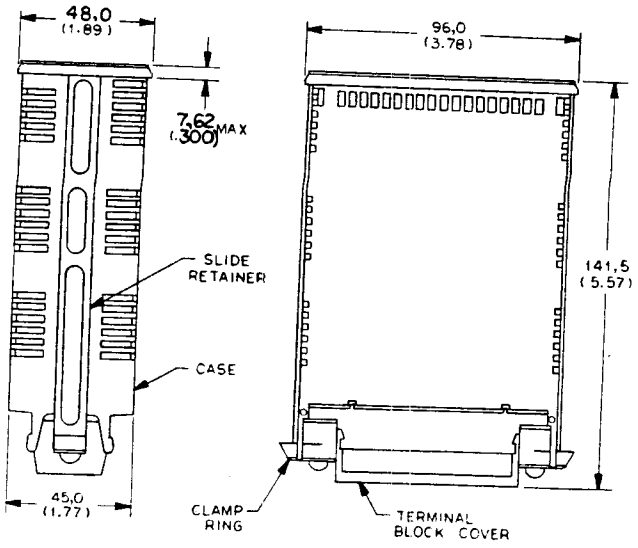


Figure 10-1 DP465 Case Dimensions

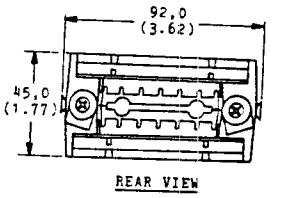


Figure 10-2 DP465 Rear View

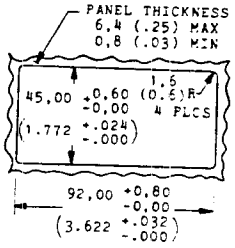


Figure 10-3 Panel Cutout

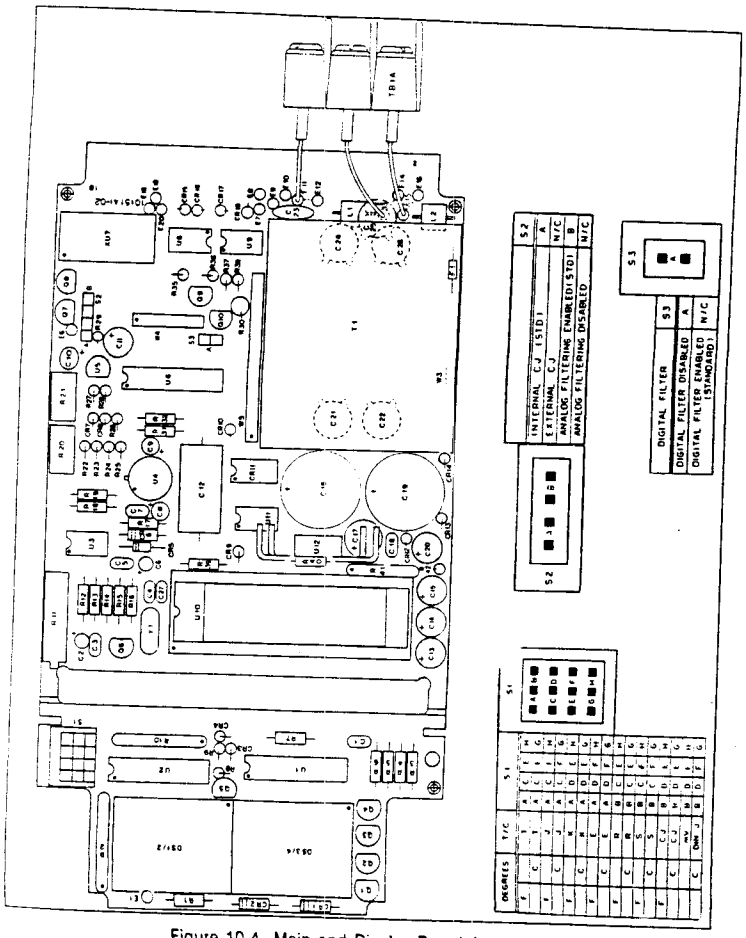


Figure 10-4 Main and Display Board Assembly

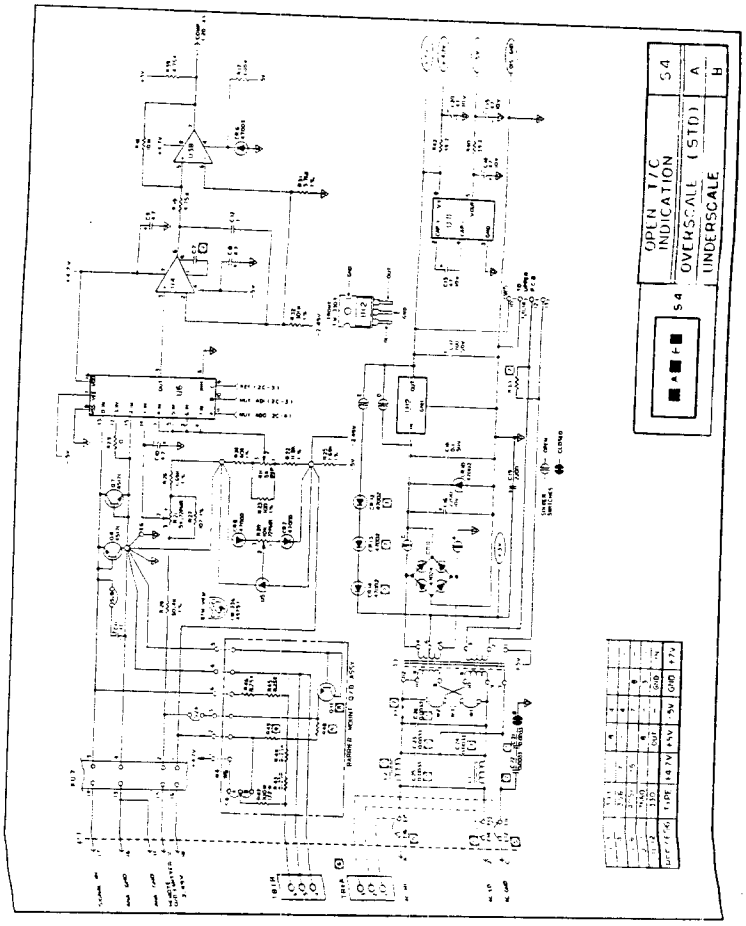


Figure 10-5 Main Board Schematic (1 of 2)

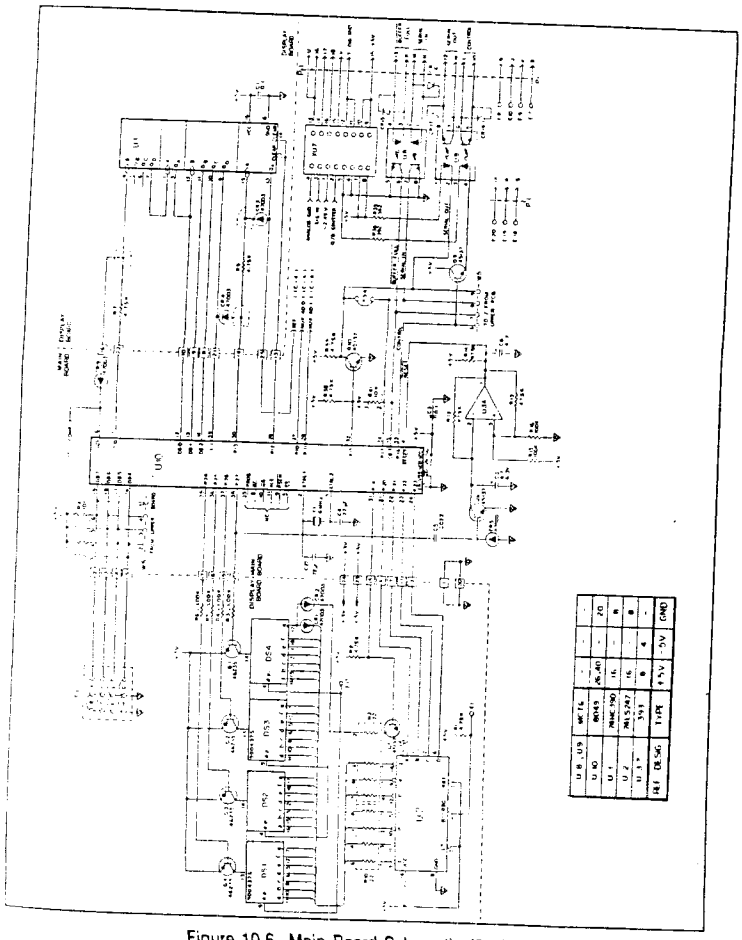


Figure 10-6 Main Board Schematic (2 of 2)

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