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This publication adds the HART High Performance Analog Input module to the Ovation I/O Reference Manual. It should be placed between Sections 14 and 15.

SECTION 14. HART HIGH PERFORMANCE ANALOG INPUT MODULE

14.1 DESCRIPTION

The HART (Highway Addressable Remote Transducer) High Performance (HP) Analog Input module is a standard Ovation I/O Module that provides eight galvanically isolated 4-20 mA analog inputs with HART transceivers. Each transceivers provides optically isolated communication to a dedicated UART, thereby, maximizing HART communication throughout.

Each channel may be individually configured for field powered or local powered transmitters via user accessible jumpers on the Personality Module.

HART is a digital communication protocol designed for industrial process measurement applications. Field measurement devices (transmitters) interface for a process control system via an analog 4-to-20 mA current loop. HART uses a low-level frequency-shift-keyed sine wave signal that is superimposed on the standard 4-to-20 mA process measurement current loop. Since the HART sine wave signal is small and its average value is zero, the current loop analog 4-to-20 mA signal is not significantly affected by the presence of the HART signal. Using HART allows a field device to provide more than one measurement, which is a feature not available when using only the 4-to-20mA analog current signal.

“Smart” field devices may be described as field devices in which the analog 4-to-20 mA signal, digital communication, and sometimes power, co-exist on the same pair of wires. The Ovation HART High Performance Analog Input (IAH) module is a standard form factor Ovation I/O module, which will permit Ovation to communicate with HART devices.

Note:

See Section 3. I/O Modules for environmental, installation, wiring and fuse information.

14.2 MODULE GROUPS

14.2.1 ELECTRONICS MODULE

There is one Electronics Module group for the HART HP Analog Input Module:

- 5X00106G01 interfaces to eight current loop signals with an input range of 4-20 mA.

14.2.2 PERSONALITY MODULE

There is one Personality Module group for the HART HP Analog Input Module.

- 5X00109G01 contains a single printed circuit board assembly with eight fused input and user accessible jumpers that configure the channels for field powered or local powered transmitters on an individual basis.

Table 14-1. HART HP Analog Input Subsystem (16 Bit)

Range	Channels	Electronic Module	Personality Module
4-20 mA	8	5X00106G01	5X00109G01

Local Powered or Field Powered transmitter interface.

14.3 MODULE BLOCK DIAGRAM AND FIELD CONNECTION WIRING DIAGRAM

The Ovation HART HP Analog Input Module subsystem consists of two modules, an electronics module containing a logic printed circuit board (LIH) and a field printed circuit board (FIH). The electronics module is used in conjunction with a personality module, which contains a single printed circuit board (PIHA). The block diagram for HART HP Performance Analog Input subsystem is shown in Figure 14-1.

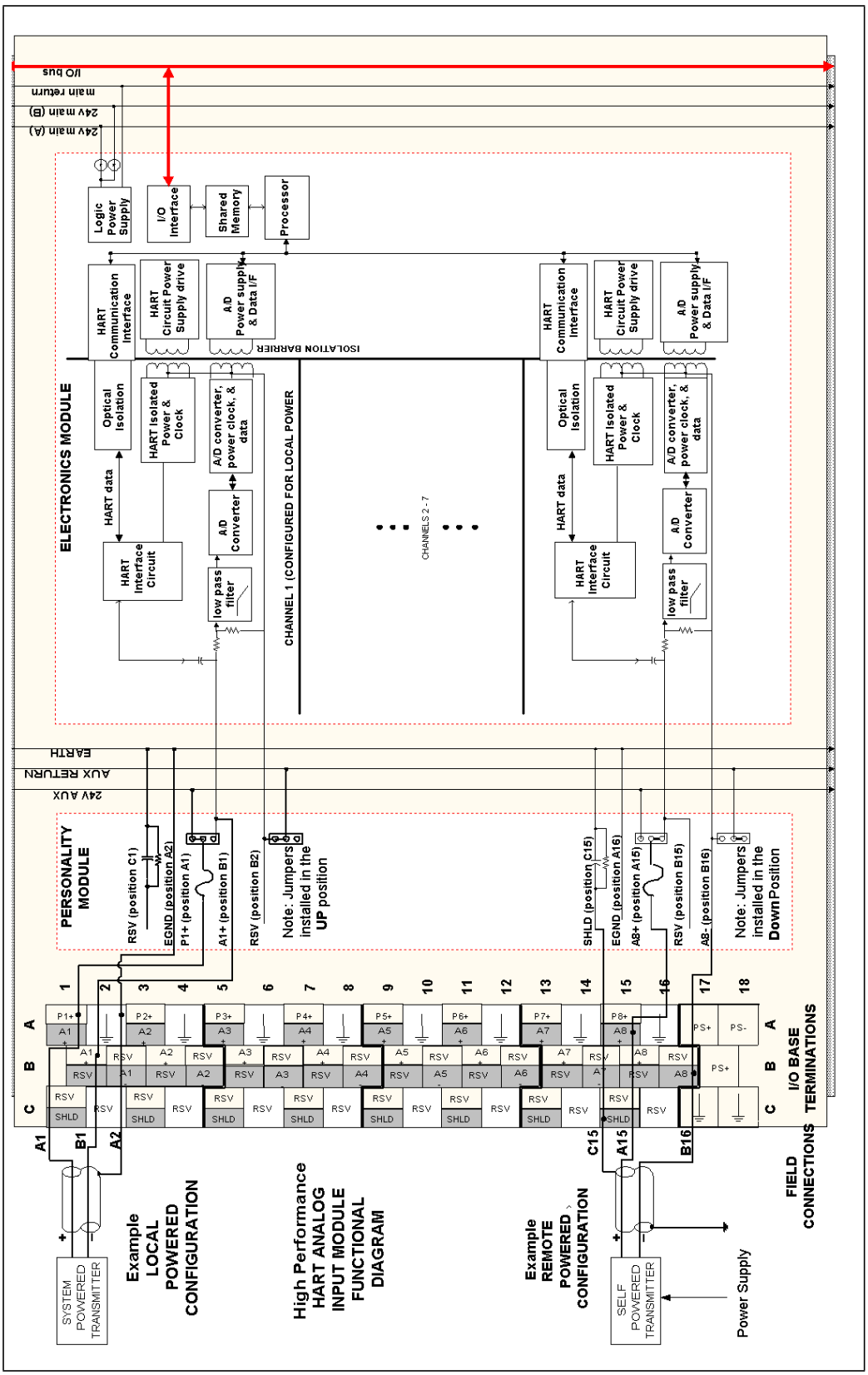

Figure 14-1. HART HP Analog Input Subsystem Block Diagram

14.4 EXTERNAL POWER SUPPLIES

Note:

*Module power specifications (main and auxiliary) refer to the actual power drawn by the module from the 24 VDC main power supply and from the +24 VDC auxiliary power supply and **NOT** from the AC or DC mains.*

The HART HP Analog Input Module utilizes the standard +24V Ovation main power supply to provide the power required for the logic circuitry.

The HART HP Analog Input Module utilizes a +24 auxiliary power supply to provide the power required for the field circuitry. This includes all 4-20 mA loop power, A/D conversion, and the remaining output channel components. This power supply may be the standard +24V Ovation Auxiliary Supply or a user supplied external power supply.

It is recommended that the HART Analog Input module utilize the Ovation cabinet's Auxiliary +24V DC power that is obtained from the standard Ovation DIN Rail power supply auxiliary output.

However, if an external auxiliary power supply is utilized by the HART HP analog input module to supply power, it is recommended that it have a low noise (≤ 1.2Vrms), due to the low signal levels of the HART communications.

Table 14-2. Power Supply Noise Output

Noise	All Rated Loads (500 HZ to 10 kHZ)	2.2 mV RMS Max.

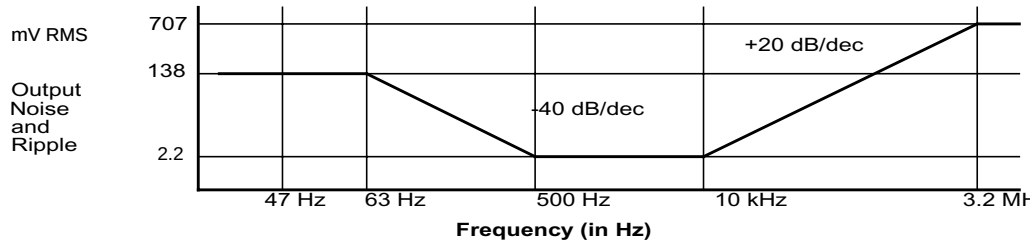

Figure 14-2. Power Supply Output Noise Requirements

In addition, all modules utilizing the auxiliary power supplies, including the HART modules, **MUST** utilize shielded I/O cables in order to suppress coupled noise and transients into the HART modules. This includes modules on the same branch utilizing the auxiliary power, or modules on other branches utilizing the same auxiliary power. This recommendation applies regardless of the type of power supply chosen by the user.

14.5 SPECIFICATIONS

Electronics Module (5X00106)
Personality Module (5X00109)

Table 14-3. HART HP Analog Input Module Specifications

Description	Value
Number of channels	8
Input range	2.5 to 25 mA with under-range and over-range checking.
A/D Resolution	14 bits
Reference accuracy (@ 25^{o}C)	+/-0.1% of full scale value (20mA) @ 99.7% confidence
Accuracy over temperature	+/-0.24% of full scale value (20mA) over the full operating temperature range
Sampling rate (per second)	20 when configured for 60 Hz rejection 25 when configured for 50 Hz rejection
Dielectric isolation: Channel to channel Channel to logic	 1000 VAC/VDC for one minute 1000 VAC/VDC for one minute
Operating temperature range	0^{o} to 60^{o}C (32^{o}F to 140^{o}F)
Humidity (non-condensing)	0% to 95%
Module power	Drawn from Main: 4.1W typical. 4.5W maximum Drawn from Aux.: 3.84W typical (20mA X 8 loops X 24V) Dissipation in module: 5.06W typ. (Emod + Pmod)
Input Impedance	300 ohms
Normal Mode Rejection	60 dB @50 Hz ± 1/2% or @60 Hz ± 1/2% (when properly configured) 30 dB (typical) @50 Hz ± 5% or @60 Hz ± 5% (when properly configured)
Common mode rejection	120 dB @ DC or @ the nominal (50/60 Hz) line frequency ± 1/2% and harmonics. 100 dB (typical) for nominal line frequency ± 5% and harmonics.

14.6 HART HP Analog Input Personality Module Information

Each Personality module provides a 1/20 A fuse on each channel for loop protection. Additionally, each channel provides a pair of user accessible jumpers for configuring each channel for local powered transmitters or field powered transmitters. This configuration is on a per channel basis. The fuses and jumpers are accessible through the top of the module. The label, shown in figure Figure 14-3, on the top of the module indicates how to position the jumpers. Note that there are two jumpers per channel and they must be positioned together.

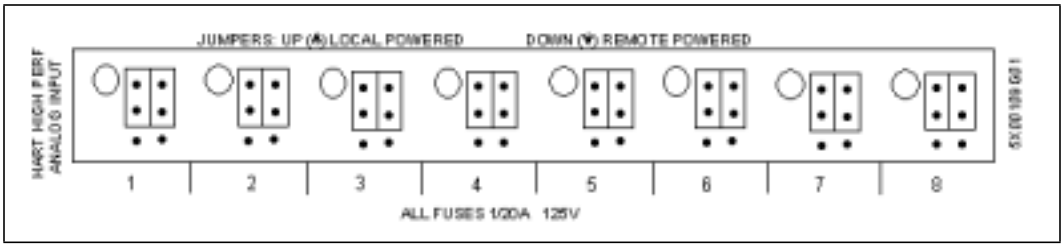

Figure 14-3. HART HP Analog Input Personality Module

Note:

Jumpers shown in Figure 14-3 are shown in the local powered configuration for all channels.

14.7 HART HP Analog Input Terminal Block Wiring Information

Each Personality module has a simplified wiring diagram label on its side which appears above the terminal block. This diagram indicates how the wiring from the field is to be connected to the terminal block in the base unit. Note that there are two wiring configurations for each channel dependant upon whether the channel is configured for Local or Field powered transmitters.

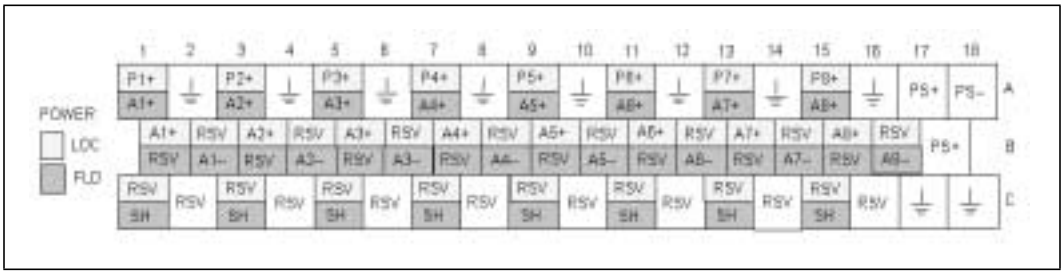

Figure 14-4. Wiring Diagram Label

The diagrams for the HART HP Analog Input Personality modules are illustrated in Figure 14-1. The following table lists and defines the abbreviations used in those diagrams.

Table 14-4. Wiring Diagram Label Definitions

Abbreviation	Abbreviation
A1 - A8 +	Analog Input terminal connection (connected to the negative terminal of a local powered transmitter or the positive terminal of field powered transmitter).
A1 - A8 -	Analog Input negative terminal connection (field powered configuration only).
P1 - P8 +	Loop power output terminals (for local powered configuration only. Connected to the positive).
SH1 - SH8	Shield terminal connection. (For landing shields where the shield is to be grounded at the transmitter).
	Earth ground terminals. (For landing shields where the shield is to be grounded at the module.
PS+, PS-	External Auxiliary power supply terminals.
RSV	Reserved terminal. No connections are allowed on these terminals.

14.8 FIELD WIRING CABLE REQUIREMENTS

Table 14-5. Recommended Minimum Conductor Size

Cable Length	Min. Conductor Size	Cable Type
Less than 5,000 feet (1524 m)	24 AWG (0.51 mm dia.)	Single-twisted pair with over-all shield.
Greater than 5,000 feet, but less than 10,000 feet (3048 meters)	20 AWG (0.81 mm dia.)	Single-twisted pair with over-all shield.

Refer to the HART FSK Physical Layer Specification (HFC_SPEC-54) for additional cabling information.

The point data registers occupy locations 2-9 for analog input points 1-8 respectively. The data format is as follows:

Bit 15	Bit 14	Bit 13 - 0
		14 bit value
	Over-range Bit	
Point quality: (for good point quality (and proper card operation))		
Example Values		
Output Data in Hex		Data Description
8000		Zero Input
8001		+ 1
C000		+ Full Scale
CZZZ		+ Over Range
*0000-7FFF		*Card Trouble/Not Warmed Up/Bad Quality

Note: Z - Not Zero

14.9 HART HP Analog Input Address Locations

14.9.1 Register Map

Each of the 16 direct registers on the HART HP Analog Input module is summarized here and shown in more detail in the following tables. The module status register #13(D in Hex) can be read by using the Point Information window at an Operator's Station. Word address #12 (C in Hex) is used to report the channel errors on the eight input channels. The definition of the bits in this register is listed in Figure 14-7.

Table 14-6. HART Analog Input Register Map

Reg	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Indirect Memory Index	NA
1	Indirect Memory Data	Indirect Memory Data
2	NA	Analog Input - Channel 1
3	NA	Analog Input - Channel 2
4	NA	Analog Input - Channel 3
5	NA	Analog Input - Channel 4
6	NA	Analog Input - Channel 5
7	NA	Analog Input - Channel 6
8	NA	Analog Input - Channel 7
9	NA	Analog Input - Channel 8
10	Calibration Register (Factory use only)	Calibration Register (Factory use only)
11	Flash down Handshaking	Firmware Revision/ Flash download Handshaking
12	NA	Channel Error Bits (See Table 14-7)
13	Module Configuration Register (See Table 14-8)	Module Status Register (See Table 14-8)
14	HART Enable (See Table 14-10	HART Enable (See Table 14-10)
15	NA	Module Electronic ID Data

Table 14-7. Channel Error Register Output Data Format (Read)

Point	Bit	Description
1	0	Communication to the Isolated Channel has failed
	1	Over/under-range, Input/blown fuse/Open Loop
2	2	Communication to the Isolated Channel has failed
	3	Over/under-range, Input/blown fuse/Open Loop
3	4	Communication to the Isolated Channel has failed
	5	Over/under-range, Input/blown fuse/Open Loop
4	6	Communication to the Isolated Channel has failed
	7	Over/under-range, Input/blown fuse/Open Loop
5	8	Communication to the Isolated Channel has failed
	9	Over/under-range, Input/blown fuse/Open Loop
6	10	Communication to the Isolated Channel has failed
	11	Over/under-range, Input/blown fuse/Open Loop
7	12	Communication to the Isolated Channel has failed
	13	Over/under-range, Input/blown fuse/Open Loop
8	14	Communication to the Isolated Channel has failed
	15	Over/under-range, Input/blown fuse/Open Loop

Communication to the Isolated Channel has failed - this bit is set when the communication to the corresponding isolated channel has failed.

Over/under-range, Input/blown fuse/Open Loop - this bit is set when the corresponding Points input is less than 2.5mA (open loop condition), or greater than 25mA (over-range).

The Module Configuration/Status register is module I/O register 13 (0xD). The register bit assignments are defined as follows:.

Table 14-8. Module Configuration/Status Register

Bit	Data Description (Write)	Data Description (Read)
0	Configure Module	Module Configured (1 = configured)
1	Force Error	Internal or forced error (1 = forced error)
2	50/60 hz selection (1=50 hz)	50/60 Hz System (1=50 Hz)
3	SELF_CAL (Initiates Self Calibration)	SELF_CAL (Initiates Self Calibration)
4	Toggle Bit (80C32 to 90S8515)	0, (Not Used)
5	0, (Not Used)	0, (Not Used)
6	0, (Not Used)	0, (Not Used)
7	80C32 diagnostics	80C32 diagnostics
8	0, (Not Used)	80C32 Memory Error
9	0, (Not Used)	9058515 Internal Error
10	0, (Not Used)	9058515 Memory Error
11	0, (Not Used)	Module not calibrated
12	0, (Not Used)	0, (Not Used)
13	Toggle Bit (90S8515 to 80C32)	Toggle Bit (90S8515 to 80C32)
14	0, (Not Used)	0, (Not Used)
15	0, (Not Used)	Point Fault[1]
[1]Refer to the Channel Error Register for the descriptions of the Point Faults.		

Bit 0: The Ovation Controller must set bit 0 of the Module Configuration register in order to access module I/O registers 0 through 11 (0xB). If bit 0 is not set, reading module I/O registers 0 through 11 (0xB) yields an Attention Status.

Bit 1: This bit (write “1”) forces the module into error state, illuminating the module’s internal Error LED. The read of bit “1” indicates that there is an internal module error, or the Controller has forced the module into the error state. The state of this bit is always reflected by the modules Internal Error LED. Whenever this bit is set, an attention status is returned to the Controller when addresses #0 through #11 (B in Hex) are read.

Bits 2: The status of this bit (read) indicates the conversion rate of the module, write to this bit configures the conversion rate of the A/D converters as shown in Section 14-9

Table 14-9. Conversion Rate

Conversion Rate (1/sec)	Bit #2
60 (for 60Hz systems)	0
50 (for 50Hz systems)	1

Bit 3: This bit (write) is used to initiate self-calibration.The sample rate during self-calibration will be two per second. The status (read) bit will be one as long as the configuration bit is set. If this is set, the module will initate one self calibration cycle. For subsequent self calibration to occur, the bit must be cleared and reset or different configuration written to the card with this bit set.

Bit 4: Reserved for inter-module handshaking.

Bit 7: Reserved for Factory diagnosis.

Bit 8: This bit (read) indicates that the module has internal memory error. If this error i**s present, the internal error LED is lit.**

Bit 9: This bit is set if bit 10 or 11 is set. If this bit is set, the internal error LED is lit. The Point Fault bit will be set as the condition of the module is undetermined. Also, I/O channel registers 2-9 will be in attention.

Bit 10: This bit (read) indicates that the module has internal memory error (FLASH checksum, Register or Static RAM error). Bit 9 will be set as well.

Bit 11: This bit indicates that the module is not calibrated. Bit 9 will be set as well.

Bit 13: Reserved for inter-module handshaking.

Bit 15: Bit indicates point fault status of the module. It is the logical “OR” of any individual channel error status bits in register C, plus bit 9 of this register. A “0” indicates that all eight points have good quality and no module error exists. When bit 9 of the Status Register is not set, this bit (when set to “1”) indicates that at least one of the points has bad quality. A subsequent read of the Channel Error Register (address C) will reveal the point(s) that have bad quality. The Channel Error Register contains data only when the module fault is due to a bad point quality.

Table 14-10. HART HP Analog Input Enable Register (Address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
0	Multivariable Channel 1	Not Used
1	Multivariable Channel 2	Not Used
2	Multivariable Channel 3	Not Used
3	Multivariable Channel 4	Not Used
4	Multivariable Channel 5	Not Used
5	Multivariable Channel 6	Not Used

Table 14-10. HART HP Analog Input Enable Register (Address 14 or E in Hex)

Bit	Data Description - Configuration Register (Write)	Data Description - Status Register (Read)
6	Multivariable Channel 7	Not Used
7	Multivariable Channel 8	Not Used
8	HART Enabled - Channel 1	Not Used
9	HART Enabled - Channel 2	Not Used
10	HART Enabled - Channel 3	Not Used
11	HART Enabled - Channel 4	Not Used
12	HART Enabled - Channel 5	Not Used
13	HART Enabled - Channel 6	Not Used
14	HART Enabled - Channel 7	Not Used
15	HART Enabled - Channel 8	Not Used

Bit 0-7: A “1” in any of these bits will cause Multivariable messaging on the corresponding channel.

Bit 8-15: A “1” in any of these bits indicate that a HART compliant device exists on the corresponding channel.

To avoid a HART communication error message, set each bit to “0” when connecting a non-HART output device.

The HAI, HAO, and IAH modules have the ability to retrieve additional variables from a field device. These variables are referred to as ‘multivariables’ and are named PV (primary variable), SV (secondary variable), TV (tertiary variable), and QV (quarterly variable).

14.10 DIAGNOSTIC LEDS

Table 14-11. HART Analog Input Diagnostic LEDs

LED	Description
P (Green)	Power OK LED. Illuminated when the +5V power is OK.
C (Green)	Communications OK LED. Illuminated when the Controller is communicating with the module.
I (Red)	Internal Error LED. Illuminated whenever there is any type of error within the module except for a loss of external auxiliary power. Possible causes are: ■ The Controller sets the module's Force Error bit. ■ Communications with the Controller is lost. ■ The module is not calibrated. ■ Flash memory, EE memory or RAM diagnostic failure.
1-8 (Green)	The eight channel LEDs serve two functions. LEDs 1-8 are used to indicate the firmware state during module startup and are then used to indicate HART communications activity and analog input hearth during normal module operation. After module configuration, the bank of eight channel LEDs (LEDs 1-8) is used to indicate HART communications activity and the health of the analog input. If the Analog Input for the associated analog input channel is healthy (bit 15 set in the point data word), then the LED will be on. If the analog input channel is bad, then the LED will be off. When a HART message is sent and received correctly, the LED will blink off for 100 msec if the analog input is healthy. When a HART message is sent and received correctly, the LED will blink off for 400 msec if the analog input is healthy.