

SERVICE AND APPLICATION NOTES

ACC-07-1

February 12, 2007
Updated July 2, 2015

Remote Outdoor Sensors (Used with Lennox Room Thermostats)

PURPOSE:

The outdoor sensor provides outdoor temperature information to the room thermostat. The room thermostat will use this outdoor air temperature information for dual fuel features such as balance point, restrict back up heating equipment operation or just display what the outdoor temperature is at its location.

OPERATION:

The outdoor sensor is a thermistor that varies resistance with surrounding temperature, resistance of thermistor going up as temperature goes down. Not all thermistor resistances change at the same rate, so for the room thermostat to read the correct temperature it must receive the correct resistance value from the outdoor sensor.

INSTALLATION:

It is important to select an appropriate location to ensure sensor accuracy:

- Choose a protective outdoor location away from direct sunlight or other heat source (best on the north side of a structure).
- Locate away from or near heat-absorbing masses which may reflect stored heat energy, attic vents, soffits or vents.
- Refer to the room thermostat or remote sensor installation instructions for more detailed information on these devices.

Table 1. Thermostat / Sensor Matchups




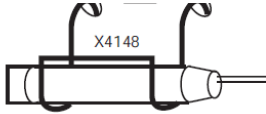









Room Thermostat	Room Thermostat (Catalog #)	Remote Sensor	Remote Sensor (Catalog #)
	81M26, 81M27, 81M28		46M98
	X4146, X4147		X4148
	51M32, 51M33, 51M34, 51M35, 51M37, 51M38, 51M39, 51M42		X2658

Table 1. Thermostat / Sensor Matchups (continued)

Room Thermostat	Room Thermostat (Catalog #)	Remote Sensor	Remote Sensor (Catalog #)
	13H14		X2658
	13H15		
	Y2081		
	49W95		
	88W58		
	12U67		

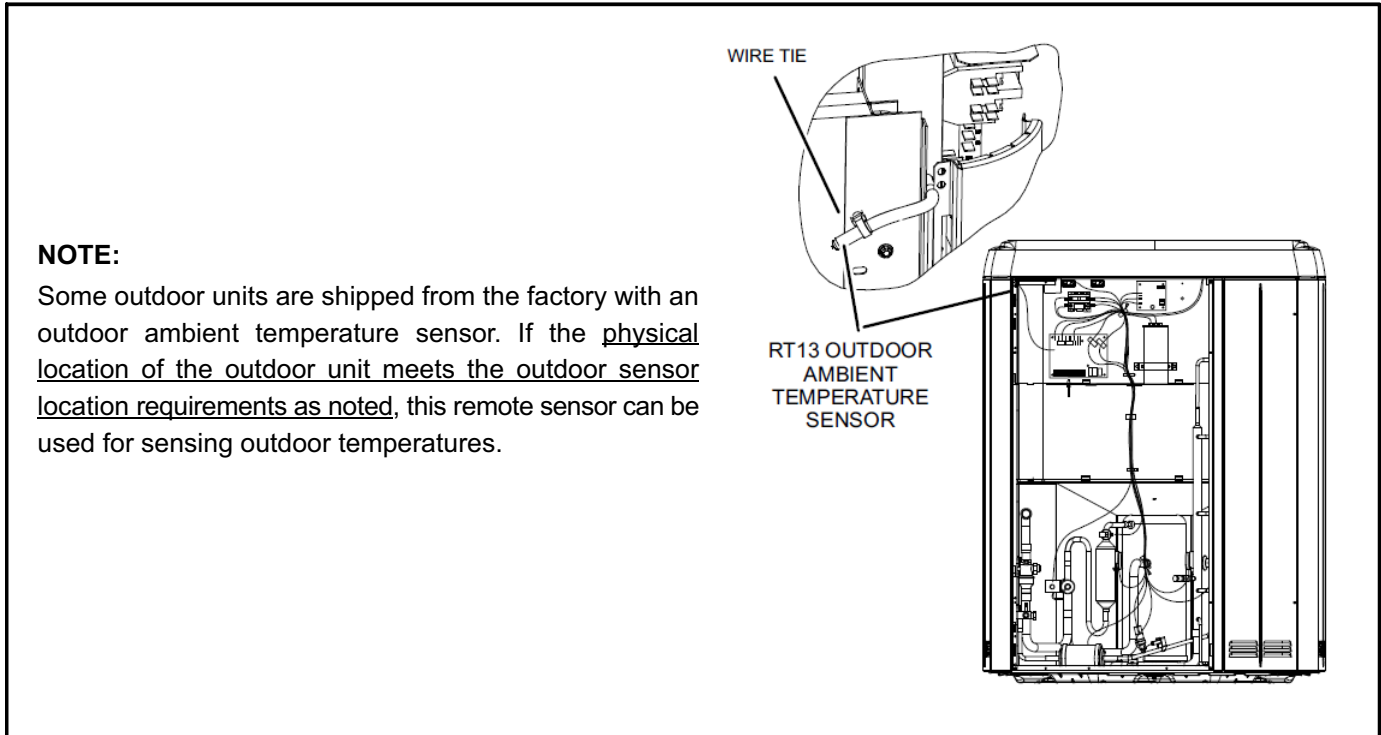


Figure 1. Factory Installed Outdoor Sensor

TROUBLESHOOTING / PROBLEM SOURCE DETERMINATION

Table 2. Troubleshooting

Symptom	Possible cause	Possible Fix
No Outdoor temperature display	Outdoor sensor not connected to proper wire connections. The outdoor sensor feature is not activated on the room thermostat. The incorrect resistance outdoor sensor is installed.	Connect sensor to correct room thermostat terminals. Refer to room thermostat instructions on how to activate outdoor air temperature reading feature. Refer to room thermostat information to determine outdoor sensor match.
Outdoor temperature displayed value on indoor room thermostat not reading correct outdoor temperature.	The incorrect resistance outdoor sensor is installed. Outdoor sensor or wires to sensor could be shorted or loose on wiring terminals. Issue with electrical noise on sensor wires. (Wires next to other electrical devices such as motors) Room thermostat measurement system may be damage.	<ul style="list-style-type: none"> Refer to room thermostat information to determine outdoor sensor match. (Note: Refer to attached charts for resistance to temperature values on sensor). Outdoor sensor should be located away from sources that can affect its ability to accurately measure its surrounding temperature. Check sensor wires for shorting and proper connection to wiring terminals. Reroute the sensor wires away from electrical devices such as motors and lighting, etc. (Note: The 46M98 sensor required a twisted pair of wires between the sensor and the room thermostat) Replace room thermostat.

Table 3. X2658 Outdoor Temperature Sensor (Reading x 1000)

Temp °F (°C)	R _{min}	R _{nominal}	R _{max}	Temp °F (°C)	R _{min}	R _{nominal}	R _{max}
-40 (-40)	184.4	191.8	199.6	42 (6)	20.85	21.22	21.60
-38 (-39)	174.7	181.7	188.9	44 (7)	20.01	20.36	20.71
-36 (-38)	165.6	172.1	178.9	46 (8)	19.21	19.53	19.86
-34 (-37)	157.0	163.1	169.4	48 (9)	18.44	18.74	19.05
-32 (-36)	149.0	154.6	160.5	50 (10)	17.71	17.99	18.28
-31 (-35)	141.3	146.6	152.1	51 (11)	17.01	17.27	17.54
-29 (-34)	134.1	139.1	144.2	53 (12)	16.34	16.59	16.84
-27 (-33)	127.3	132.0	136.8	55 (13)	15.70	15.93	16.17
-25 (-32)	120.9	125.3	129.8	57 (14)	15.09	15.31	15.53
-23 (-31)	114.9	118.9	123.1	59 (15)	14.51	14.71	14.91
-22 (-30)	109.2	113.0	116.9	60 (16)	13.95	14.14	14.33
-20 (-29)	103.7	107.3	111.0	62 (17)	13.42	13.59	13.77
-18 (-28)	98.64	102.0	105.4	64 (18)	12.91	13.07	13.24
-16 (-27)	93.81	96.94	100.2	66 (19)	12.42	12.57	12.73
-14 (-26)	89.24	92.17	95.18	68 (20)	11.95	12.10	12.24
-13 (-25)	84.92	87.66	90.48	69 (21)	11.50	11.64	11.77
-11 (-24)	80.84	83.40	86.04	71 (22)	11.08	11.20	11.33
-9 (-23)	76.97	79.37	81.84	73 (23)	10.67	10.78	10.90
-7 (-22)	73.30	75.56	77.87	75 (24)	10.28	10.38	10.49
-5 (-21)	69.83	71.94	74.11	77 (25)	9.900	10.00	10.10
-4 (-20)	66.55	68.52	70.55	78 (26)	9.533	9.633	9.733
-2 (-19)	63.43	65.29	67.19	80 (27)	9.181	9.281	9.381
-0.4 (-18)	60.48	62.22	64.00	82 (28)	8.845	8.944	9.043
1 (-17)	57.68	59.31	60.98	84 (29)	8.522	8.621	8.720
3 (-16)	55.03	56.55	58.12	86 (30)	8.213	8.311	8.410
5 (-15)	52.51	53.94	55.41	87 (31)	7.916	8.014	8.112
6 (-14)	50.12	51.46	52.84	89 (32)	7.632	7.729	7.827
8 (-13)	47.85	49.11	50.40	91 (33)	7.360	7.456	7.553
10 (-12)	45.70	46.88	48.09	93 (34)	7.099	7.194	7.290
12 (-11)	43.66	44.76	45.89	95 (35)	6.848	6.942	7.038
14 (-10)	41.71	42.75	43.81	96 (36)	6.607	6.701	6.795
16 (-9)	39.87	40.84	41.84	98 (37)	6.377	6.469	6.562
17 (-8)	38.12	39.03	39.96	100 (38)	6.155	6.247	6.339
19 (-7)	36.45	37.31	38.18	102 (39)	5.942	6.033	6.124
21 (-6)	34.86	35.67	36.48	104 (40)	5.738	5.827	5.918
23 (-5)	33.36	34.11	34.88	105 (41)	5.542	5.630	5.719
24 (-4)	31.92	32.63	33.35	107 (42)	5.353	5.440	5.528
26 (-3)	30.56	31.22	31.89	109 (43)	5.172	5.258	5.345
28 (-2)	29.26	29.88	30.51	111 (44)	4.998	5.083	5.168
30 (-1)	28.02	28.60	29.19	113 (45)	4.831	4.914	4.999
32 (0)	26.84	27.39	27.94	114 (46)	4.670	4.752	4.835
33 (1)	25.72	26.23	26.75	116 (47)	4.515	4.596	4.678
35 (2)	24.65	25.13	25.62	118 (48)	4.366	4.446	4.527
37 (3)	23.63	24.08	24.54	120 (49)	4.223	4.302	4.381
39 (4)	22.66	23.08	23.51	122 (50)	4.085	4.163	4.241
41 (5)	21.74	22.13	22.53				

Table 4. X4148 Outdoor Temperature Sensor

Temp °F (°C)	Ohms	Temp °F (°C)	Ohms	Temp °F (°C)	Ohms
4 (-15.4)	55,077	44 (6.7)	20,546	82 (27.8)	9,020
6 (-14.4)	53,358	46 (7.8)	19,626	84 (28.9)	8,659
8 (-13.3)	49,598	48 (8.9)	18,754	86 (30.0)	8,315
10 (-12.2)	47,092	50 (10.0)	17,926	88 (31.1)	7,986
12 (-11.1)	44,732	52 (11.1)	17,136	90 (32.2)	7,672
14 (-10.0)	42,506	54 (12.2)	16,387	92 (33.3)	7,372
16 (-8.9)	40,394	56 (13.3)	15,675	94 (34.4)	7,086
18 (-7.8)	38,400	58 (14.4)	14,999	96 (35.6)	6,813
20 (-6.7)	36,519	60 (15.6)	14,356	98 (36.7)	6,551
22 (-5.6)	34,743	62 (16.7)	13,743	100 (37.8)	6,301
24 (-4.4)	33,063	64 (17.8)	13,161	102 (38.9)	6,062
26 (-3.3)	31,475	66 (18.9)	12,607	104 (40.0)	5,834
28 (-2.2)	29,975	68 (20.0)	12,081	106 (41.1)	5,614
30 (-1.1)	28,558	70 (21.1)	11,578	108 (42.2)	5,404
32 (0.0)	27,219	72 (22.2)	11,100	110 (43.3)	5,203
34 (1.1)	25,949	74 (23.3)	10,644	112 (44.4)	5,010
36 (2.2)	24,749	76 (24.4)	10,210	114 (45.6)	4,826
38 (3.3)	23,613	77 (25)	10,003	116 (46.7)	4,649
40 (4.4)	22,537	78 (25.6)	9,795	118 (47.8)	4,479
42 (5.6)	21,516	80 (26.7)	9,398	120 (48.9)	4,317

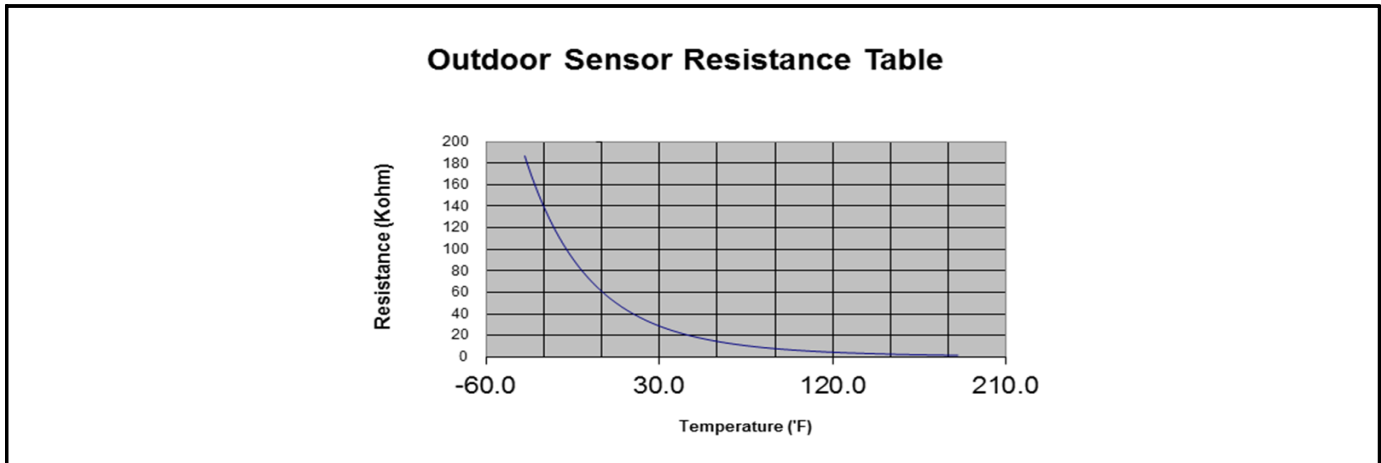


Figure 2. 46M98 Outdoor Temperature Sensor

Table 5. 46M98 Outdoor Temperature Sensor

Outdoor Temperature		Ohms of Resistance
°F	°C	
23	-5	42,160
32	0	32,560
41	5	25,340
50	10	19,870
59	15	15,700
68	20	12,490
77	25	10,000
86	30	8,059
95	35	6,535
104	40	5,330

Table 6. Outdoor Temperature Sensor (icomfort™ -enabled Outdoor Units)

Degrees Fahrenheit	Resistance	Degrees Fahrenheit	Resistance	Degrees Fahrenheit	Resistance	Degrees Fahrenheit	Resistance
136.3	2680	56.8	16657	21.6	44154	-11.3	123152
133.1	2859	56.0	16973	21.0	44851	-11.9	125787
130.1	3040	55.3	17293	20.5	45560	-12.6	128508
127.3	3223	54.6	17616	20.0	46281	-13.2	131320
124.7	3407	53.9	17942	19.4	47014	-13.9	134227
122.1	3592	53.2	18273	18.9	47759	-14.5	137234
119.7	3779	52.5	18607	18.4	48517	-15.2	140347
117.5	3968	51.9	18945	17.8	49289	-15.9	143571
115.3	4159	51.2	19287	17.3	50074	-16.5	146913
113.2	4351	50.5	19633	16.8	50873	-17.2	150378
111.2	4544	49.9	19982	16.3	51686	-17.9	153974
109.3	4740	49.2	20336	15.7	52514	-18.6	157708
107.4	4937	48.5	20695	15.2	53356	-19.3	161588
105.6	5136	47.9	21057	14.7	54215	-20.1	165624
103.9	5336	47.3	21424	14.1	55089	-20.8	169824
102.3	5539	46.6	21795	13.6	55979	-21.5	174200
100.6	5743	46.0	22171	13.1	56887	-22.3	178762
99.1	5949	45.4	22551	12.5	57811	-23.0	183522
97.6	6157	44.7	22936	12.0	58754	-23.8	188493
96.1	6367	44.1	23326	11.5	59715	-24.6	193691
94.7	6578	43.5	23720	11.0	60694	-25.4	199130
93.3	6792	42.9	24120	10.4	61693	-26.2	204829
92.0	7007	42.3	24525	9.9	62712	-27.0	210805
90.6	7225	41.7	24934	9.3	63752	-27.8	217080
89.4	7444	41.1	25349	8.8	64812	-28.7	223677
88.1	7666	40.5	25769	8.3	65895	-29.5	230621
86.9	7890	39.9	26195	7.7	67000	-30.4	237941
85.7	8115	39.3	26626	7.2	68128	-31.3	245667
84.5	8343	38.7	27063	6.7	69281	-32.2	253834
83.4	8573	38.1	27505	6.1	70458	-33.2	262482
82.3	8806	37.5	27954	5.6	71661	-34.1	271655
81.2	9040	37.0	28408	5.0	72890	-35.1	281400
80.1	9277	36.4	28868	4.5	74147	-36.1	291774
79.0	9516	35.8	29335	3.9	75431	-37.1	302840
78.0	9757	35.2	29808	3.4	76745	-38.2	314669
77.0	10001	34.7	30288	2.8	78090	-39.2	327343
76.0	10247	34.1	30774	2.3	79465		
75.0	10496	33.5	31267	1.7	80873		
74.1	10747	33.0	31766	1.2	82314		
73.1	11000	32.4	32273	0.6	83790		
72.2	11256	31.9	32787	0.0	85302		
71.3	11515	31.3	33309	-0.5	86852		
70.4	11776	30.7	33837	-1.1	88440		
69.5	12040	30.2	34374	-1.7	90068		
68.6	12306	29.6	34918	-2.2	91738		
67.7	12575	29.1	35471	-2.8	93452		
66.9	12847	28.6	36031	-3.4	95211		
66.0	13122	28.0	36600	-4.0	97016		
65.2	13400	27.5	37177	-4.6	98870		
64.4	13681	26.9	37764	-5.2	100775		
63.6	13964	26.4	38359	-5.7	102733		
62.8	14251	25.8	38963	-6.3	104746		
62.0	14540	25.3	39577	-6.9	106817		
61.2	14833	24.8	40200	-7.5	108948		
60.5	15129	24.2	40833	-8.2	111141		
59.7	15428	23.7	41476	-8.8	113400		
59.0	15730	23.2	42130	-9.4	115727		
58.2	16036	22.6	42794	-10.0	118126		
57.5	16345	22.1	43468	-10.6	120600		

TROUBLESHOOTING / PROBLEM SOURCE DETERMINATION.

The reading is wrong in one way or another so let's identify the source. The results will point you to; bad connection, bad/wrong wire, bad sensor, or bad wire positioning and resulting noise problems.

1. First isolate the problem by using a substitute outdoor sensor or fixed resistor.
 - 1.1. Measure the substitute sensor with an Ohm meter and check that it reads a reasonable value. Remember your hands will easily heat up the sensor so an 86°F / 8.06K ohm measurement might be considered normal. A sensor in free air will approach room temperature in a few minutes. Inside the plastic case it will take longer.
 - 1.2. Connect the substitute it to the outdoor terminal block in the thermostat with short wires that you trust. This can be the short wires from the sensor or any spare wire jumpers that fit the terminal block. Polarity is not important. Twisted pair wiring is not necessary for this test where the wires are kept at less than 8 feet and kept away from lights, light dimmers, motors and televisions. Only one sensor should be connected to the Outdoor Sensor terminal block.
2. Verify the displayed reading.
 - 2.1. Note that when you connect the sensor to a working unit the display controller should indicate the available information within 30 seconds. If not, you have a problem with the terminal block connections or the Display board (front half of the unit). You may temporarily substitute a front half of the same model number to observe operation. Keep the base and front cover matched to avoid revision mismatches that might cause loss of thermostat features.
 - 2.2. If a value shows up but it is very wrong or does not change when you expect it to change, then there is likely a problem with the Display board. Try a temporary exchange with an equivalent model and see that the problem is gone when you use a new display board.
 - 2.3. If the information shows up, is correct, and acts as expected, you have verified the unit and sensor.
3. Check the installation and long wire hook up.
 - 3.1. An optional step: Now attach the sensor to long wires in the same room as the thermostat. If the information shows up, is correct, and acts as expected, you have verified the unit and sensor at the end of a long wire.
 - 3.2. With the thermostat working (Fan OFF, Heat OFF, Cool OFF) but with the installed outdoor sensor wires disconnected from the thermostat, measure the voltage from the installed sensor wire pair to C. There should be only a small noise voltage, possibly 1 volt or less. No 24Vac signals at all. Determine the source of high voltage if it is present. It may have already damaged the thermostat.
 - 3.3. If there is no high voltage it is safe to measure the resistance from the wire pairs to C and R. There should be no connection to C or R. If a low (less than 1Megohm) resistance is seen then determine the source of the short or miswired connection.
 - 3.4. Measure the resistance across the sensor wire pair. If the sensor or a fixed resistor is installed you should see the expected resistance and expected changes. If the wrong resistance is observed find the source of the short or miswired connection. See the next step if the resistance is close and the wire resistance is in question.
 - 3.5. Short the leads together at the sensor and measure the resistance at the thermostat end of the wires. 18 AWG wire is <6 ohms per 1000 ft. 24AWG is <26ohms per 1000 ft. You should be measuring about 1 to 26 ohms and that will only amount to something less than a -0.2 degree error. If you see significantly greater resistance (30 Ohms or more) than expected, find the cause and correct it. Noise sometimes causes high and variable readings.

If displayed readings are still bad but the previous steps were acceptable or close but not stable, look for noise by activating the fan, disconnecting the sensor, and remove the short if present, from the far end and measure the voltage on the supposedly isolated wires. It should be near zero (Less than 1 volt) **or easily suppressed by reconnecting the sensor across the leads.** [If not, you may have a noise problem. Attempt to solve by rerouting the wire away from noise sources (Furnaces, fans, fluorescent lights, light dimmers, fan speed controls, AC house wiring) or using twisted pair as advised in the instructions].