HART® Field Device Specification:

DELTA CONTROLS CORPORATION

MODEL HIR REV 3.0

Document 00-HIR35, rev. B

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1. INTRODUCTION

1.1 Scope

The Delta Controls Corporation Infrared Pyrometer, model HIR, revision 3 complies with HART Protocol Revision 7.06. This document specifies all the device specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART capable Host Applications.

1.2 Purpose

This specification is designed to complement other documentation (e.g., the *HIR Installation Manual*) by providing a complete, unambiguous description of this Field Device from a HART Communication perspective

1.3 Who should use this document?

The specification is designed to be a technical reference for HART capable Host Application Developers, System Integrators and knowledgeable End Users. It also provides functional specifications (e.g., commands, enumerations and performance requirements) used during Field Device development, maintenance and testing. This document assumes the reader is familiar with HART Protocol requirements and terminology.

1.4 Abbreviations and definitions

ADC	Analog to Digital Converter
CPU	Central Processing Unit (of microprocessor)
DAC	Digital to Analog Converter
EEPROM	Electrically-Erasable Read-Only Memory
IR	Infrared

1.5 References

HART Smart Communications Protocol Specification. HCF_SPEC-12. Available from the HCF.

HIR Installation Manual, Document 00-HIR03. Available from the Delta Controls Corporation.

2. DEVICE IDENTIFICATION

Manufacturer Name:	Delta Controls Corporation	**Model Name(s):**	HIR
Manufacture ID Code:	24842 (0x610A)	**Device Type Code:**	58374 (0xE406)
HART Protocol Revision	7.06	**Device Revision:**	1
Number of Device Variables	2		
Physical Layers Supported	FSK		
Physical Device Category	Transmitter, Non-DC-isolated Bus Device		

The HIR consists of a remote-mounted explosion-proof housing connected to a vessel-mounted lens assembly via a fiber optic cable. The name plate is located on the housing cover and indicates the model name and revision.

3. PRODUCT OVERVIEW

The HIR is a simple two-wire loop-powered temperature transmitter, with a 4-to-20mA output. Measurement is via optical pyrometery.

The HIR rev. 3 replaces the earlier rev. 2 model, providing improved HART communication capability.

The analogue output of this device is linear with temperature over the working range of 300 to 1700 °C.

4. PRODUCT INTERFACES

4.1 Process Interface

4.1.1 Sensor Input Channels

Infrared light from the process is channeled to an optical sensor where it is converted to a 4-wire electrical signal. The signal is connected to the electronics module using 4 terminal labeled “Red”,”Green”,”Blue”, and “White”.

4.2 Host interface

4.2.1 Analog Output: Process Temperature

The two-wire 4-to-20mA current loop is connected on two terminals marked "Loop+" and "Loop-". Refer to the Installation Manual for connection details.

This is the only output from this transmitter, representing the process temperature measurement, linearized and scaled according to the configured range of the instrument. This output corresponds to the Primary Variable. HART Communication is supported on this loop. This device has a CN number of 1.

A guaranteed linear over-range is provided. Device malfunction can be indicated by down-scale or up-scale current. The direction is selectable by the user; see Section 4.3 below. Current values are shown in the table below.

	Direction	Values (percent of range)	Values (mA or V)
Linear over-range	Down	-2.50%	3.9 mA
	Up	+106.25%	21.0 mA
Device malfunction indication	Down: less than	-2.5%	3.6 mA
	Up: greater than	+112.5%	22.0 mA
Maximum current		+112.5%	22.0 mA
Multi-Drop current draw			4.0 mA
Lift-off voltage			12 V

4.3 Local Interfaces, Jumpers and Switches

4.3.1 Local Controls and Displays

The field device has a window providing visible access to an LCD display.

4.3.2 Internal Jumpers and Switches

Four pushbuttons are provided to set up operating parameters without connection to an external controller. Detailed information is provided in the HIR Operation Manual. Device Variables

5. VARIABLES

5.1 Device Variables

Variable	Meaning	Units	Unit Codes
DV0	Temperature	Celsius, Fahrenheit	32,32
DV1	Signal Strength	%	57

5.2 Dynamic Variables

One Dynamic Variable is implemented.

	Meaning	**Units**
PV	Process Temperature	degC, degF

6. STATUS INFORMATION

6.1 Device Status

BIT	Name	Meaning
0	0 Primary Variable out of limits	Set if the Device Variable mapped to PV is out of transducer limits. Range setting by Command 35 does not affect these limits.
1	Non PV out of limits	Set if any of the Device Variables not mapped to PV is out of limits. This bit is formed by OR-ing all out-of-limit informations of DV 0 to 5 except the one mapped to PV.
2	Loop Current Saturated	Set if the analog output 1 (channel 0) current is out of the linear overrange Limits.
3	Loop Current Fixed	Set if analog output 1 (channel 0) current no longer tracks the PV value. Use of any of commands 6, 40, 66 or 79 may cause the current to be fixed.
4	More Status Available	Set whenever any irregularity is detected. Use of Command 48 will read additional details.
5	Cold Start	Set after initial power up and after execution of Command 42. Bit is cleared for each Master individually after recognition of the first command.
6	Configuration Changed	Set when the Field Device configuration is modified. Each Master will clear this bit individually by use of Command 38.
7	Device Malfunction	Set if the Field Device's self-monitoring detected an abnormal condition of class Error. Warnings will not set this bit.

6.2 Extended Device Status

Bit	Name	Meaning
0	Maintenance Required	Device requires maintenance. This is usually set when the optical window needs to be cleaned.
1	Device Variable Alert	Some device variable is in an alarm or warning state
2	unused	Bit not supported
3	Failure	Bit not supported
4	Out of Spec	Bit not supported
5	Function Check	Bit not supported
6	Unused	Undefined
7	Unused	Undefined

6.3 Additional Device Status (Command #48)

Command #48 returns 9 bytes of data, with the following status information:

Byte	Bit	Meaning	Class	Device Status Bits Set
0	DEVICE SPECIFIC STATUS			
	0	HIGH ALARM	WARNING	4
	1	LOW ALARM	WARNING	4
	2	TRANSMISSIVITY ALARM	WARNING	4
	3	OVERRANGE	ERROR	4
	4	UNDERRANGE	ERROR	4
	5	Not Defined		
	6	Not Defined		
	7	Not Defined		
1,2,3,4,5	Not Defined			
6	EXENDED DEVICE STATUS			
	0	Device requires maintenance. This is usually set when the optical window needs to be cleaned.	WARNING	4
	1	Some device variable is in an alarm or warning state	WARNING	4
	2	Bit not supported		
	3	Bit not supported	ERROR	
	4	Bit not supported	WARNING	
	5	Bit not supported		
	6,7	Not Defined		
7	Not supported			
8	STANDARD STATUS			
	0,1,2	Bit(s) not supported		
	3	Watchdog reset occurred	WARNING	4
	4,5,6,7	Bit(s) not supported		

"Not Defined" bits are always set to 0.

7. UNIVERSAL COMMANDS

Command #3 returns PV for a total of 9 bytes of response data).

Sensor serial number is Not Defined, and returns 0.

8. COMMON-PRACTICE COMMANDS

8.1 Supported Commands

The following common-practice commands are implemented:

33 Read Device Variables

34 Write Damping Value

35 Write Range Values

40 Enter/Exit Fixed Current Mode

42 Perform Master Reset

44 Write PV Units

45 Trim DAC Zero

46 Trim DAC Gain

48 Read Additional Device Status

54 Read Device Variable Information

59 Write Number of Response Preambles

72 Squawk (Causes Outline Rectangle on LCD for 2 seconds)

103 Write Burst Period

104 Write Burst Trigger

105 Read Burst Mode Configuration

107 Write Burst Device Variables

108 Write Burst Mode Command Number

109 Burst Mode Control

8.2 Burst Mode

This Field Device supports three Burst Messages.

The following commands can be represented in a Burst Message:

1 Read Primary Variable

2 Read Loop Current and Percent Of Range

3 Read Dynamic Variables and Loop Current

9 Read Device Variables with Status

33 Read Device Variables

48 Read Additional Device Status

8.3 Catch Device Variable

This Field Device does not support Catch Device Variable.

9. DEVICE-SPECIFIC COMMANDS

The following device-specific commands are implemented:

128 Calibrate

129 Read Alarm Setpoints

130 Write Alarm Setpoints

9.1 Command #128: CALIBRATE

Calibrates the instrument to a known temperature

Calibrate by exposing the instrument to a known temperature and send command 128 with that known temperature. The instrument will measure the amount of infrared light reaching the sensors and calculate calibration constants to cause the instrument to read that amount of light as the known temperature.

Request Data Bytes

Byte	Format	Description
0	Enum	Temperature Units, only 32(°C) or 33(°F) allowed
1-4	Float	Calibration Temperature (900 °C to 1800 °C)

Response Data Bytes

Byte	Format	Description
0	Enum	Temperature Units, only 32(°C) or 33(°F)
1-4	Float	Calibration Temperature

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
2	Error	Invalid selection (of units)

Code	Class	Description
3	Error	Value too high
4	Error	Value too low
5	Error	Too few data bytes

9.2 Command #129: READ ALARM SETPOINTS

Request Data Bytes

None

Response Data Bytes

Byte	Format	Description
0	Enum	Temperature Units, only 32(°C) or 33(°F)
1-4	Float	Low Alarm Setpoint
5-8	Float	High Alarm Setpoint
9-12	Float	Transmissivity Alarm Setpoint

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
2	Error	Invalid selection (of units)
3	Error	Value too high
4	Error	Value too low
5	Error	Too few data bytes

9.3 Command #130: WRITE ALARM SETPOINTS

Request Data Bytes

Byte	Format	Description
0	Enum	Temperature Units, only 32(°C) or 33(°F)
1-4	Float	Low Alarm Setpoint
5-8	Float	High Alarm Setpoint
9-12	Float	Transmissivity Alarm Setpoint

Response Data Bytes

Byte	Format	Description
0	Enum	Temperature Units, only 32(°C) or 33(°F)
1-4	Float	Low Alarm Setpoint

5-8	Float	High Alarm Setpoint
9-12	Float	Transmissivity Alarm Setpoint

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
2	Error	Invalid selection (of units)
3	Error	Value too high
4	Error	Value too low
5	Error	Too few data bytes

10. TABLES

10.1 Temperature Unit Codes

(subset of HART Common Table 2, Unit Codes)

32	degrees Celsius
33	degrees Fahrenheit

10.2 Code 243 - NAMUR NE43 Configuration

0	Loop current tracks signal value
1	Loop current down in case of malfunction
2	Loop current up in case of malfunction

10.3 Unit Conversion

Conversion to and from degrees Fahrenheit is made using the equation:

$$C = (F - 32) \times 5/9.$$

11. PERFORMANCE

11.1 Sampling Rates

Typical sampling rates are shown in the following table.

Primary temperature sensor sample	1 per second
PV digital value calculation	1 per second
Analog output update	1 per second

11.2 Power-Up

On power up, the transmitter goes through an initialization procedure, which takes approximately 2 seconds. During this period, the device will not respond to HART commands, and the analog output is set at 4.0mA.

Fixed-current mode is cancelled by power loss.

11.3 Reset

Command 42 ("Device Reset") causes the device to reset its microprocessor. The resulting restart is identical to the normal power up sequence.

11.4 Self-Test

Continuous self-testing is part of the normal device operation.

11.5 Command Response Times

Minimum	20ms
Typical	50ms
Maximum	100ms *

11.6 Busy and Delayed-Response

The transmitter does not respond with Delayed Response. Changing units (command 44) may cause subsequent commands to respond with BUSY for a few seconds.

11.7 Long Messages

The largest data field used is in the response to Command 9: 66 bytes including the two status bytes.

11.8 Non-Volatile Memory

EEPROM is used to hold the device's configuration parameters. New data is written to this memory immediately on execution of a write command.

11.9 Modes

Fixed current mode is implemented, using Command 40. This mode is cleared by power loss or reset. Another method to affect the loop current is Command 6 with Loop Current Mode parameter set to disabled. This mode setting is not affected by power cycle or reset but has to be changed by execution of Command 6 with Loop Current Mode parameter set to enabled.

11.10 Write Protection

This Field Device does not support write-protection. A hardware switch or jumper cannot be accessed during operation in explosion hazard areas.

11.11 Damping

The damping function has a first order low pass characteristic affecting only the PV and the loop current signal. The device accepts values from 0 to 60 seconds.

ANNEX A. CAPABILITY CHECKLIST

Manufacturer, model and revision	Delta Controls Corporation model HIR Rev 3
Device type	Transmitter
HART revision	7.06
Device Description available	Yes
Number and type of sensors	2 internal photodetectors
Number and type of actuators	0
Number and type of host side signals	1: 4 - 20mA analog
Number of Device Variables	4
Number of Dynamic Variables	1
Mappable Dynamic Variables?	No
Number of common-practice commands	19
Number of device-specific commands	1
Bits of additional device status	8
Alternative operating modes?	No
Burst mode?	Yes
Write-protection?	No

ANNEX B. DEFAULT CONFIGURATION

Parameter	Default value
Lower Range Value	300
Upper Range Value	1700
PV Units	degC
Damping time constant	1 second
Polling Address	0
Number of response preambles	5

ANNEX C. REVISION HISTORY

A1. Changes from Rev 2.0 to Rev 3.0

Support was added for HART 7.

B. Revised Linear Over-range and Device Malfunction Indication values. Command #48 byte 0 bits 0,1,2 do not set Device Status Bit 7