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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 NO_2/H_2S 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 1 1K 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:
      I . 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 Ml 00 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 Ml00 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 Ml00 and M200 cooler circuits.

A. The M100-M200 coolers are located in the PMT 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 10-1 1 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 1/0 card isn't functioning properly.

B. If the Voltage on the green wire of the top connector reads O-.5 Volts, the cooler is open and should be replaced.

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 Ul-3 and verifying it is about 8.5 Volts, this is the reference voltage. The voltage at Ul-2 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 R3 1. The voltage at E6 divided by the current through R31 will give you the thermistor resistance in ohms.

TEMP	RES.
-40°	884.6KΩ
-39°	830.9KΩ
-38°	780.8KΩ
-37°	733.9KΩ
-36°	690.2KΩ
-35°	649.3KΩ
-34°	611.0KΩ
-33°	575.2KΩ
-32°	541.7KΩ
-31°	510.4KΩ
-30°	481.0KΩ
-29°	453.5KΩ
-28°	427.7KΩ
-27°	403.5KΩ
-26°	380.9KΩ
-25°	359.6KΩ
-24°	339.6KΩ
-23°	320.9KΩ
-22°	303.3KΩ
-21°	286.7KΩ
-20°	271.2KΩ
-19°	256.5KΩ
-18°	242.8KΩ
-17°	229.8KΩ
-16°	217.6KΩ
-15°	206.2KΩ
-14°	195.4KΩ
-13°	185.2KΩ
-12°	175.6KΩ
-11°	166.6KΩ
-10°	158.0KΩ
-9°	150.0KΩ
-8°	142.4KΩ
-7°	135.2KΩ
-6°	128.5KΩ
-5°	122.1KΩ
-4°	116.0KΩ
-3°	110.3KΩ
-2°	104.9KΩ
-1°	99.8KΩ

TEMP	RES.
0°	95.0KΩ
1°	90.4KΩ
2°	86.1KΩ
3°	82.0KΩ
4°	78.1KΩ
5°	74.4KΩ
6°	71.0KΩ
7°	67.7KΩ
8°	64.5KΩ
9°	61.6KΩ
10°	58.8KΩ
11°	56.1KΩ
12°	53.5KΩ
13°	51.1KΩ
14°	48.8KΩ
15°	46.7KΩ
16°	44.6KΩ
17°	42.6KΩ
18°	40.8KΩ
19°	39.0KΩ
20°	37.3KΩ
21°	35.7KΩ
22°	34.2KΩ
23°	32.7KΩ
24°	31.3KΩ
25°	30.0KΩ
26°	28.7KΩ
27°	27.5KΩ
28°	26.4KΩ
29°	25.3KΩ
30°	24.3KΩ
31°	23.3KΩ
32°	22.3KΩ
33°	21.4KΩ
34°	20.6KΩ
35°	19.7KΩ
36°	19.0KΩ
37°	18.2KΩ
38°	17.5KΩ
39°	16.8KΩ

TEMP	RES.
40°	16.15KΩ
41°	15.52KΩ
42°	14.92KΩ
43°	14.35KΩ
44°	13.80KΩ
45°	13.28KΩ
46°	12.77KΩ
47°	12.29KΩ
48°	11.83KΩ
49°	11.39KΩ
50°	10.97KΩ
51°	10.57KΩ
52°	10.18KΩ
53°	9.807KΩ
54°	9.450KΩ
55°	9.109KΩ
56°	8.781KΩ
57°	8.467KΩ
58°	8.166KΩ
59°	7.876KΩ
60°	7.599KΩ
61°	7.332KΩ
62°	7.076KΩ
63°	6.830KΩ
64°	6.594KΩ
65°	6.367KΩ
66°	6.149KΩ
67°	5.940KΩ
68°	5.738KΩ
69°	5.545KΩ
70°	5.359KΩ
71°	5.180KΩ
72°	5.007KΩ
73°	4.842KΩ
74°	4.682KΩ
75°	4.529KΩ
76°	4.381KΩ
77°	4.239KΩ
78°	4.102KΩ
79°	3.970KΩ

TEMP	RES.
80°	3.843KΩ
81°	3.720KΩ
82°	3.602KΩ
83°	3.489KΩ
84°	3.379KΩ
85°	3.273KΩ
86°	3.172KΩ
87°	3.073KΩ
88°	2.979KΩ
89°	2.887KΩ
90°	2.799KΩ
91°	2.714KΩ
92°	2.632KΩ
93°	2.552KΩ
94°	2.476KΩ
95°	2.402KΩ
96°	2.331KΩ
97°	2.262KΩ
98°	2.195KΩ
99°	2.131KΩ
100°	2.069KΩ
101°	2.009KΩ
102°	1.950KΩ
103°	1.894KΩ
104°	1.840KΩ
105°	1.788KΩ
106°	1.737KΩ
107°	1.688KΩ
108°	1.640KΩ
109°	1.594KΩ
110°	1.550KΩ
111°	1.507KΩ
112°	1.465KΩ
113°	1.425KΩ
114°	1.386KΩ
115°	1.348KΩ
116°	1.311KΩ
117°	1.276KΩ
118°	1.241KΩ
119°	1.208KΩ

TEMP	RES.
120°	1.176KΩ
121°	1.145KΩ
122°	1.114KΩ
123°	1.085KΩ
124°	1.057KΩ
125°	1.029KΩ
126°	1.002KΩ
127°	976.3Ω
128°	951.1Ω
129°	926.7Ω
130°	903.0Ω
131°	880.0Ω
132°	857.7Ω
133°	836.1Ω
134°	815.0Ω
135°	794.6Ω
136°	774.8Ω
137°	755.6Ω
138°	736.9Ω
139°	718.8Ω
140°	701.2Ω
141°	684.1Ω
142°	667.5Ω
143°	651.3Ω
144°	635.6Ω
145°	620.3Ω
146°	605.5Ω
147°	591.1Ω
148°	577.1Ω
149°	563.5Ω
150°	550.2Ω

Resistance

vs.

Temp (Deg. C)