

Process Instruments

# **Thermalert 4.0 Series**

## HART Communication Protocol

Preamble:	2-20 Bytes of "FF"				
Start Char:	02 -> STX frame in short format				
	06 -> ACK frame in short format				
	82 -> STX frame in long format				
	86 -> ACK frame in long format				
	81 -> Burst Frame in long format				
Addr:	Bit 7 -> Master Address Bit (Slave has to echo this bit)				
	Bit 6 -> Device in Burst Mode Bit (in Slave answer)				
	short frame: Bit 0-3 -> Polling Address				
	long frame: Bit 0-5 -> Lower 6 Bits of Manufacturers ID				
	Byte 2 -> Manufacturers Device Type Code				
	Byte 3-5 -> Device ID Number				
Cmd:	Command Number:	0- 31 -> Universal Commands			
		32-127 -> Common Practice Commands			
		128-250 -> Transmitter Specific Commands			

## **Protocol Manual**

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#### Information

This document is part of the user manual for the Thermalert 4.0 series. It contains important information to programme the Thermalert 4.0 sensor in particular for a 2-wire instrument supporting the HART communication protocol. The document should be kept at all times with the instrument during its operational life. Other users of this instrument should be given these instructions with the sensor. Eventual updates to this information must be added to the original document.

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#### **Contacts**

#### **Fluke Process Instruments**

#### America

Everett, WA USA Tel: +1 800 227 8074 (USA and Canada, only) +1 425 446 6300 solutions@flukeprocessinstruments.com

#### EMEA

Berlin, Germany Tel: +49 30 478 0080 info@flukeprocessinstruments.de

China Beijing, China Tel: +86 10 6438 4691 info@flukeprocessinstruments.cn

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## **1** Specification

HART protocolversion 7.5Interface parameters1200 baud, 8 bits, odd parity

## 1.1 Frame Structure

| Preamble | Start Char | Addr | Cmd | Byte-Count | Data-Field | Checksum |

Preamble	2-20 Bytes of "FF"
Start Char	02 $\rightarrow$ STX frame in short format
	06 $\rightarrow$ ACK frame in short format
	82 $\rightarrow$ STX frame in long format
	86 $\rightarrow$ ACK frame in long format
	81 $\rightarrow$ Burst Frame in long format
Addr	Bit 7 $\rightarrow$ Master Address Bit (Slave has to echo this bit)
	Bit 6 $\rightarrow$ Device in Burst Mode Bit (in Slave answer)
	short frame: Bit 0-3 $\rightarrow$ Polling Address
	long frame: Bit 0-5 $\rightarrow$ Lower 6 Bits of Manufacturers ID
	Byte 2 $\rightarrow$ Manufacturers Device Type Code
	Byte 3 – 5 $\rightarrow$ Device ID Number
Cmd	Command Number:
	0 – 31 $\rightarrow$ Universal Commands
	32 – 127 $\rightarrow$ Common Practice Commands
	128 – 250 $\rightarrow$ Transmitter Specific Commands
Byte Count	Count of bytes in the following Data Field
Data Field	The data bytes to be transferred. All data frames coming from the slave are preceded by 2 'response' bytes; the first byte is status of the communications and second is the slave device status
Checksum	XOR-ed result from the Start Char to the last data byte

#### First Response Byte:

Error codes:

- Bit 7: Error sum bit (0 = Warning as described below, 1 = error)
- Bit 6: Vertical Parity Error (Byte-Parity)
- Bit 5: Receive Overrun
- Bit 4: Framing Error
- Bit 3: Longitudinal Parity Error (Frame-Parity)
- Bit 2: Reserved
- Bit 1: Receiver Buffer Overflow
- Bit 0: Undefined

Warning codes:

- 2 : Invalid selection, code or index was not allowed
- 3 : Passed parameter is too large
- 4 : Passed parameter is too small
- 5 : Too few data bytes received
- 7 : Device is write protected
- 8 : Parameter is set to the nearest possible value
- 9 : Lower range value too high
- 10 : Lower range value too low
- 11 : Upper range value too high
- 12 : Upper range value too low
- 13 : Upper and Lower range values out of limits
- 14 : Span too small
- 16 : Access restricted
- 28 : Invalid range unit code
- 32 : Device busy
- 64 : Command not implemented

#### Second Response Byte:

Status:

- Bit 7=1 : Malfunction, Hardware Error
- Bit 6=1 : Configuration changed
- Bit 5=1 : Cold start bit (valid until 1.Transfer)
- Bit 3=1 : Primary variable analog output fixed
- Bit 2=1 : Primary variable output out of limits
- Bit 1=1 : Non primary variable out of limits (internal Temperature)
- Bit 0=1 : primary variable out of limits (object Temperature)

## **1.2 Universal Commands**

Description	Command	Requested Data Bytes	Response Data Bytes	Response Codes
READ UNIQUE IDENTIFIER	COMMAND #0	none	<ul> <li>#0: Extension-Code (254)</li> <li>#1#2: Expanded Device Type</li> <li>#3: Number of requested Preambles</li> <li>#4: Universal Command Revision</li> <li>#5: Device Revision</li> <li>#6: Software Revision</li> <li>#7: Hardware Revision</li> <li>#8: Flags</li> <li>#9#11: Device-ID-Number</li> <li>#12: Number of response Preambles</li> <li>#13: Number of Device Variables</li> <li>#14#15: Configuration Change Counter</li> <li>#15: Extended Field Device Status</li> <li>#17#18: Manufacturer ID Code</li> <li>#19#20: Private Label Distributor Code</li> <li>#21: Device Profile</li> </ul>	0: No Command- Specific Errors
READ PRIMARY VALUE (PV)	COMMAND #1	none	#0: PV-Units #1#4: PV in IEEE 754	0: No Command- Specific Errors
READ PV CURRENT AND PERCENT OF RANGE	COMMAND #2	none	#0#3: PV-Current in IEEE 754 #4#7: PV-Percent of Range in IEEE 754	0: No Command- Specific Errors
READ DYNAMIC VARIABLES AND PV CURRENT	COMMAND #3	none	#0.#3: PV-Current in IEEE 754 #4 : PV-Units #5#8: PV in IEEE 754 #9 : SV-Units #10#13: SV in IEEE 754 #14 : TV-Units #15#18: TV in IEEE 754 #19 : FV-Units #20#23: FV in IEEE 754	0: No Command- Specific Errors
WRITE POLLING ADDRESS	COMMAND #6	#0: Polling Address #1: Loop Current Mode	#0: Polling Address #1: Loop Current Mode	0: No Command- Specific Errors 2: Invalid Poll Address Selection 5: Too Few Data Bytes 7: In Write Protect Mode 8: Set to nearest
READ LOOP CONFIGRATION	COMMAND #7	none	#0: Polling Address #1: Loop Current Mode	0: No Command- Specific Errors
READ UNIQUE IDENTIFIER ASSOCIATED WITH TAG	COMMAND #11	#0#5: TAG in packed- ASCII	Same as Command 0# Response	0: No Command- Specific Errors
READ MESSAGE	COMMAND #12	none	#0#23: Message in Packed-ASCII	0: No Command- Specific Errors
READ TAG, DESCRIPTOR, DATE	COMMAND #13	none	#0#5: Tag in Packed-ASCII #6#17: Descriptor #18#20: Date	0: No Command- Specific Errors
READ PRIMARY VARIABLE SENSOR INFORMATION	COMMAND #14	none	#0#2: Serial Number#3: PV-Limits/Min-Span-Units#4#7: PV Upper Limit in IEEE 754#8#11: PV Lower Limit in IEEE 754#12#15: PV Minimum Span	0: No Command- Specific Errors
READ PRIMARY VARIABLE OUTPUT INFORMATION	COMMAND #15	none	<ul> <li>#0: N.A.</li> <li>#1: PV Transfer Function Code (0-&gt;linear)</li> <li>#2: PV-Range-Value-Units</li> <li>#3#6 : PV Upper Range in IEEE 754</li> <li>#7#10: PV Lower Range in IEEE 754</li> <li>#11#14: PV Damping Value in IEEE 754 (Default = 0, no definition for IR meter)</li> <li>#15: Write Protect Code</li> <li>#16: Private Label Distributor Code(Reserved, set to 0xFA)</li> <li>#17: PV Analog Channel Flags (1-&gt;analog input channel, 0-&gt;analog output channel)</li> <li>#0.#2: Final Assembly Number</li> </ul>	0: No Command- Specific Errors
ASSEMBLY NUMBER	#16	none		Specific Errors

Description	Command	Requested Data Bytes	Response Data Bytes	Response Codes
WRITE MESSAGE	COMMAND #17	#0#23: Message in Packed- ASCII	#0#23: Message in Packed-ASCII	0: No Command- Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode
WRITE TAG, DESCRIPTOR, DATE	COMMAND #18	#0#5: Tag in Packed- ASCII #6#17: Descriptor #18#20: Date	#0#5: Tag in Packed-ASCII #6#17: Descriptor #18#20: Date	0: No Command- Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode
WRITE FINAL ASSEMBLY NUMBER	COMMAND #19	#0#2: Final Assembly Number	#0#2: Final Assembly Number	0: No Command- Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode
READ LONG TAG	COMMAND #20	none	#0#31: Latin-1 Long Tag	0: No Command- Specific Errors
READ UNIQUE ID ASSOCIATE WITH LONG TAG	COMMAND #21	#0#31: Long Tag	Same as Command 0# Response	0: No Command- Specific Errors
WRITE LONG TAG	COMMAND #22	#0#31: Long Tag	#0#31: Long Tag	0: No Command- Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode

## **1.3 Common Practice Commands**

Description	Command	Requested Data Bytes	Response Data Bytes	Response Codes
WRITE PV DAMPING VALUE	COMMAND #34	#0#3: PV Damping Value in seconds (IEEE 754) (Default = 0, no definition for IR meter)	#0#3: Actual Damping Value in seconds (IEEE 754)	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode
WRITE PV RANGE VALUES	COMMAND #35	#0: PV Range Value Units #1#4: PV Upper Range Value in IEEE 754 #5#8: PV Lower Range Value in IEEE 754	#0: PV Range Value Units #1#4: PV Upper Range Value in IEEE 754 #5#8: PV Lower Range Value in IEEE 754	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode 13: URV and LRV out of limit 18: Invalid Units Code 29: Invalid span
RESET CONFIGURATION FLAG	COMMAND #38	#0#1: Configuration Change Counter	#0#1: Configuration Change Counter	0: No Command-Specific Errors 9: Configuration Change Counter Mismatch
ENTER/EXIT FIXED PV CURRENT MODE	COMMAND #40	#0#3: PV Current Level in IEEE 754	#0#3: PV Current Level in IEEE 754	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode 8: Set to Nearest 11: Access Restrict
PERFORM DEVICE RESET	COMMAND #42	none	none	0: No Command-Specific Errors
WRITE PV UNITS	COMMAND #44	<ul><li>#0: PV Units Code</li><li>32: Degree Celsius</li><li>33: Degree Fahrenheit</li></ul>	#0: PV Units Code	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode 18: 2: Invalid Unit Code
TRIM PV CURRENT DAC ZERO	COMMAND #45	#0#3: Measured PV Current in IEEE 754	#0#3: Measured PV Current in IEEE 754	0: No Command-Specific Errors 7: In Write Protect Mode 9: Not in Proper Current Mode 11: In Multidrop Mode
TRIM PV CURRENT DAC GAIN	COMMAND #46	#0#3: Measured PV Current in IEEE 754	#0#3: Measured PV Current in IEEE 754	Same as COMMAND #45
READ UNIT TAG, DESCRIPTOR, DATE	COMMAND #57	none	#0#5: Unit Tag in Packed-ASCII #6#17: Unit Descriptor in Packed-ASCII #18#20: Unit Date in Day, Month, Year	0: No Command-Specific Errors
WRITE NUMBER OF RESPONSE PREAMBLES	COMMAND #59	#0: Number of Response Preambles	#0: Number of Response Preambles	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode 8: Set to Nearest
WRITE BURST MODE COMMAND NUMBER	COMMAND #108	#0#1: Burst Mode Command Number 2#: Burst Message	#0#1 : Burst Mode Command Number	0: No Command-Specific Errors 2: Invalid Selection 5: Too Few Data Bytes 7: In Write Protect Mode
BURST MODE CONTROL	COMMAND #109	#0: Burst Mode Select Code 0: Exit Burst Mode 1: Enter Burst Mode 1#: Burst Message	#0: Burst Mode Select Code #1: Burst Message	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode 8: Set to nearest

## **1.4 Transmitter Specific Commands**

Description	Command	Requested Data Bytes	Response Data Bytes	Response Codes
READ EMISSIVITY	COMMAND #128	none	#0#3: Emissivity in IEEE 754	0: No Command-Specific Errors
WRITE EMISSIVITY	COMMAND #129	#0#3: Emissivity in IEEE 754	#0#3: Emissivity in IEEE 754	0: No Command-Specific Errors 3: Passed Parameter too large 4: Passed Parameter too small 5: Too Few Data Bytes 7: In Write Protect Mode
READ TRANSMISSIVITY	COMMAND #130	none	#0#3: Transmission in IEEE 754	0: No Command-Specific Errors
WRITE TRANSMISSIVITY	COMMAND #131	#0#3: Transmissivity in IEEE 754	#0#3: Transmissivity in IEEE 754	0: No Command-Specific Errors 3: Passed Parameter too large 4: Passed Parameter too small 5: Too Few Data Bytes 7: In Write Protect Mode
READ HOLD FUNCTION VALUE	COMMAND #132	none	<ul> <li>#0: Hold Function Code</li> <li>0: Hold Function off</li> <li>3: Average</li> <li>4: Hold Function Valley</li> <li>5: Hold Function Peak</li> <li>6: Hold Function Valley</li> <li>Advanced</li> <li>7: Hold Function Peak</li> <li>Advanced</li> <li>#1#4: Hold Time in IEEE 754</li> <li>#5#8: Average Time in IEEE 754</li> <li>in IEEE 754</li> </ul>	0: No Command-Specific Errors
WRITE HOLD FUNCTION VALUE	COMMAND #133	<ul> <li>#0: Hold Function Code <ul> <li>0: Hold Function off</li> <li>3: Average</li> <li>4: Hold Function Valley</li> <li>5: Hold Function Peak</li> <li>6: Hold Function Valley</li> </ul> </li> <li>Advanced <ul> <li>7: Hold Function Peak</li> <li>Advanced</li> <li>#1#4: Hold Time in IEEE 754</li> <li>#5#8: Average Time in IEEE 754</li> </ul> </li> </ul>	#0: Hold Function Code #1#4: Hold Time in IEEE 754 #5#8: Average Time in IEEE 754 #0#12: Advanced Average Time in IEEE 754	0: No Command-Specific Errors 2: Invalid Selection 5: Too Few Data Bytes 7: In Write Protect Mode 8: Set to Nearest
READ ALARM FUNCTION VALUES	COMMAND #134	none	<ul> <li>#0: Alarm Function Code <ol> <li>alarm off, open;</li> <li>alarm off, closed;</li> <li>a alarm on, target norm.</li> </ol> </li> <li>open; <ol> <li>alarm on, target norm.</li> </ol> </li> <li>closed; <ol> <li>alarm on, amb norm.</li> <li>open;</li> <li>alarm on, amb norm.</li> </ol> </li> <li>open;</li> <li>alarm on, amb norm.</li> <li>closed;</li> <li>bland norm.</li> <li>closed;</li> <li>#1: Units Code</li> <li>#2#5: Dead Band Value in IEEE</li> <li>754</li> <li>#6#9: Upper Alarm Value in <ol> <li>IEEE 754</li> <li>#10#13: Lower Alarm Value in</li> </ol> </li> </ul>	0: No Command-Specific Errors

Description	Command	Requested Data Bytes	Response Data Bytes	Response Codes
WRITE ALARM FUNCTION VALUES	COMMAND #135	<ul> <li>#0: Alarm Function Code <ol> <li>alarm off, open;</li> <li>alarm off, closed;</li> <li>alarm on, target norm.</li> </ol> </li> <li>open; <ol> <li>alarm on, target norm.</li> </ol> </li> <li>closed;</li> <li>alarm on, amb norm. open;</li> <li>alarm on, amb norm.</li> <li>closed;</li> <li>#1: Units Code</li> <li>#2#5: Dead Band Value in IEEE</li> <li>754</li> <li>#6#9: Upper Alarm Value in IEEE</li> <li>754</li> <li>#10#13: Lower Alarm Value in IEEE</li> </ul>	#0: Alarm Function Code #1: Units Code #2#5: Dead Band Value in IEEE 754 #6#9: Upper Alarm Value in IEEE 754 #10#13: Lower Alarm Value in IEEE 754	0: No Command-Specific Errors 2: Invalid selection 5: Too Few Data Bytes 7: In Write Protect Mode 8: Set to Nearest
WRITE PROTECT CONTROL	COMMAND #141	<ul> <li>#0: Write Protect Control Code</li> <li>0: Not Write Protected</li> <li>1: Write Protected</li> <li>#1#6: Password = current Tag</li> </ul>	#0: Write Protect Control Code	0: No Command-Specific Errors 2: Invalid Selection 5:Too Few Data Bytes 8: Set to Nearest
READ FAIL SAFE MODE	COMMAND #144	none	<ul><li>#0: Fail Safe Mode</li><li>0: off</li><li>2: low current at fail safe</li><li>3: high current at fail safe</li></ul>	0: No Command-Specific Errors
WRITE FAIL SAFE MODE	COMMAND #145	<ul> <li>#0: Fail Safe Mode</li> <li>0: off</li> <li>2: low current at fail safe</li> <li>3: high current at fail safe</li> </ul>	#0: Fail Safe Mode	0: No Command-Specific Errors 5:Too Few Data Bytes 7: In Write Protect Mode
READ SPECIAL CODE	COMMAND #146	none	#0#11:Special information	0: No Command-Specific Errors
READ ERROR CODE	COMMAND #147	none	<ul> <li>#0: Error Code <ul> <li>0x0001 = Target</li> <li>temperature over range;</li> <li>0x0002 = Target</li> </ul> </li> <li>temperature under range;</li> <li>0x0010 = Ambient</li> <li>temperature over range;</li> <li>0x0020 = Ambient</li> <li>temperature under range</li> <li>0x0100 = Analog output</li> <li>over range;</li> <li>0x0200 = Analog output</li> <li>under range</li> </ul>	0: No Command-Specific Errors
READ HOLD TRIGGER TEMPERATURE	COMMAND #148	none	#0: Unit Code #1#4: Trigger Temperature in IEEE 754 #5#8: Hold Hysteresis in IEEE 754	0: No Command-Specific Errors
WRITE HOLD TRIGGER TEMPERATURE	COMMAND #149	#0: Unit Code #1#4: Hold Trigger Threshold Temperature in IEEE 754 #5#8: Hold Hysteresis in IEEE 754	#0: Unit Code #1#4: Hold Trigger Temperature in IEEE 754 #5#8: Hold Hysteresis in IEEE 754	0: No Command-Specific Errors 8: set to Nearest 5: Too Few Data Bytes 7: In Write Protect Mode 18: Invalid unit code
READ DEVICE IDENTIFICATION	COMMAND #150	none	#0#23: Special information	0: No Command-Specific Errors
RESET HART DATA	COMMAND #151	none	none	0: No Command-Specific Errors
WRITE PV LIMIT VALUES	COMMAND #160	#0: PV Limit Value Units #1#4: PV Upper Limit Value in IEEE 754 #5#8: PV Lower Limit Value in IEEE 754	#0: PV Limit Value Units #1#4: PV Upper Limit Value in IEEE 754 #5#8: PV Lower Limit Value in IEEE 754	0: No Command-Specific Errors 5: Too Few Data Bytes 7: In Write Protect Mode 18: Invalid Units Code 29: Invalid span