Home Automation, Inc.

Omnistat2

RC-1000 and RC-2000
Communicating Thermostat

Serial Protocol Description

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INTRODUCTION

This document describes the serial communications protocol of the HAI Omnistat2 RC1000 and RC2000 communicating thermostats. The Omnistat2 Series thermostats are capable of several communications modes. This document describes two: RS-232 mode and System mode. These differ in electrical connections and transmission speed. The messages, however, are the same for both modes.

ELECTRICAL CONNECTIONS

RS-232 mode

Intended for connection to personal computers or other systems with RS-232 ports. 4 wires to the thermostat: DTR, RXD, TXD and Ground. All wires are optically isolated in the thermostat. The thermostat transmits with a modified RS-232 transmitter that can be tri-state (high impedance) so that more than one thermostat can be connected in parallel to a single RS-232 port.

In RS-232 mode, the transmitted RS-232 voltage levels are generated by using DTR as a source for +12 volts when transmitting a space (0 bit) and the received RS-232 signal as a source for -12 volts when transmitting a mark (1 bit). Therefore, DTR must be set high at all times by the host, and the host must not transmit while a thermostat is transmitting.

A typical RS-232 port on a personal computer can drive 4 thermostats directly using HAI p/n RC-201 cable. A signal booster (HAI p/n RC-202) is needed to increase the output current of the RS-232 port for more than 4 thermostats.

System mode

Intended for connection to automation systems that do not have RS-232 voltage levels. 3 wires to the thermostat: TXD, RXD, and GND. The communications wires are optically isolated from the HVAC circuits in the thermostat. RXD is 0V when the host is sending a mark (bit 1) or idle, 12 V when host is transmitting a space (bit 0). The thermostat TXD is an open collector optoisolator, open when idle or transmitting a mark (bit 1) or conducting to GND when transmitting a space (bit 0.)

ELECTRICAL SPECIFICATIONS

RS-232 mode:

Thermostat receiver - The thermostat will draw the following current at the following voltage:

RS-232 receive space (bit 0):	2.0mA at 12V
RS-232 receive mark (bit 1)	
transmitter idle:	0.0mA at -12V
transmitter active:	-4 ma max at -12 V

Thermostat transmitter - The thermostat will provide the following current and voltage. Note that +12 is drawn from DTR, -12 V is drawn from the thermostat receive line (TXD) while it is idle.

tri state: (off):	open collector, 0mA
RS-232 transmit space (bit 0):	10V at 4mA
RS-232 transmit mark (bit 1):	10V at -4mA

Note: these levels are compatible with RS-232.

System mode:

Thermostat receiver

System mode receive space (bit 0) :	1.0mA at 12V
System mode receive mark (bit 1):	0.0mA at 0V

Thermostat transmitter

tri state: (off):	open collector, 0mA
System mode transmit space (bit 0):	2 V maximum at 4mA
System mode transmit mark (bit 1):	open collector, 0mA

PROTOCOL

The thermostat will respond to properly formatted messages from a polling device. The thermostat does not initiate messages. The protocol is half-duplex, meaning that the thermostat does not receive while it is transmitting. The host must not transmit while the thermostat is transmitting.

a. Byte format: 1 start bit, 8 data bits, 1 stop bit, no parity. LSB is transmitted first.

b. Data rates: 100, 300, 1200, 2400, and 9600 baud.

c. Message Format:

Byte 1:	Start/Remote Address
Bit 0-6:	Remote address (0 - 127, 0 = broadcast, 250 = universal address)
Bit 7:	1 for thermostat reply 0 for host message
Byte 2:	Data Length/Message type
Bits 7-4:	Data Length (0 - 15), invalid for ASCII strings.
Bits 3-0:	Message Type (0 - 15)
Bytes 3-n:	Data 0 to 15 bytes
Byte n+1:	checksum (add bytes 1-N to get checksum)

HOST TIMING REQUIREMENTS

a. The host initiates polls. The host should not poll while a thermostat is transmitting.

b. The thermostat will reply to a poll with a response.

c. Thermostats do not reply to broadcast messages (remote address 0). Thermostats always respond to address 250.

d. A thermostat will not take action on, nor reply to a message with an invalid checksum byte. If a thermostat does not reply, the host should try again after an intermessage timeout.

e. Intermessage (between messages) timeout: 1.25 seconds. If a thermostat does not reply, the host should wait a minimum of 1.25 seconds after the end of the host's transmission to retry the message.

f. Intramessage (within messages) timeout: 500ms. There should be no gaps longer than 500ms between bytes of a message.

g. The thermostat takes a maximum of 30ms to set a register. When setting registers, the thermostat will reply after it has written the registers to its internal EEPROM. The host may transmit another message immediately after the thermostat completes its reply. If setting registers with a broadcast message, the thermostat will not reply, and it will not enable its receiver until after it has written all registers. Therefore, when using a broadcast message, the host must wait at least 30ms per register set before starting any subsequent message. A worst case example is to send a broadcast message that sets 14 registers. The host must wait 14*30ms = 420ms before sending any other message.

THERMOSTAT ERROR HANDLING AND BIT TIMING:

a. Error handling: If a framing error occurs (no start or stop bit where one was expected) or an incorrect checksum is detected, the thermostat ignores the remainder of the message. The thermostat will continue to receive and ignore bytes until an intramessage timeout occurs.

b. Bit timing: The center of each bit of the reply occurs at integer intervals of the beginning of the start bit of the last byte in the message that caused the reply. The thermostat requires anywhere from 0 to 420ms to format a reply and begin sending it. Therefore, a reply could begin anywhere from 0.5 to 42.5 bit times after the end of the stop bit of the message that caused the reply at 100 baud. However, the reply will always start on .5 bit time intervals (1.5, 3.5, etc.).

Note: this bit timing is compatible with all PC serial ports, and any other port with a hardware Universal Asynchronous Receiver Transmitter (UART). It also allows communications with a software UART using input/output pins, because the bits of the reply are synchronized with the transmitter's bit clock.

MESSAGE TYPES

a. Host to Thermostat

0: Poll for register(s)

This message requests from one to 14 registers be returned in a Data message. The thermostat will reply with the data or a negative acknowledge.

RA	
DL/MT	2 / 0
DATA	first register address, number of registers (1-14)
CKSUM	

Valid response message types:
Data
Negative Acknowledge (message received but invalid register address)

1: Set Register(s)

This message tells the thermostat to set one to 14 consecutive registers starting with the "start register address". The number of registers to set with the data bytes following the "start register address" is determined by subtracting one (1) from the data length DL. If the start register is an ASCII string register, the data length (DL) is ignored and the ASCII string is written. If an ASCII string register is the start register, the DATA is the string followed by an End Of text (0x03) to signify the checksum is the next byte.

RA
DL/MT 2-15 / 1
DATA start register address, data byte(s)
CKSUM

Valid response message types:
Acknowledge (message received and accepted)
Negative acknowledge (one or more registers out of range)

2: Poll for Group 1 data

This message requests a special data message containing cool setpoint, heat setpoint, mode, fan, hold and current temperature.

RA
DL/MT 0 / 2
CKSUM

Valid response
Group 1 data

3: Poll for group 2 data

Request for a special data message containing group 2 data.

RA
DL/MT 0 / 3
CKSUM

Valid response
Group 2 data

4: Poll for group 3 data

Request for a special data message containing group 3 data.

RA
DL/MT 0 / 4
CKSUM

Valid response
Group 3 data

b. Thermostat responses to Host

0: Acknowledge
Information sent by the host has been received and accepted.

RA
DL/MT 0 / 0
CKSUM

1: Negative acknowledge

Information sent by the host has been received but is invalid or out of range.

RA	
DL/MT	0 / 1
CKSUM	

2: Data

The thermostat is returning the data requested in a "Poll for registers" message. If the start register is an ASCII string register, data length (DL) is ignored. If a string is being responded, it will end with an End Of Text (0x03) to signify the end of string.

RA	
DL/MT	1-15 / 2
DATA	Start register, 1 - 14 bytes corresponding to registers requested
CKSUM	

3: Group 1 Data

The thermostat is returning the following specific registers: cool setpoint, heat setpoint, mode, fan, hold, current temperature.

RA	
DL/MT	6 / 3
DATA	cool setpoint, heat setpoint, mode, fan, hold, current temperature
CKSUM	

4: Group 2 Data

The thermostat is returning specific registers: Indoor Humidity (162), Dehumidify Setpoint (135), Humidify setpoint (134), Outside temperature (68), Filter days left (15), Energy Level (169).

RA	
DL/MT	6 / 3
DATA	Indoor Humidity, Dehumidify setpoint, Humidify setpoint, Outdoor temperature, Filter days left, Energy Level
CKSUM	

5: Group 3 Data

The thermostat is returning specific registers: Energy Level (169), Mid level setback (18), High level setback (19), Critical level setback (20), Energy Price (74), Energy total cost upper (170), Energy total cost lower (171), Medium price (165), High price (166), Critical price (167).

RA	
DL/MT	B / 3
DATA	Energy Level, Mid level setback, High level setback, Critical level setback, Energy Price, Energy total cost upper, Energy total cost lower, Medium price, High price, Critical price.
CKSUM	

Example Messages (Data shown in parenthesis are in Hex)

Host: Poll thermostat 1 for Group 1 data:
RA(01), DL/MT(02), CS(03)

Thermostat 1: RA(81), DL/MT(63), low setpoint(xx), high setpoint(xx), mode(xx), fan(xx), hold(xx), current temperature (xx), CS(xx)

Host: Broadcast time:
RA(00), DL/MT(41), start register(41), seconds(xx), minutes(xx) , hours(xx), CS(xx)

Thermostat(s): no reply, it was a broadcast message.

The host should wait a minimum of 90ms before transmitting next message.

Host: Set cooling setpoint on thermostat 5
RA(05), DL/MT(21), start register(3B), setpoint(xx), CS(xx)

Thermostat 5: RA(85), MT/DL(00), CS(85) (acknowledge)

Host: Set the energy custom message to "CUSTOM MESSAGE" on thermostat 1.

RA(01),DL/MT(21), start register(AF) , 'C'(43), 'U'(55), 'S'(53) , 'T'(54), 'O'(4F), 'M'(4D), ' '(20), 'M'(4D), 'E'(45), 'S'(53), 'S'(53), 'A'(41), 'G' (47), 'E' (45), ETX (03), CS(34)

Thermostat 1: RA(81), MT/DL(00), CS(81) (acknowledge)

INTERNAL REGISTERS (RO = READ ONLY)

Setup:

0 (RO) Communication address of the thermostat (1-127)
1 (RO) Communication mode baud (0=300, 1=100, 42=1200, 54=2400, 126=9600, 211=Day/Night)
2 (RO) System type (0/1=Heat/Cool-Auto, 4/5= Heat/Cool-Manual, 12/13=Heat only, 20=Cool only, odd=Fan on with heat, even=Fan off with heat)
3 Display Options (Bit 0: 0=Celsius, 1=Fahrenheit; Bit 1: 0=12hour, 1=24hour; Bit 2: 0=Advanced display, 1=Simple display)
4 Calibration offset (+\- 30 Omnitemp units)
5 Low Cool Limit (51-91 Omnitemp units)
6 High Heat Limit (51-91 Omnitemp units)
7 Energy Efficient Control (Turn on, 1 or off, 0 the EEC)
8 Current OMNI version
9 Cool Anticipator (1-10, only valid in 1 stage units, 1=AC comes on the cycles air frequently, 10=infrequently)
10 Second stage differential (for multi stage units)
11 Cooling cycle time (2-30 minutes, ignored if used separate on/off times)
12 Heating cycle time (2-30 minutes, ignored if used separate on/off times)
13 Third stage differential (for multi stage units)
14 Clock adjust (+/- 30 seconds per day, 0=-30, 60=+30)
15 Days remaining for filter reminder
16 (RO) System run time, current week - hours
17 (RO) System run time, last week - hours

Energy Setback Registers:

18 Number of degrees to setback for medium energy level (in Fahrenheit)
19 Number of degrees to setback for high energy level (in Fahrenheit)
20 Number of degrees to setback for critical energy level (in Fahrenheit)

Programming Monday, Saturday, Sunday:

21 Programming Monday morning time (15 minute increments)
22 Programming Monday morning cool setpoint (in Omnitemp)
23 Programming Monday morning heat setpoint (in Omnitemp)
24 Programming Monday day time (15 minute increments)
25 Programming Monday day cool setpoint (in Omnitemp)
26 Programming Monday day heat setpoint (in Omnitemp)
27 Programming Monday evening time (15 minute increments)
28 Programming Monday evening cool setpoint (in Omnitemp)
29 Programming Monday evening heat setpoint (in Omnitemp)
30 Programming Monday night time (15 minute increments)
31 Programming Monday night cool setpoint (in Omnitemp)
32 Programming Monday night heat setpoint (in Omnitemp)
33 Programming Saturday morning time (15 minute increments)
34 Programming Saturday morning cool setpoint (in Omnitemp)
35 Programming Saturday morning heat setpoint (in Omnitemp)
36 Programming Saturday day time (15 minute increments)
37 Programming Saturday day cool setpoint (in Omnitemp)
38 Programming Saturday day heat setpoint (in Omnitemp)
39 Programming Saturday evening time (15 minute increments)
40 Programming Saturday evening cool setpoint (in Omnitemp)
41 Programming Saturday evening heat setpoint (in Omnitemp)
42 Programming Saturday night time (15 minute increments)
43 Programming Saturday night cool setpoint (in Omnitemp)
44 Programming Saturday night heat setpoint (in Omnitemp)
45 Programming Sunday morning time (15 minute increments)
46 Programming Sunday morning cool setpoint (in Omnitemp)
47 Programming Sunday morning heat setpoint (in Omnitemp)
48 Programming Sunday day time (15 minute increments)
49 Programming Sunday day cool setpoint (in Omnitemp)
50 Programming Sunday day heat setpoint (in Omnitemp)
51 Programming Sunday evening time (15 minute increments)
52 Programming Sunday evening cool setpoint (in Omnitemp)
53 Programming Sunday evening heat setpoint (in Omnitemp)
54 Programming Sunday night time (15 minute increments)
55 Programming Sunday night cool setpoint (in Omnitemp)
56 Programming Sunday night heat setpoint (in Omnitemp)

Status:

57 Outside humidity
58 Current day of the week (0=Sunday)
59 Cool Setpoint (51-91 in Omnitemp)
60 Heat Setpoint (51-91 in Omnitemp)
61 Current mode (0=Off, 1=Heat, 2=Cool, 3=Auto, 4=EM Heat)
62 Fan mode (0=Auto, 1=On, 2=Cycle)
63 Hold mode (0=Off, 1=On, 2=Vacation)
64 Current temperature (in Omnitemp)
65 Current time – seconds (0-59)
66 Current time – minutes (0-59)
67 Current time – hours (0-23)
68 Current outside temperature (in Omnitemp)
70 Energy price level set by controller (0=low, 1=Mid, 2=High, 4=Critical)
71 Current mode (0=Off, 1=Heat, 2=Cool)
72 Current status of Relays
73 Model number
74 Current energy cost (0 – 254, 255=disabled)

Programming Tuesday - Friday:

75 Programming Tuesday morning time (15 minute increments)
76 Programming Tuesday morning cool setpoint (in Omnitemp)
77 Programming Tuesday morning heat setpoint (in Omnitemp)
78 Programming Tuesday day time (15 minute increments)
79 Programming Tuesday day cool setpoint (in Omnitemp)
80 Programming Tuesday day heat setpoint (in Omnitemp)
81 Programming Tuesday evening time (15 minute increments)
82 Programming Tuesday evening cool setpoint (in Omnitemp)
83 Programming Tuesday evening heat setpoint (in Omnitemp)
84 Programming Tuesday night time (15 minute increments)
85 Programming Tuesday night cool setpoint (in Omnitemp)
86 Programming Tuesday night heat setpoint (in Omnitemp)
87 Programming Wednesday morning time (15 minute increments)
88 Programming Wednesday morning cool setpoint (in Omnitemp)
89 Programming Wednesday morning heat setpoint (in Omnitemp)
90 Programming Wednesday day time (15 minute increments)
91 Programming Wednesday day cool setpoint (in Omnitemp)
92 Programming Wednesday day heat setpoint (in Omnitemp)
93 Programming Wednesday evening time (15 minute increments)
94 Programming Wednesday evening cool setpoint (in Omnitemp)
95 Programming Wednesday evening heat setpoint (in Omnitemp)
96 Programming Wednesday night time (15 minute increments)
97 Programming Wednesday night cool setpoint (in Omnitemp)
98 Programming Wednesday night heat setpoint (in Omnitemp)
99 Programming Thursday morning time (15 minute increments)
100 Programming Thursday morning cool setpoint (in Omnitemp)
101 Programming Thursday morning heat setpoint (in Omnitemp)
102 Programming Thursday day time (15 minute increments)
103 Programming Thursday day cool setpoint (in Omnitemp)
104 Programming Thursday day heat setpoint (in Omnitemp)
105 Programming Thursday evening time (15 minute increments)
106 Programming Thursday evening cool setpoint (in Omnitemp)

107 Programming Thursday evening heat setpoint (in Omnitemp)
108 Programming Thursday night time (15 minute increments)
109 Programming Thursday night cool setpoint (in Omnitemp)
110 Programming Thursday night heat setpoint (in Omnitemp)
111 Programming Friday morning time (15 minute increments)
112 Programming Friday morning cool setpoint (in Omnitemp)
113 Programming Friday morning heat setpoint (in Omnitemp)
114 Programming Friday day time (15 minute increments)
115 Programming Friday day cool setpoint (in Omnitemp)
116 Programming Friday day heat setpoint (in Omnitemp)
117 Programming Friday evening time (15 minute increments)
118 Programming Friday evening cool setpoint (in Omnitemp)
119 Programming Friday evening heat setpoint (in Omnitemp)
120 Programming Friday night time (15 minute increments)
121 Programming Friday night cool setpoint (in Omnitemp)
122 Programming Friday night heat setpoint (in Omnitemp)

Programming Occupancy:

123 Programming Day Cool setpoint (in Omnitemp)
124 Programming Day Heat setpoint (in Omnitemp)
125 Programming Night Cool setpoint (in Omnitemp)
126 Programming Night Heat setpoint (in Omnitemp)
127 Programming Away Cool setpoint (in Omnitemp)
128 Programming Away Heat setpoint (in Omnitemp)
129 Programming Vacation Cool setpoint (in Omnitemp)
130 Programming Vacation Heat setpoint (in Omnitemp)

Setup:

131 Program mode (0=None, 1=Schedule, 2=Occupancy)
132 Expansion baud (0=300, 1=100, 42=1200, 54=2400, 126=9600)
133 Days until filter reminder appears
134 Humidity Setpoint
135 Dehumidify Setpoint
136 Dehumidifier output options (0=Not used, 1=Standalone, 2= variable speed fan)
137 Humidifier output (0=Not used, 1=Standalone)
138 Minutes out of 20 that fan is on during cycle (1-19)
139 Backlight settings (0=Off, 1=On, 2=Auto)
140 Backlight color (0-100)
141 Backlight intensity (1-10)
142 Selective message enable/disable
143 Minimum on time for cool (2-30)
144 Minimum off time for cool (2-30)
145 Minimum on time for heat (2-30)
146 Minimum off time for heat (2-30)
147 System type (0=Heat Pump, 1=Conventional, 2=Dual Fuel)
148 Reserved
149 End of vacation date: day
151 End of vacation date: hour
152 Hours HVAC used in Week 0
153 Hours HVAC used in Week 1
154 Hours HVAC used in Week 2
155 Hours HVAC used in Week 3

156 Reserved
157 Reserved
158 Enable/disable individual temp sensors
159 Number of cool stages
160 Number of heat stages
161 Current occupancy mode (0=Day, 1=Night, 2=Away, 3=Vacation)
162 Current indoor humidity
163 Cool setpoint for vacation mode (51-91)
164 Heat setpoint for vacation mode (51-91)

Energy:

165 Displayed price of energy with medium level energy
166 Displayed price of energy with high level energy
167 Displayed price of energy with critical level energy
168 Sensitivity setting for proximity sensor (0-99)
169 Energy level as set by the meter
170 Current energy total cost, upper byte
171 Current energy total cost, lower byte
172 STRING ASCII display for first load control module
173 STRING ASCII display for second load control module
174 STRING ASCII display for third load control module
175 STRING ASCII display for Energy message
176 STRING ASCII display for emergency broadcast message (not implemented)
177 STRING ASCII display for custom message (not implemented)
178 STRING ASCII display for energy graph title bar
179 STRING ASCII display for energy graph x axis
180 STRING ASCII display for energy graph y axis
181 STRING ASCII display for long messages (not implemented)
182 graph bar max height, upper byte
183 graph bar max height, lower byte
184 graph bar one value, upper byte
185 graph bar one value, lower byte
186 graph bar two value, upper byte
187 graph bar two value, lower byte
188 graph bar three value, upper byte
189 graph bar three value, lower byte
190 graph bar four value, upper byte
191 graph bar four value, lower byte
192 Status and enable/disable of each load control module

Sensors:

200 Current temperature of sensor 3
201 Current temperature of sensor 4
202 Reserved

Wireless:

224	Wireless MAC address byte 1
225	Wireless MAC address byte 2
226	Wireless MAC address byte 3
227	Wireless MAC address byte 4
228	Wireless MAC address byte 5
229	Wireless MAC address byte 6
230	Wireless MAC address byte 7
231	Wireless MAC address byte 8
232	Wireless firmware version integer place
233	Wireless firmware version decimal place
234	Wireless strength (0-100)
235	Wireless buzzer enable or disable
236	Wireless IP address byte 1
237	Wireless IP address byte 2
238	Wireless IP address byte 3
239	Wireless IP address byte 4
253	Reserved
254	Reserved

REGISTER NOTES

a. Outside Temperature: writing to the outside temperature register will cause the thermostat to display the outside temperature every 4 seconds. The thermostat will stop displaying the outside temperature if this register is not refreshed at least every 5 minutes.

b. Registers with an upper and lower byte: These registers combine to make a 16 bit number (0-65025). The 10,000 decimal place is the decimal precision. For example: Register 182 is 0x87 and register 183 is 0x07, which makes 0x8707 or 34567 in decimal. This combined value will be evaluated as 4.567.

DATA FORMATS

a. Registers: All registers are 1 byte long.

b. Temperatures: "Omni" format: Temperatures are 1 byte, 0 to 255. 0 is -40 degrees Celsius and -40 degrees Fahrenheit. 255 is 87.5 degrees Celsius, 189 degrees Fahrenheit. Each increment is .5 degrees Celsius. A table is presented in appendix A relating temperature bytes to degrees C and F. In Fahrenheit mode, the thermostat rounds the display to the nearest whole degree. (71.6 and 72.5 will be displayed as 72.) In Celsius mode, half degree increments are displayed.

c. Programming register time: Time in 15 minute increments. 0 is 0:00 hours, 1 is 0:15, 2 is 0:30,… 95 is 23:45. 96 = blank display, thermostat treats this as having no time for this period (period not in use)

OTHER COMMUNICATIONS MODES

Day/Night Mode:

The thermostat input is a 12V signal to select preprogrammed night setpoints, no 12V signal to select preprogrammed day setpoints. This mode is intended for operation with occupied/unoccupied switches or control systems. Serial protocol is not used in day/night mode.

APPENDIX A – Omnitemp to C to F Table

Omni	Deg. C	Deg. F	Omni	Deg. C	Deg. F	Omni	Deg. C	Deg. F
0	- 40.0	- 40.0	44	- 18.0	- 00.4	88	04.0	39.2
1	- 39.5	- 39.1	45	- 17.5	00.5	89	04.5	40.1
2	- 39.0	- 38.2	46	- 17.0	01.4	90	05.0	41.0
3	- 38.5	- 37.3	47	- 16.5	02.3	91	05.5	41.9
4	- 38.0	- 36.4	48	- 16.0	03.2	92	06.0	42.8
5	- 37.5	- 35.5	49	- 15.5	04.1	93	06.5	43.7
6	- 37.0	- 34.6	50	- 15.0	05.0	94	07.0	44.6
7	- 36.5	- 33.7	51	- 14.5	05.9	95	07.5	45.5
8	- 36.0	- 32.8	52	- 14.0	06.8	96	08.0	46.4
9	- 35.5	- 31.9	53	- 13.5	07.7	97	08.5	47.3
10	- 35.0	- 31.0	54	- 13.0	08.6	98	09.0	48.2
11	- 34.5	- 30.1	55	- 12.5	09.5	99	09.5	49.1
12	- 34.0	- 29.2	56	- 12.0	10.4	100	10.0	50.0
13	- 33.5	- 28.3	57	- 11.5	11.3	101	10.5	50.9
14	- 33.0	- 27.4	58	- 11.0	12.2	102	11.0	51.8
15	- 32.5	- 26.5	59	- 10.5	13.1	103	11.5	52.7
16	- 32.0	- 25.6	60	- 10.0	14.0	104	12.0	53.6
17	- 31.5	- 24.7	61	- 09.5	14.9	105	12.5	54.5
18	- 31.0	- 23.8	62	- 09.0	15.8	106	13.0	55.4
19	- 30.5	- 22.9	63	- 08.5	16.7	107	13.5	56.3
20	- 30.0	- 22.0	64	- 08.0	17.6	108	14.0	57.2
21	- 29.5	- 21.1	65	- 07.5	18.5	109	14.5	58.1
22	- 29.0	- 20.2	66	- 07.0	19.4	110	15.0	59.0
23	- 28.5	- 19.3	67	- 06.5	20.3	111	15.5	59.9
24	- 28.0	- 18.4	68	- 06.0	21.2	112	16.0	60.8
25	- 27.5	- 17.5	69	- 05.5	22.1	113	16.5	61.7
26	- 27.0	- 16.6	70	- 05.0	23.0	114	17.0	62.6
27	- 26.5	- 15.7	71	- 04.5	23.9	115	17.5	63.5
28	- 26.0	- 14.4	72	- 04.0	24.8	116	18.0	64.4
29	- 25.5	- 13.9	73	- 03.5	25.7	117	18.5	65.3
30	- 25.0	- 13.0	74	- 03.0	26.6	118	19.0	66.2
31	- 24.5	- 12.1	75	- 02.5	27.5	119	19.5	67.1
32	- 24.0	- 11.2	76	- 02.0	28.4	120	20.0	68.0
33	- 23.5	- 10.3	77	- 01.5	29.3	121	20.5	68.9
34	- 23.0	- 09.4	78	- 01.0	30.2	122	21.0	69.8
35	- 22.5	- 08.5	79	- 00.5	31.1	123	21.5	70.7
36	- 22.0	- 07.6	80	0	32.0	124	22.0	71.6
37	- 21.5	- 06.7	81	00.5	32.9	125	22.5	72.5
38	- 21.0	- 05.8	82	01.0	33.8	126	23.0	73.4
39	- 20.5	- 04.9	83	01.5	34.7	127	23.5	74.3
40	- 20.0	- 04.0	84	02.0	35.6	128	24.0	75.2
41	- 19.5	- 03.1	85	02.5	36.5	129	24.5	76.1
42	- 19.0	- 02.2	86	03.0	37.4	130	25.0	77.0
43	- 18.5	- 01.3	87	03.5	38.3	131	25.5	77.9

Omni	Deg. C	Deg. F		Omni	Deg. C	Deg. F		Omni	Deg. C	Deg. F
132	26.0	78.8		176	48.0	118.4		220	70.0	158.0
133	26.5	79.7		177	48.5	119.3		221	70.5	158.9
134	27.0	80.6		178	49.0	120.2		222	71.0	159.8
135	27.5	81.5		179	49.5	121.1		223	71.5	160.7
136	28.0	82.4		180	50.0	122.0		224	72.0	161.6
137	28.5	83.3		181	50.5	122.9		225	72.5	162.5
138	29.0	84.2		182	51.0	123.8		226	73.0	163.4
139	29.5	85.1		183	51.5	124.7		227	73.5	164.3
140	30.0	86.0		184	52.0	125.6		228	74.0	165.2
141	30.5	86.9		185	52.5	126.5		229	74.5	166.1
142	31.0	87.8		186	53.0	127.4		230	75.0	167.0
143	31.5	88.7		187	53.5	127.3		231	75.5	167.9
144	32.0	89.6		188	54.0	129.2		232	76.0	168.8
145	32.5	90.5		189	54.5	130.1		233	76.5	169.7
146	33.0	91.4		190	55.0	131.0		234	77.0	170.6
147	33.5	92.3		191	55.5	131.9		235	77.5	171.5
148	34.0	93.2		192	56.0	132.8		236	78.0	172.4
149	34.5	94.1		193	56.5	133.7		237	78.5	173.3
150	35.0	95.0		194	57.0	134.6		238	79.0	174.2
151	35.5	95.9		195	57.5	135.5		239	79.5	175.1
152	36.0	96.8		196	58.0	136.4		240	80.0	176.0
153	36.5	97.7		197	58.5	137.3		241	80.5	176.9
154	37.0	98.6		198	59.0	138.2		242	81.0	177.8
155	37.5	99.5		199	59.5	139.1		243	81.5	178.7
156	38.0	100.4		200	60.0	140.0		244	82.0	179.6
157	38.5	101.3		201	60.5	140.9		245	82.5	180.5
158	39.0	102.2		202	61.0	141.8		246	83.0	181.4
159	39.5	103.1		203	61.5	142.7		247	83.5	182.3
160	40.0	104.0		204	62.0	143.6		248	84.0	183.2
161	40.5	104.9		205	62.5	144.5		249	84.5	184.1
162	41.0	105.8		206	63.0	145.4		250	85.0	185.0
163	41.5	106.7		207	63.5	146.3		251	85.5	185.9
164	42.0	107.6		208	64.0	147.2		252	86.0	186.8
165	42.5	108.5		209	64.5	148.1		253	86.5	187.7
166	43.0	109.4		210	65.0	149.0		254	87.0	188.6
167	43.5	110.3		211	65.5	149.9		255	87.5	189.5
168	44.0	111.2		212	66.0	150.8				
169	44.5	112.1		213	66.5	151.7				
170	45.0	113.0		214	67.0	152.6				
171	45.5	113.9		215	67.5	153.5				
172	46.0	114.8		216	68.0	154.4				
173	46.5	115.7		217	68.5	155.3				
174	47.0	116.6		218	69.0	156.2				
175	47.5	117.5		219	69.5	157.1				

APPENDIX B – Direct Connect Cables

A typical RS-232 port on a personal computer can drive 4 thermostats directly on up to 500 feet of wire. HAI makes a 10 foot cable, p/n RC-201, with a DB-9F on one end and the thermostat connector on the other. You can make this cable easily as described below. For more than 4 thermostats or wiring lengths greater than 500 feet, HAI recommends the RC-202 signal booster to increase the drive capacity of the RS-232 port and to provide additional surge protection for the serial port. An RC-202 can drive up to 127 thermostats over 10,000 feet of wire.

Direct Connect Cables

Serial ports on most computers have two connector types: DB-9M and DB-25M. To make a cable to connect one or more thermostats to this port, you will need:

1. One DB-9F or DB-25F connector, depending whether your computer has a DB-9M or DB-25M connector for its serial port (F stands for female, M stands for male).

2. Four (4) conductor wire. Use 22 to 24 gauge shielded or unshielded, stranded or solid, twisted or untwisted, the wire type is not critical. Use shielded if your environment calls for running the communications wire along with power wires, and connect the shield to a good ground at the computer (do not connect the shield at the thermostat).

Make the connections as follows:

If using a DB-9F connector:

1. On the DB-9F connector: Connect pins 7 and 8 together. (RTS and CTS)
2. On the DB-9F connector: Connect pins 1, 6 and 4 together. (DCD, DTR and DSR)
3. Connect pin 4 of the DB-9F to the YELLOW connector on the COMM portion of connectors on the thermostat back housing. (DTR)
4. Connect pin 3 of the DB-9F to the GREEN connector on the COMM portion of connectors on the thermostat back housing. (TXD)
5. Connect pin 2 of the DB-9F to the BLACK connector on the COMM portion of connectors on the thermostat back housing. (RXD)
6. Connect pin 5 of the DB-9F to the N/C connector on the COMM portion of connectors on the thermostat back housing. (GND)

If using a DB-25F connector:

1. On the DB-25F connector: Connect pins 4 and 5 together. (RTS and CTS)
2. On the DB-25F connector: Connect pins 8, 6 and 20 together. (DCD, DTR and DSR)
3. Connect pin 20 of the DB-25F to the YELLOW connector on the COMM portion of connectors on the thermostat back housing. (DTR)
4. Connect pin 2 of the DB-25F to the GREEN connector on the COMM portion of connectors on the thermostat back housing. housing (TXD)
5. Connect pin 3 of the DB-25F to the BLACK connector on the COMM portion of connectors on the thermostat back housing. (RXD)
6. Connect pin 7 of the DB-25F to the N/C connector on the COMM portion of connectors on the thermostat back housing. (GND)
7. Additional thermostats are connected in parallel (yellow to yellow, green to green, red to red, and black to black).

Wiring for additional thermostats can be home run or daisy chained, or a combination of both.