Thermal Gas *Systems* inc.

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Haloguard® and Oxyguard® Monitors

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Haloguard® BACnet MS/TP Interface Module
(Model H3BAC1)

Description

The Haloguard® IR/ III Refrigerant Monitor is a miniature and highly specialized photoacoustic infrared spectrometer for use in detection of specific refrigerant gases in the 1 to 1000 PPM range (20 to 1000 PPM range for the Haloguard® III). It is designed to be a permanent-placement room monitor to provide continuous monitoring of up to 24 measurement locations of a refrigerant gas concentration in nonhazardous areas. Using the proven photoacoustic infrared principle, it can detect the concentration of a specific refrigerant in a complex mixture of background gases promoting the safety of personnel and the environment, and improving equipment efficiency.

The Haloguard® BACnet MS/TP Interface Module – model **H3BAC1** – adds the BACnet™ master/slave token passing (MS/TP) protocol to any Haloguard IR/ III system that contains a standard RS-232 digital communications interface. Incorporating the module is plug-and-play – it requires no setup or modifications to the Haloguard IR/ III system. It allows the Haloguard to retain all of its normal external interfaces – on-board horn and strobe; six independent alarm levels including relays for external devices such as horns and strobes; an independent fault level indicator with power fail indication; and analog communications transmitted using two 0–10 Vdc or 4–20 mA current loop outputs.

The BACnet Vendor ID for Thermal Gas Systems is **1068**. For a list of the BACnet Objects that are available for exchange with a BACnet controller, refer to the Supported BACnet Objects section starting on page 6.

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Installation

The Haloguard BACnet MS/TP Interface Module should be installed indoors, in an appropriate location near the Haloguard IR/ III controller and at a location easily visible to operators. DO NOT MOUNT DIRECTLY TO CHILLER. Convenient mounting ears are provided on the enclosure. To insure proper configuring, apply power to the Haloguard IR/ III controller before applying power to the Interface Module.
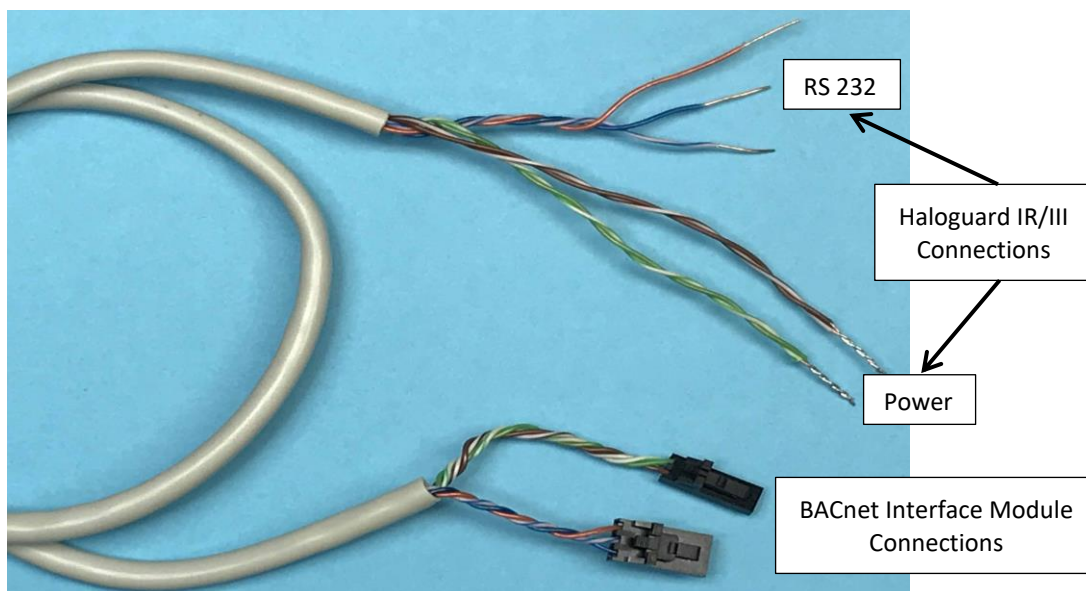

Figure 1 - TGS Umbilical Cable

Hardware Setup

There are only 3 hardware connections that must be made for proper operation:

1) Power (7.5Vdc – 18Vdc) to the BACnet MS/TP Interface Module
2) RS-232 connection from BACnet MS/TP Interface Module to the Haloguard IR/III monitor
3) RS-485 from the BACnet MS/TP Interface Module to the BACnet controller (wire not provided)

For connection locations referred to in the following section see "Figure 2 – BACnet Interface Module PC Board" on Page 4

Along with the Haloguard BACnet MS/TP Interface Module, Thermal Gas Systems includes a TGS Umbilical Cable (**Figure 1**) that provides connections from the Haloguard IR/ III to connect both power and the RS-232 to the Interface module. For the RS-485 connection, or to extend the RS-232 beyond the provided umbilical, use typical industrial RS-232 and RS-485 cables. These are of the sheathed, unshielded, twisted-pair type, (UTP), with a characteristic impedance of 100 Ω, a shunt capacitance of 16 pF per foot, and 22–24 AWG. Category 5 cable (CAT 5), as defined by the EIA/TIA/ANSI 568 standard, meets the required specifications, is inexpensive, and is readily available. Therefore, it is a common choice for both of these connections.

As it can be difficult to quantify whether shielding is required in a particular system or not until problems arise, Thermal Gas Systems recommends erring on the side of caution and using shielded cable, as shielded cable is only slightly more expensive than unshielded.

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1) Power (7.5Vdc):

The Haloguard BACnet MS/TP Interface Module has no ON/ OFF switch, nor lengthy power-up sequences – the module will begin to operate as soon as voltage is applied. The Interface Module provides its own on-board voltage regulation and therefore will operate on an unregulated voltage from 7.5Vdc – 18Vdc. The Haloguard IR/ III controller provides 7.5Vdc via the **EXT INPUT 3** connector's V+ and ground terminals, and is connected to the Interface Module through the provided TGS Umbilical Cable. Connections are as shown below:

Twisted Pair Wire Color	Haloguard IR/ III EXT INPUT 3	BACnet MS/TP Term. Number
Green/ White-Green	**V+**	Pin 2
Brown/ White-Brown	⏚ (ground)	Pin 1

Table 1

2) RS-232 hardware connection:

Only 3 wires are needed to connect the Haloguard IR/ III RS-232 to the BACnet MS/TP Interface Module. The provided TGS Umbilical Cable connector plugs on to connector **JP3** in the Interface Module as shown below and on **Figure 2**:

Haloguard IR/ III Terminal Number	TGS Umbilical Cable Wire Color	Signal Name	BACnet MS/TP Term. Number (JP3)
5	Orange	**TXD**	3 (WX)
2	White-Blue	**RXD**	2 (TX)
3	Blue	**GND**	1 (GND)

Table 2

3) RS-485 hardware connection:

The Haloguard BACnet MS/TP Interface Module uses a simple 2 wire RS-485 interface to a BACnet controller. Connections are made at terminal block X2 on the Interface Module as shown below:

Name	BACnet MS/TP Term. Number (X2)
A+	1
B-	2
GND	3

Table 3

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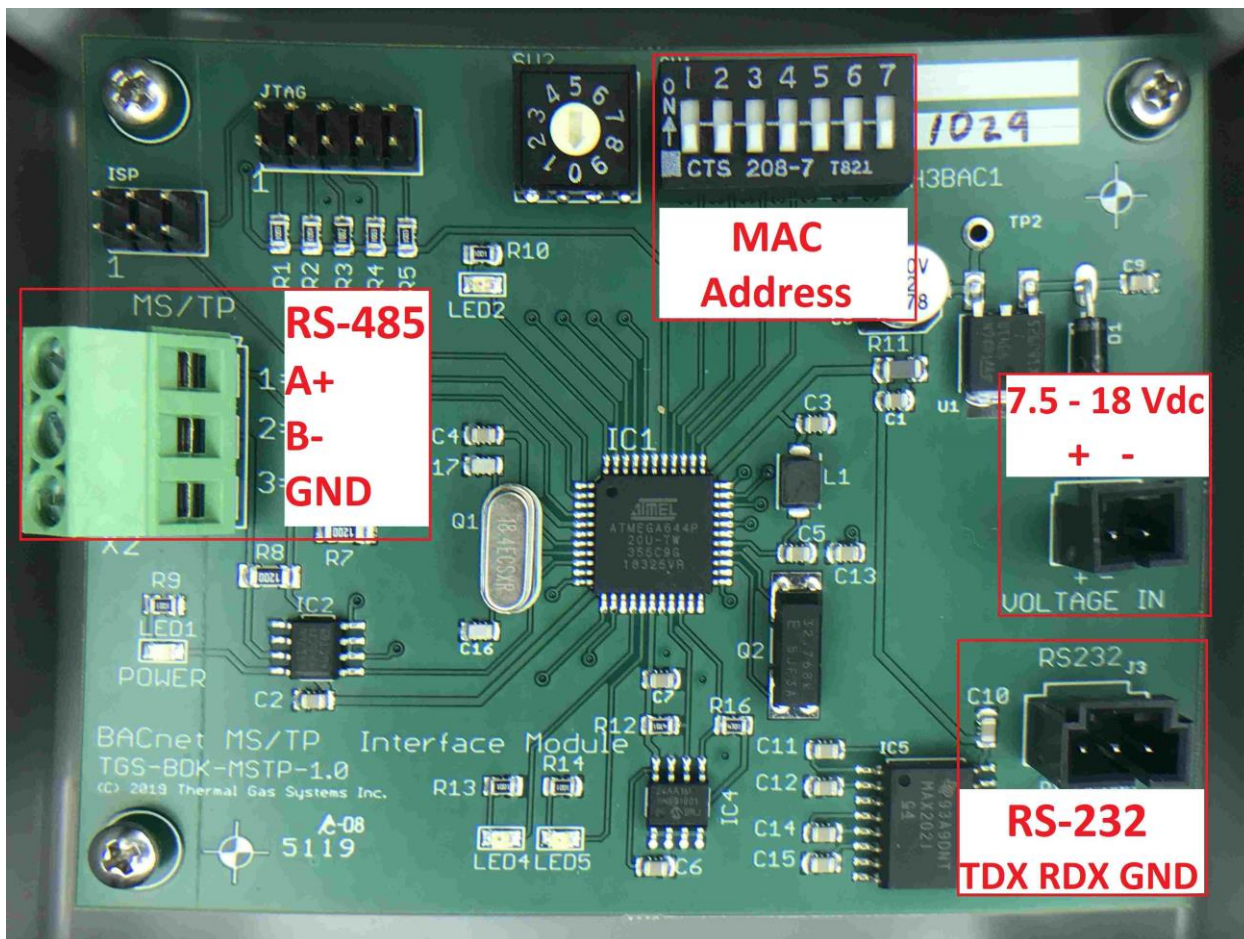**TEL (770) 667-3865**
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Figure 2 - BACnet Interface Module PC Board

Adjustment

No adjustment is required for the Haloguard BACnet MS/TP Interface Module to operate. The module will begin to send data as soon as voltage is applied. Adjustments are available to allow the setting of a **MAC address** and unique **Instance Number**.

The Haloguard IR/ III RS-232 Serial port parameters are not adjustable in the field. **Baud** is fixed at 38400 bps. **Data** is fixed at **8 Bits** with **1 Stop Bit. Flow control** and **Parity** are both fixed at **NONE**.

The Haloguard BACnet MS/TP Interface Module **baud** is also fixed at 38400 bps and is not adjustable in the field.

The Haloguard BACnet MS/TP Interface Module **Max-Master** is 127 and is not adjustable in the field.

The default **MAC address** on the Haloguard BACnet MS/TP Interface Module is 15 (1111000). The MAC address can be configured using the DIP switch (SW1) and can be set from 0 to 127. Switches 1 through 7 are the binary of the MAC address with switch 1 being the LSB and switch 7 being the MSB. The ON position defines logic "1". The OFF position defines logic "0". *NOTE: The MSB is on the RIGHT side of the switch (switch #7) and the LSB is on the LEFT side (switch #1). This is reversed to conventional binary number arrangement with the MSB on the left and LSB on the right.*

To change the MAC address, open the plastic housing by removing the 4 screws on its lid and move the DIP switch (SW1) switches 1 – 7 to set the binary address as needed.

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The **Instance Number** (BACnet Device ID) is a number from 0 to 4194302 and must be unique across the building networks for all device instances. In the Haloguard BACnet MS/TP Interface Module this is created by making the number 1068XYY where the XYY represents a number from 0 through 764. This number is a combination of the **Thermal Gas Systems Vendor ID** (1068), rotary switch **SW2** (0-9), and the low part of the **MAC address** (0-63) set in the previous paragraph. If using MAC addresses above 63 (64-127) exercise caution to avoid duplicate numbers when creating the Instance Number. For example:

If **SW2** is set to 0 and the **MAC address** is set at **00** then the Instance Number will be 1068000.
If **SW2** is set to 0 and the **MAC address** is set at **64** then the Instance Number will *also* be 1068000.

Configuration Notes

Upon power up the Haloguard BACnet MS/TP Interface Module determines the status of the attached Haloguard IR/ III controller. Therefore, the Interface Module should be restarted (power removed then re-applied) if any configuration setting is changed in the Haloguard IR/ III controller. This allows the Interface module to detect the current configuration and remain in sync. Failure to follow this procedure could result in false data remaining in the Interface Module registers, causing unexpected data to be sent to the BACnet controller.

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Supported BACnet Objects

Section	Haloguard IR/ III Reference	Object Name	Object Type Instance #	Property Type	Notes
General		Manufacturer ID	Analog Input 0	Read	1068
		Product ID	Analog Input 1	Read	"667377" (ASCII "BIM")
		Firmware Version	Analog Input 2	Read	Build(MSB:2b)/Major(2b)/ Minor(2b) Ex: Version 01.02.03 outputs 10203 (leading 0 is suppressed)
		Reserved	Analog Input 3	Read	Unknown
		Reserved	Analog Input 4	Read	Unknown
		Reserved	Analog Input 5	Read	Unknown
		Reserved	Analog Input 6	Read	Unknown
		Reserved	Analog Input 7	Read	Unknown
		Reserved	Analog Input 8	Read	Unknown
		Reserved	Analog Input 9	Read	Unknown
	Internal System Fault	Fault Status	Analog Input 109	Read	For on-board errors only- Refer to "Fault Types" Section
	External System Fault	Fault Status	Analog Input 110	Read	For Remote IR Module 1 - Refer to "Fault Types" Section
	External System Fault	Fault Status	Analog Input 111	Read	For Remote IR Module 2 only - Refer to "Fault Types" Section
Channels On-Baoard	Channel 1	Gas Type	Analog Input 10	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 11	Read	PPM
		Alarm Status	Analog Input 12	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 13	Read	Only applies to R123 and NH3 gases
	Channel 2	Gas Type	Analog Input 14	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 15	Read	PPM
		Alarm Status	Analog Input 16	Read	Refer to "Alarm Status" Section
		TWA	Analog Input 17	Read	Only applies to R123 and NH3 gases
	Channel 3	Gas Type	Analog Input 18	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 19	Read	PPM
		Alarm Status	Analog Input 20	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 21	Read	Only applies to R123 and NH3 gases
	Channel 4	Gas Type	Analog Input 22	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 23	Read	PPM
		Alarm Status	Analog Input 24	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 25	Read	Only applies to R123 and NH3 gases

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Section	Haloguard IR/ III Reference	Object Name	Object Type Instance #	Property Type	Notes
Channels On-Baoard	Channel 5	Gas Type	Analog Input 26	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 27	Read	PPM
		Alarm Status	Analog Input 28	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 29	Read	Only applies to R123 and NH3 gases
	Channel 6	Gas Type	Analog Input 30	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 31	Read	PPM
		Alarm Status	Analog Input 32	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 33	Read	Only applies to R123 and NH3 gases
	Channel 7	Gas Type	Analog Input 34	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 35	Read	PPM
		Alarm Status	Analog Input 36	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 37	Read	Only applies to R123 and NH3 gases
	Channel 8	Gas Type	Analog Input 38	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 39	Read	PPM
		Alarm Status	Analog Input 40	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 41	Read	Only applies to R123 and NH3 gases
Channels (Remote IR Module 1)	Channel 9	Gas Type	Analog Input 42	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 43	Read	PPM
		Alarm Status	Analog Input 44	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 45	Read	Only applies to R123 and NH3 gases
	Channel 10	Gas Type	Analog Input 46	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 47	Read	PPM
		Alarm Status	Analog Input 48	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 49	Read	Only applies to R123 and NH3 gases
	Channel 11	Gas Type	Analog Input 50	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 51	Read	PPM
		Alarm Status	Analog Input 52	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 53	Read	Only applies to R123 and NH3 gases
	Channel 12	Gas Type	Analog Input 54	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 55	Read	PPM
		Alarm Status	Analog Input 56	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 57	Read	Only applies to R123 and NH3 gases

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Section	Haloguard IR/ III Reference	Object Name	Object Type Instance #	Property Type	Notes
Channels (Remote IR Module 1)	Channel 13	Gas Type	Analog Input 58	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 59	Read	PPM
		Alarm Status	Analog Input 60	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 61	Read	Only applies to R123 and NH3 gases
	Channel 14	Gas Type	Analog Input 62	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 63	Read	PPM
		Alarm Status	Analog Input 64	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 65	Read	Only applies to R123 and NH3 gases
	Channel 15	Gas Type	Analog Input 66	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 67	Read	PPM
		Alarm Status	Analog Input 68	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 69	Read	Only applies to R123 and NH3 gases
	Channel 16	Gas Type	Analog Input 70	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 71	Read	PPM
		Alarm Status	Analog Input 72	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 73	Read	Only applies to R123 and NH3 gases
	Channel 17	Gas Type	Analog Input 74	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 75	Read	PPM
		Alarm Status	Analog Input 76	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 77	Read	Only applies to R123 and NH3 gases
Channels (Remote IR Module 2)	Channel 18	Gas Type	Analog Input 78	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 79	Read	PPM
		Alarm Status	Analog Input 80	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 81	Read	Only applies to R123 and NH3 gases
	Channel 19	Gas Type	Analog Input 82	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 83	Read	PPM
		Alarm Status	Analog Input 84	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 85	Read	Only applies to R123 and NH3 gases
	Channel 20	Gas Type	Analog Input 86	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 87	Read	PPM
		Alarm Status	Analog Input 88	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 89	Read	Only applies to R123 and NH3 gases

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Section	Haloguard IR/ III Reference	Object Name	Object Type Instance #	Property Type	Notes
Channels (Remote IR Module 2)	Channel 21	Gas Type	Analog Input 90	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 91	Read	PPM
		Alarm Status	Analog Input 92	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 93	Read	Only applies to R123 and NH3 gases
	Channel 22	Gas Type	Analog Input 94	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 95	Read	PPM
		Alarm Status	Analog Input 96	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 97	Read	Only applies to R123 and NH3 gases
	Channel 23	Gas Type	Analog Input 98	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 99	Read	PPM
		Alarm Status	Analog Input 100	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 101	Read	Only applies to R123 and NH3 gases
	Channel 24	Gas Type	Analog Input 102	Read	Refer to "Gas Types" Section
		Gas Concentration	Analog Input 103	Read	PPM
		Alarm Status	Analog Input 104	Read	Refer to " Alarm Status " Section
		TWA	Analog Input 105	Read	Only applies to R123 and NH3 gases
	O$_2$ #1	Gas Concentration	Analog Input 106	Read	% Oxygen (a value of 99 = Discontinuity Fault)
	O$_2$ #2	Gas Concentration	Analog Input 107	Read	% Oxygen (A value of 99 = Discontinuity Fault)
	O$_2$ #3	Gas Concentration	Analog Input 108	Read	% Oxygen (A value of 99 = Discontinuity Fault)

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Gas Types

Gas Type	BACnet Code	Notes
UNKNOWN	0	
R-11	1	
R-12	2	
R-14	3	
R-22	4	
R-23	5	
R-113	6	
R-123	7	
R-124	8	
R-134a	9	
R-141	10	
R-245fa	11	
R-404a	12	
R-407c	13	
R-410a	14	
R-500	15	
R-502	16	
R-507	17	
R-514a	18	
R-717 (NH3)	19	
R-1234ze	20	
EtO	21	
SF6	22	
R-1233Zd	23	
R-448a	24	
R-513a	25	

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Fault Types

Faults are listed by priority of fault.

For internal, on-board faults (Haloguard IR/ III controller inputs 1-8):

BACnet Code	Fault	Notes
4	Lamp Failure	
2	Chopper Failure	
8	Flow Failure	
16	Low Temperature	

For External, Remote IR Modules (Haloguard IR/ III controller inputs 9 – 24):

BACnet Code	Fault	Notes
16	Lamp Failure	
32	Chopper Failure	
4	Flow Failure	
2	Remote EE Error	Remote Module Memory Error
1024	Scanner Stopped	
512	Remote Channel Error	
64	Remote In Setup	
256	Remote Discontinuity	
8	Low Temperature	
1	Off Scale	***Currently Not sent***

For Oxygen Sensors a discontinuity fault (broken wire) is indicated by placing a BACnet Code value of 99 in the associated input (Analog Inputs 106 – 108).

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Alarm Status

BACnet Code	Alarm Status	Notes
0	No Alarm	
32	Alarm #6	Binary Bit 5
16	Alarm #5	Binary Bit 4
8	Alarm #4	Binary Bit 3
4	Alarm #3	Binary Bit 2
2	Alarm #2	Binary Bit 1
1	Alarm #1	Binary Bit 0

Any or all alarms can occur at the same time. The BACnet Code shows the total alarm status in a binary form. To translate the BACnet Code into the actual Alarm status, change the decimal number to a binary number. Any "1" indicates an *active* alarm – "0" indicates an *inactive* alarm.

Mathematically this is accomplished by subtracting the alarm code until the result is 0 starting with the largest code (32 for Alarm #6). If the result of the subtraction is a positive number or 0 then the alarm is active. A negative result indicates the alarm is inactive. For Example:

If the BACnet Code is **13**:

13 – **32** = a negative number	therefore Alarm #6 is NOT active
13 – **16** = a negative number	therefore Alarm #5 is NOT active
13 – **8** = 5	therefore Alarm #4 is active
5 – **4** = 1	therefore Alarm #3 is active
1 – **2** = a negative number	therefore Alarm #2 is NOT active
1 – **1** = 0	therefore Alarm #1 is active

Percent Oxygen Translation

BACnet Code	O2 Amount (%)	Notes
99	FAULT	Discontinuity Fault (Broken wire)
150	15.0	
160	16.0	
170	17.0	
180	18.0	
190	19.0	
200	20.0	
210	21.0	
220	22.0	
230	23.0	
240	24.0	
250	25.0	

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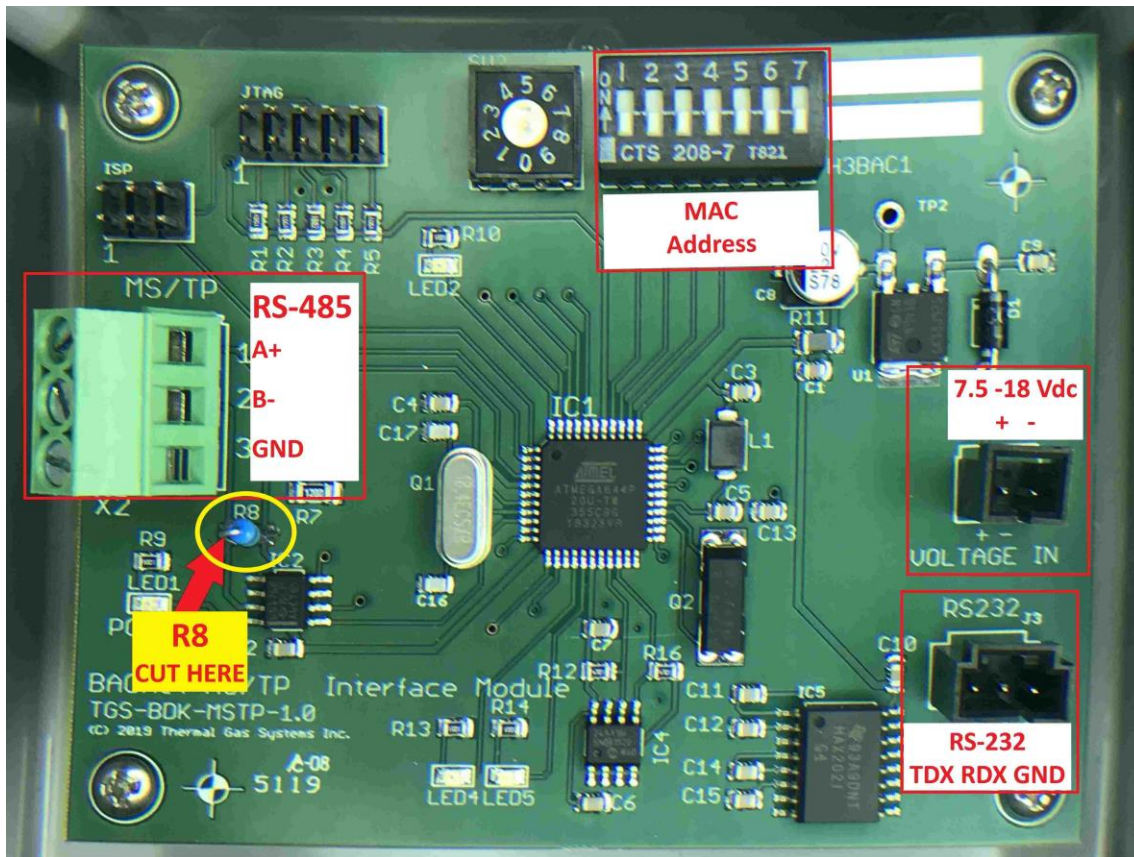## (Termination Resistor R8 Addendum)

Figure 3 - BACnet Interface Module PC Board

This bulletin provides brief information concerning the RS-485 termination resistor in single and multi-device networks. It outlines locating and, if needed, removing this 120 Ω resistor labeled R8 on the Haloguard® BACnet MS/TP Interface Module.

Removal of this resistor on multi device RS-485 systems will reduce or eliminate potential signal reflections caused from more than one termination device on the RS-485 data lines. These reflections could create interference to the BACnet router causing the communications to be garbled and confused. This data confusion could result in device traffic collisions and system lockup.

A termination resistor is normally only located on the last device in the wire chain, so it is only needed on the Haloguard® BACnet MS/TP Interface Module if this is the last or only device on the RS-485 segment. In cases where the BACnet MS/TP Interface Module is **not** the last or only device in the wiring chain then the termination resistor on the BACnet MS/TP Interface Module pc board should be removed as outlined on pages 2 and 3.

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**** CAUTION ***

Before proceeding remove 7.5-18Vdc power to the BACnet MS/TP Interface Module.

Termination Resistor (R8) Removal

On the Haloguard® BACnet MS/TP Interface Module there are 3 methods used to remove resistor R8 depending on the age of the device. The correct method is determined by the module's serial number located to the right of the MAC Address DIP switch.

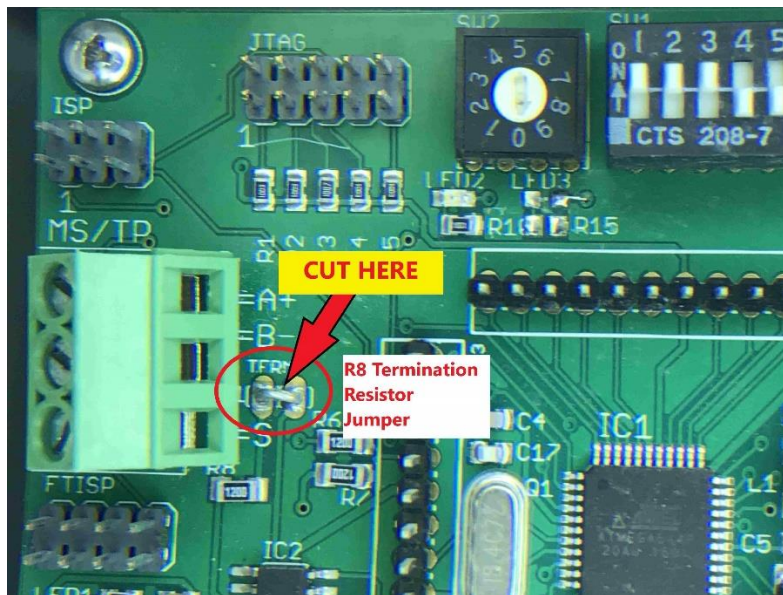1) In devices prior to serial number 1026. Clip the wire jumper marked *TERM* near the green RS-232 terminal block.

Figure 4 - Devices Prior to Serial Number 1026

2) In devices with a serial number between 1026 and 1040 resistor R8 is a surface mounted device and removal requires proper de-soldering. Contact Thermal Gas Systems for an RMA (Return Merchandise Approval) to return the BACnet Interface Module PC Board for removal.
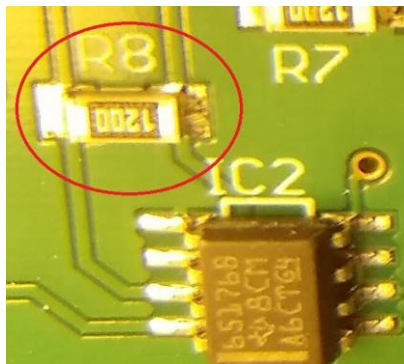

Figure 5 - Devices with Serial Number Between 1026 and 1040

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3) In devices after serial number 1040 the surface mounted device has been replaced with a vertical resistor with one lead exposed. To remove the termination resistor simply clip the exposed lead.
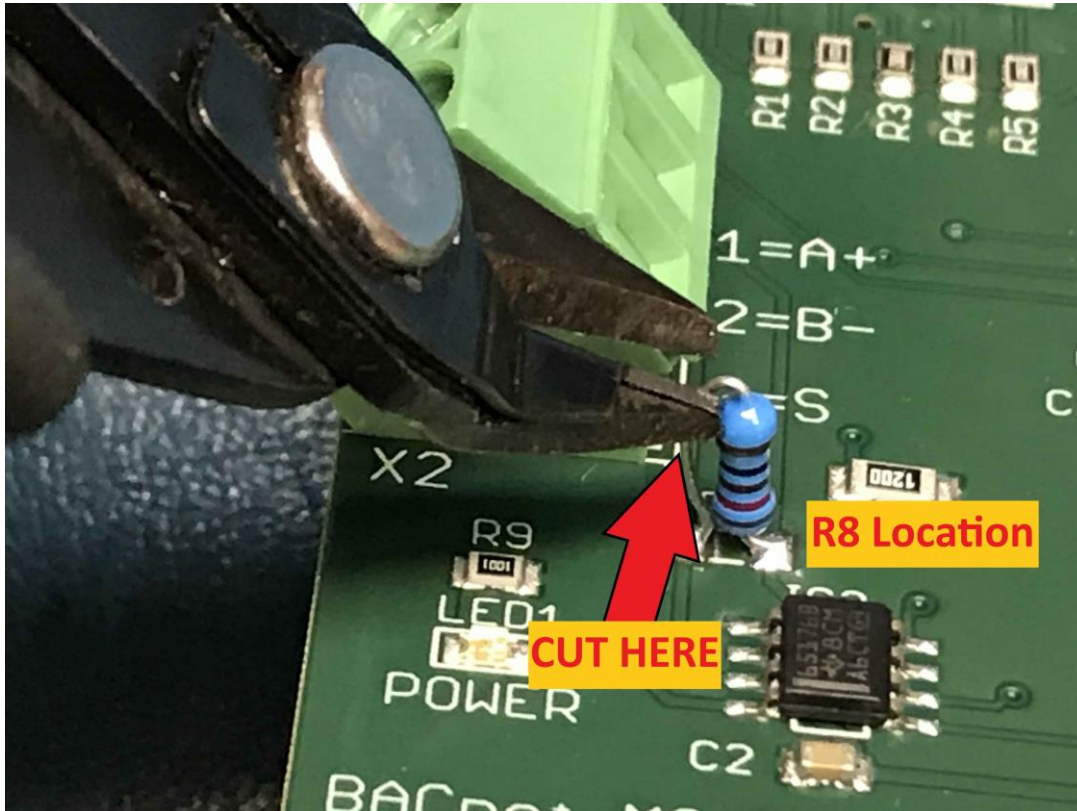

Figure 6 – Devices After Serial Number 1040

Once the resistor has been removed reconnect the 7.5-18Vdc power connector to the BACnet MS/TP Interface Module. and return to service.