



TELEDYNE INSTRUMENTS

Advanced Pollution Instrumentation

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Service Note

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TROUBLESHOOTING TEMPERATURE CIRCUITS FOR ALL MICROPROCESSOR BASED ANALYZERS

NOTE: ALL THERMISTORS USE A TWISTED PAIR OF YELLOW WIRES. ANYTIME YOU SEE A TWISTED PAIR OF YELLOW WIRES, THAT IS A THERMISTOR CIRCUIT. WHEN CHECKING RESISTANCE OR SUBSTITUTING RESISTORS, BE SURE YOU ARE WORKING WITH THE YELLOW WIRES!

1. All temperature circuits, with the exception of N02/H2S converters use thermistors to sense temperature. The thermistor is a resistor which varies resistance with temperature. Higher temperature equals lower resistance and vice versa.
2. On M100-M400 series analyzers, the thermistor sensing circuits are located on the DCPS, (See schematic drawing #00016). A modified wheatstone bridge is used, with a LM317 regulator added to linearize the thermistor. This circuit creates a voltage which is proportional to temperature. This voltage is sent to the A/D card and then to the processor which displays it as a temperature on the front panel. On M100A and M200A the sensing circuits are located on the Status/Temp PCB.
3. The trick to troubleshooting these circuits is to divide them into two parts; a temperature sensing circuit and a control circuit. Essentially, the sensing circuit consists of the thermistor, the DCPS, and the A/D board. The control circuit consists of the heater/cooler (the element), the power supply for the element, the switch to turn the element on, and the I/O card which sends a signal to the switch.

CAUTION!!! SOME THERMISTORS SHARE CONNECTORS WITH HEATERS, SO 110VAC MAY BE PRESENT ON SOME PINS OF SOME CONNECTORS! PAIRS OF RED WIRES ARE HEATER!

4. In troubleshooting the sensing circuit, the easiest way is the resistor substitution method. This consists of disconnecting the thermistor in question and substituting a resistor of known value into the circuit. Then, observing the display, verify that the expected temperature is displayed as follows:
 - A. For Rcell, or IZS heater circuits, unplug the thermistor connector and plug an 11K ohm resistor into the non-thermistor side of the connector. **BE SURE TO PLUG THE RESISTOR INTO THE YELLOW WIRES OF THE CONNECTOR TO AVOID ELECTROCUTION!** The yellow wires are input wires from the thermistor to the DCPS circuit. Look for a reading of 49 or 50 degrees centigrade on the front panel test function RCELL TEMP or IZS TEMP depending on which circuit you are troubleshooting. A correct reading indicates the DCPS, motherboard and A/D cards are working. A wrong reading is almost always the DCPS card.
 - B. When troubleshooting other heater circuits, use the attached resistance to temperature chart to determine which resistor value should be used for the circuit in question.
 - C. If a cooler failure, remove the top connector from the end of the barrel assembly and place a 47K Ohm resistor into the connector on the two pins with yellow wires. The front panel PMT TEMP display should read 15 degrees C.
 - D. If the correct reading is obtained, make the following measurements:
 1. Measure Ohms across the two yellow wires of the thermistor. The reading should be between 5K and 49K ohms. If the indication is a short or open, replace the thermistor.
 2. Measure Ohms from either side of the thermistor to the case the thermistor is housed in. Anything other than an infinite reading indicates that the thermistor is shorted to case and must be replaced.
 - E. If the temperature sensing circuit is working, the problem most likely lies in the control circuit.

5. The control circuits for the heaters are all the same. They consist of a heater, a 115VAC power source and an opto-isolator switch or solid state relay.
 - A. First verify the heater isn't open. Unplug the heater at the molex connector and use an ohmmeter to verify that it measures correctly, (typically less than 1K ohms).
 - B. Next verify that the heater led is on. The LED is located on the opto in M100 and M200. In M300, M400, M100A and M200A, the led is located on the Power Supply Module.
 - C. If the heater resistance is correct and the LED is lit, then measure the AC voltage at the red wires of the heater connector. If the voltage is not between 105 and 125 VAC, then the opto-isolator or relay is suspect. In M100 and M200 you can pull the small round fuse out and measure the resistance. It should read short. If bad, replace it.
 - D. Using the motherboard schematic, you can look for the appropriate logic signal to the opto-isolator or Power Supply Module and verify the +5V signal is at the opto-isolator or Power Supply Module connector. If the +5V signal is present, swap the opto-isolator, or if the unit has a Power Supply Module, you should call the Factory to get assistance on troubleshooting or replacing the Module.
6. When troubleshooting the cooler, keep in mind that the power supply for the cooler is not regulated. Typical voltages for the power supply are 10-11 volts with an open cooler/cooler turned off, and 8-9 volts with a working cooler when on. The power supply is located on a small vertical bracket in the M100 and M200. In all others it is located in the Power Supply Module. See attached schematic for M100 and M200 cooler circuits.
 - A. The M100-M200 coolers are located in the PMT barrel barrel ass'y. Measure the voltage on the red wire of the top connector on the end of the barrel. It should read 8-9 Volts when on. Measure the voltage on the green wire on the end of the same connector, it should be 1.2 to 1.5 Volts. If the green and red wires both read 10-11 Volts, the FET is open or not on. Measure the voltage on both sides of the resistor on the FET, you should have ground on one side and 4.7-5. 1VDC on the other. If not, there is a bad connection, short or the I/O card isn't functioning properly.
 - B. If the Voltage on the green wire of the top connector reads 0-.5 Volts, the cooler is open and should be replaced.

Page 4
Service Note #94-012
November 28, 1994

7. The M100A and M200A cooler circuit is located on the preamp board. The schematic is located on the preamp schematic. Troubleshooting consists of measuring the voltage at U1-3 and verifying it is about 8.5 Volts, this is the reference voltage. The voltage at U12 is from the thermistor and should start around zero when at ambient temperature and increase to 8.5 Volts. Verify the thermistor resistance by measuring the voltage at E6 of the preamp board and calculating the current through R31. The voltage at E6 divided by the current through R31 will give you the thermistor resistance in ohms.

RESISTANCE VERSUS TEMPERATURE —40° to +150°C

TEMP° C RES	TEMP° C RES	TEMP° C RES	TEMP° C RES	TEMP° C RES	TEMP° C RES	TEMP° C RES
40 884.6K	-10 158.0K	+20 37.30K	+50 10.97K ^T	+80 38.43	+110 155.0	+140 701.2
39 830.9K	9 150.0K	21 35.70K	51 10.57K	81 37.20	111 150.7	+141 684.1
38 780.8K	8 142.4K	22 34.17K	52 10.18K	82 36.02	112 146.5	142 667.5
37 733.9K	7 135.2K	23 32.71K	53 9.807	83 34.89	113 142.5	143 651.3
36 690.2K	6 128.5K	24 31.32K	54 9.450	84 33.79	114 138.6	144 635.6
35 649.3K	5 122.1K	25 30.00K	55 9.109	85 32.73	115 134.8	145 620.3
34 611.0K	4 116.0K	26 28.74K	56 8.781	86 31.72	116 131.1	146 605.5
33 575.2K	3 110.3K	27 27.54K	57 8.467	87 30.73	117 127.6	147 591.1
32 541.7K	2 104.9K	28 26.40K	58 8.166	88 29.79	118 124.1	148 577.1
31 510.4K	1 99.80K	29 25.31K	59 7.876	89 28.87	119 120.8	149 563.5
30 481.0K	0 94.98K	+30 24.27K	+60 7.599	+90 27.99	+120 117.6	+150 550.2
29 453.5K	1 90.41K	31 23.28K	61 7.332	91 27.14	121 114.5	
28 427.7K	2 86.09K	32 22.33K	62 7.076	92 26.32	122 111.4	
27 403.5K	3 81.99K	33 21.43K	63 6.830	93 25.52	123 108.5	
26 380.9K	4 78.11K	34 20.57K	64 6.594	94 24.76	124 105.7	
25 359.6K	5 74.44K	35 19.74K	65 6.367	95 24.02	125 102.9	
24 339.6K	6 70.96K	36 18.96K	66 6.149	96 23.31	126 100.2	
23 320.9K	7 67.66K	37 18.21K	67 5.940	97 22.62	127 97.6	
22 303.3K	8 64.53K	38 17.49K	68 5.738	98 21.95	128 95.1	
21 286.7K	9 61.56K	39 16.80K	69 5.545	99 21.31	129 92.6	
20 271.2K	+10 58.75K	+40 16.15K	+70 5.359	+100 20.69	+130 90.3	
19 256.5K	11 56.07K	41 15.52K	71 5.180	101 20.09	131 88.0	
18 242.8K	12 53.54K	42 14.92K	72 5.007	102 19.50	132 85.7	
17 229.8K	13 51.13K	43 14.35K	73 4.842	103 18.94	133 83.6	
16 217.6K	14 48.84K	44 13.80K	74 4.682	104 18.40	134 81.5	
15 206.2K	15 46.67K	45 13.28K	75 4.529	105 17.88	135 79.4	
14 195.4K	16 44.60K	46 12.77K	76 4.381	106 17.37	136 77.4	
13 185.2K	17 42.64K	47 12.29K	77 4.239	107 16.88	137 75.5	
12 175.6K	18 40.77K	48 11.83K	78 4.102	108 16.40	138 73.6	
11 166.6K	19 38.99K	49 11.39K	79 3.970	109 15.94	139 71.8	