STANDARD

Universal Command Specification

HCF_SPEC-127, Revision 7.1

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Addendum To
Universal Command Specification (HCF_SPEC-127)

May 10, 2008

Since release of the HART Communication Protocol Revision 7.0 Specifications in September 2007, HCF staff and Technical Working Groups updating and developing test specifications have closely scrutinized the Protocol Specifications. Any anomalies, errors or omissions discovered in the Specifications have been identified, tracked and resolved. Changes, clarifications and corrections resulting from the anomalies discovered and resolved during this process are detailed in this addendum.

This addendum provides developers with the most current, accurate and up-to-date information on the HART 7 Specifications. Each change is detailed below by Subsection and brief explanation of the change. All changes described in this addendum are mandatory. HART-enabled product implementations must comply with the Specification corrections and clarifications described in this addendum.

Subsection 6.23 Command 38 Reset Configuration Changed Flag
If only 1 byte is received from the master, a Response Code of 5 - Too Few Bytes should be sent. Consequently the Response Codes for Command 38 must be modified as follows:

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8		Undefined
9	Error	Configuration Change Counter Mismatch
10 - 15		Undefined
16	Error	Access Restricted
17 -127		Undefined

Subsection 6.24 Command 48 Read Additional Device Status

If more than 0 but less than the number of bytes required to clear more status available status then the "Too few data bytes received" Response Code must be returned. In addition, a "Status bytes mismatch" must be returned if the status bytes in the request do not match those in the field device. Consequently the Response Codes for Command 48 must be modified as follows:

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7		Undefined
8	Warning	Update In Progress
9 - 13		Undefined
14	Warning	Status bytes mismatch
15		Undefined
16	Error	Access Restricted
17 -127		Undefined

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Preface

This preface is included for informational purposes only.

HART 7 represents the first major revision to the Protocol in over 6 years. However, developers, manufacturers and users of the HART compatible devices can be assured that fundamental HART principles are maintained. HART 7 is backward compatible with previous protocol versions while increasing the capabilities of 4-20mA devices and systems.

No new commands have been added in this version of the Universal Command Specification. However two bytes have been added to the Command 0 Response and a Time stamp has been added to Command 9.

The change to Command 0 results from the widespread growth and adoption of the HART Protocol. This has resulted in the available code space for 8-bit Manufacturer ID Code being exhausted. Resolution of this dilemma requires that the Manufacturer ID Code be expanded from 8-bits to 16-bits.

Command 9 now adds a 4-byte time stamp to the response generated by the field device. The value corresponds to the time that Device Variable in Slot 0 of Command 9 was calculated. This feature was added as the result of widespread demand by Host Systems vendors and to support WirelessHART™. The number of device variables that can be returned in Command 9 is now allowed to be up to 8 Device Variables.

These additions are valuable in many applications. However, the changes are incremental enhancements that do not fundamentally change the Protocol.

Introduction

The *Universal Command Specification* is a key document in the HART Specifications that establishes the minimum Application Layer support required of all HART Devices. In fact, the Universal Command Specification is consider so important that the major revision level of the entire Protocol always matches the major revision level of this document.

HART is a master-slave protocol and is loosely organized around the ISO/OSI 7-layer model for communications protocols (see Figure 1). The Application Layer is the topmost layer in the Open System Interconnect (OSI) model. More HART specification documents address the Application Layer than any other OSI Layer.

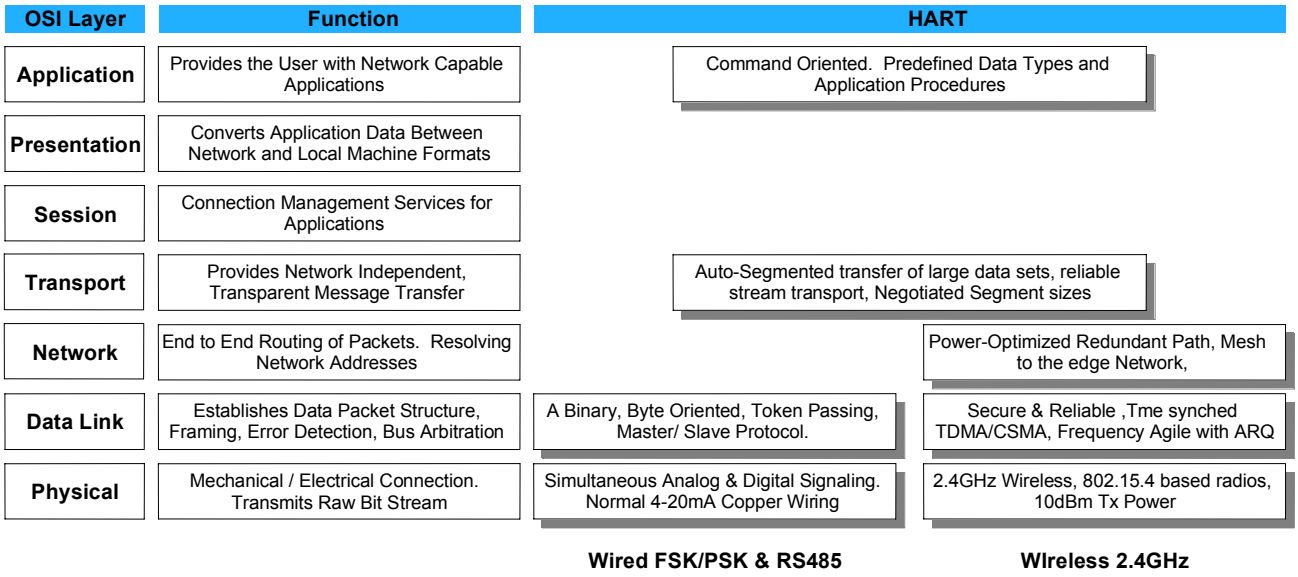

Figure 1. OSI 7-Layer Model

The Application Layer in HART defines the commands, responses, data types and status reporting supported by the Protocol. In addition, there are certain conventions in HART (for example how to trim the loop current) that are also considered part of the Application Layer. While the Command Summary, Common Tables and Command Response Code Specifications all establish mandatory Application Layer practices (e.g. data types, common definitions of data items, and procedures), the Universal Commands specify the minimum Application Layer content of all HART compatible devices.

1. SCOPE

This document is an Application Layer specification and, as a result, builds on the Application Layer requirements found in the *Command Summary Specification* (HCF_SPEC-99). Conformance to the *Universal Command Specification* requires *Command Summary Specification* conformance as a prerequisite. This document supersedes all previous revisions of the *Universal Command Specification*.

The *Universal Command Specification* contains definitions of all HART Protocol Universal Commands. HART compatible devices must implement all universal commands exactly as described within this specification. Many Universal Commands refer to tables from the *Common Tables Specification* (HCF_SPEC-183). When Common Tables are referenced, data from the tables must be used exactly as specified.

2. REFERENCES

2.1 The HART-Field Communications Protocol Specifications

These documents published by the HART Communication Foundation are referenced throughout this specification:

HART Field Communications Protocol Specification. HCF_SPEC-12

Data Link Layer Specification. HCF_SPEC-81

Command Summary Specification. HCF_SPEC-99

Common Practice Command Specification. HCF_SPEC-151

Common Tables Specification. HCF_SPEC-183

Command Response Code Specification. HCF_SPEC-307

2.2 Related HART Documents

The HART Protocol Specifications frequently reference the manufacturer's device-specific document. Device-specific documents are developed and controlled by the respective manufacturer and should follow the requirements of the following HART Communication Foundation document:

Requirements for Device Specific Documentation. HCF_LIT-18

3. DEFINITIONS

Definitions for terms can be found in *Communications Protocol Specification.* Terms used in this document include: ASCII, Broadcast Address, Data Link Layer, Delayed Response, Delayed Response Mechanism, Device Reset, Device Variable, Busy, Dynamic Variable, Fixed Current Mode, Floating Point, ISO Latin-1, Master, Multi-drop, Not-A-Number, Packed ASCII, Preamble, Request Data Bytes, Response Data Bytes, Response Message, Slave, Slave Time-Out, Software Revision Level, Time Constant, Units Code.

4. SYMBOLS/ABBREVIATIONS

ADC	**A**nalog-to-**D**igital **C**onverter
DAC	**D**igital-to-**A**nalog **C**onverter.
DAQ	**D**ata **Aq**uistion. This referes to a devices specific ADC or DAC
DR	**D**elayed **R**esponse
HCF	**H**ART **C**ommunication **F**oundation
LRV	**L**ower **R**ange **V**alue. Defines the relationship between a Dynamic Variable value and an analog channel lower endpoint (e.g. 4.00mA).
LSB	**L**east **S**ignificant **B**yte. The LSB is always the last byte transmitted over a HART data link
LTL	**L**ower **T**ransducer **L**imit. The digital value that defines the minimum reliable and accurate value of a dynamic or Device Variable
MSB	**M**ost **S**ignificant **B**yte. The MSB is always the first byte transmitted over a HART data link.
URV	**U**pper **R**ange **V**alue. Defines the relationship between a Dynamic Variable value and an analog channel upper endpoint (e.g. 20.0mA).
UTL	**U**pper **T**ransducer **L**imit. The digital value that defines the maximum reliable and accurate value of a dynamic or Device Variable

5. DATA FORMAT

In HART Protocol command specifications, the following key words are used to refer to the data formats. For more information about these formats refer to the *Command Summary Specification*.

Bits	Each individual bit in the byte has a specific meaning. Only values specified by the command may be used. Bit 0 is the least significant bit.
Date	The Date consists of three 8-bit binary unsigned integers representing, respectively, the day, month, and year minus 1900. Date is transmitted day first followed by the month and year bytes.
Time	The Time consists of a unsigned 32-bit binary integer with the least significant bit representing 1/32 of a millisecond (i.e., 0.03125 milliseconds).
Enum	An integer enumeration with each numeric value having a specific meaning. Only values specified in the *Common Tables Specification* may be used.
Float	An IEEE 754 single precision floating point number. The exponent is transmitted first followed by the most significant mantissa byte.
Latin-1	A string using the 8-bit ISO Latin-1 character set. Latin-1 strings are padded out with zeroes (0x00).
Packed	A string consisting of 6-bit alpha-numeric characters that are a subset of the ASCII character set. This allows four characters to be packed into three bytes. Packed ASCII strings are padded out with space (0x20) characters.
Unsigned-*nn*	An unsigned integer where *nn* indicates the number of bits in this integer. Multi-byte integers are transmitted MSB – LSB.

6. COMMANDS

6.1 Command 0 Read Unique Identifier

This is an Identity Command (see the *Command Summary Specification*).

Returns identity information about the field device including: the Device Type, revision levels, and Device ID. This command is implemented by a field device in both Short and Long Frame Formats. Command 0 is the only command that may respond to a short frame address.

The combination of Device Type, and Device ID make up the Unique ID used to construct the long frame address. No two devices ever manufactured may have the same combination of these data.

The Configuration Change Counter must be incremented once for every command received that changes the devices configuration. The counter must also be incremented once for every user action that changes the device's configuration or calibration (e.g., from a local operator interface). This value is never reset or written and must be maintained even if power is removed from the device or a device reset is performed.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	"254"
1-2	Enum	Expanded Device Type (see Common Table 1, Device Type Codes and the *Command Summary Specification*, Section 6).
3	Unsigned-8	Minimum number of Preambles required for the request message from the Master to the Slave. This number includes the two preambles used in asynchronous Physical Layers (along with the Delimiter) to detect the start of message.
4	Unsigned-8	HART Protocol Major Revision Number implemented by this device. For HART Revision 7, this value must be the number 7.
5	Unsigned-8	Device Revision Level (refer to the *Command Summary Specification*)
6	Unsigned-8	Software Revision Level of this device. Levels 254 and 255 are reserved.
7	Unsigned-5	(Most Significant 5 Bits) Hardware Revision Level of the electronics in this particular device. Does Not Necessarily Trace Individual Component Changes. Level 31 is Reserved.
7	Enum	(Least Significant 3 Bits) Physical Signaling Code (see Common Table 10, Physical Signaling Codes)
8	Bits	Flags (see Common Table 11, Flag Assignments)
9-11	Unsigned-24	Device ID. This number must be different for every device manufactured with a given Device Type.
12	Unsigned-8	Minimum number of preambles to be sent with the response message from the slave to the master.
13	Unsigned-8	Maximum Number of Device Variables. This indicates the last Device Variable code that a host application should expect to be found in the field device (e.g., when identifying the Device Variables using Command 54).
14-15	Unsigned-16	Configuration Change Counter
16	Bits	Extended Field Device Status (refer to Common Table 17, Extended Field Device Status)
17-18	Enum	Manufacturer Identification Code (see Common Table 8, Manufacturer Identification Codes)
19-20	Enum	Private Label Distributor Code (see Common Table 8, Manufacturer Identification Codes)
21	Enum	Device Profile (see Common Table 57)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

6.2 Command 1 Read Primary Variable

Read the Primary Variable. The Primary Variable value is returned along with its Units Code.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Primary Variable Units (refer to *Common Tables Specification*)
1-4	Float	Primary Variable

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7		Undefined
8	Warning	Update Failure
9-15		Undefined
16	Error	Access Restricted
17-127		Undefined

6.3 Command 2 Read Loop Current And Percent Of Range

Reads the Loop Current and its associated Percent of Range. The Loop Current always matches the current that can be measured by a milli-ammeter in series with the field device; this includes the loop current under alarm conditions.

6.3.1 Percent of Range (Transmitters)

Percent of Range always follows the Primary Variable value, even if Loop Current is in an alarm condition or set to a value. The Upper and Lower Range Values maps the Primary Variable value to the Percent of Range. Percent of Range is not limited to values between 0% and 100%, but tracks the Primary Variable to the Transducer Limits when they are defined.

6.3.2 Percent of Range (Actuators)

Percent of Range always follows the Loop Current even if it is set to a value. The Upper and Lower Range Values map the Loop Current Value to the Percent of Range. As a result the Percent of Range is not limited to values between 0% and 100%, but tracks the Loop Current to Transducer Limits when they are defined.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-3	Float	Primary Variable Loop Current (units of milli-amperes)
4-7	Float	Primary Variable Percent of Range (units of percent)

Note Voltage Mode Field Devices use "Volts DC" as their engineering units

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7		Undefined
8	Warning	Update Failure
9-15		Undefined
16	Error	Access Restricted
17-127		Undefined

6.4 Command 3 Read Dynamic Variables And Loop Current

Reads the Loop Current and up to four predefined Dynamic Variables. The Loop Current always matches the current that can be measured by a milli-ammeter in series with the field device; this includes alarm conditions and set values.

The Response Data is truncated after the last Dynamic Variable supported by each Device Type (see Table 2). For a given Device Type the number of Response Data bytes must be fixed. In other words, a Device type may not return PV, SV, and TV in one operating mode and later (in a different operating) only return PV and SV.

Table 1. Command 3 Response Based on Number of Dynamic Variables Supported.

Dynamic Variables Supported	No. of Response Data Bytes
PV	9
PV, SV	14
PV, SV, TV	19
PV, SV, TV, QV	24

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-3	Float	Primary Variable Loop Current (units of milli-amperes)
4	Enum	Primary Variable Units Code (refer to *Common Tables Specification*)
5-8	Float	Primary Variable
9	Enum	Secondary Variable Units Code (refer to *Common Tables Specification*)
10-13	Float	Secondary Variable
14	Enum	Tertiary Variable Units Code (refer to *Common Tables Specification*)
15-18	Float	Tertiary Variable
19	Enum	Quaternary Variable Units Code (refer to *Common Tables Specification*)
20-23	Float	Quaternary Variable

Note Voltage Mode Field Devices use "Volts DC" as their engineering units for "Loop Current" rather then milliamps

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7		Undefined
8	Warning	Update Failure
9-15		Undefined
16	Error	Access Restricted
17-127		Undefined

6.5 Command 4 Reserved

Revisions 3 and 4 of this document included this command. These commands must not be implemented in any field device.

6.6 Command 5 Reserved

Revisions 3 and 4 of this document included this command. These commands must not be implemented in any field device.

6.7 Command 6 Write Polling Address

This is a Data Link Layer Management Command.

Writes the polling address and the loop current mode to the field device. The polling address is used for automatic master identification of field devices. The loop current mode determines whether current signaling is being used by the field device.

Masters claiming compatibility with this revision of the specification must always supply the all request data bytes.

All Field Devices must be able to operate in multi-drop with loop current signaling disabled. When current signaling is disabled, the loop current is set to the minimum value required for field device operation, the field device status bit 3, Loop Current Fixed, is set, and, if appropriate, the Upscale/ Downscale Alarm is disabled. Furthermore, commands that affect the Loop Current must not be executed while loop current signaling is disabled. These include:

- Command 40 Enter/Exit Fixed Current Mode;
- Command 45 Trim Loop Current Zero; and
- Command 46 Trim Loop Current Gain.

These Commands shall return Command-Specific Response Code 11, In Multidrop Mode, while loop current signaling is disabled . In addition,

- Command 66 Enter/Exit Fixed Analog Output Mode;
- Command 67, Trim Analog Output Zero; and
- Command 68, Trim Analog Output Gain

shall return Command-Specific Response Code 11, In Multidrop Mode, when Analog Channel 0 is selected and loop current signaling is disabled.

All Field Devices should be manufactured with the polling address set to a default value of zero (0) and the loop current mode set to active. This ensures HART field devices will operate in place of an analog only field device by default.

6.7.1 Backward Compatibility Requirements

Field devices receiving Command 6 with a single data byte **must**: assume the Master is HART Revision 5; enable current signaling if the polling address is zero; disable current signaling if the polling address is non-zero and answer providing both the polling address in the master request and the appropriately set Loop Current Mode byte.

When a field device receives a single request data byte, it must answer the master request without returning Response Code 5, Too Few Data Bytes Received.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Polling Address of Device (refer to the *Data Link Layer Specification*)
1	Enum	Loop Current Mode (refer to Common Table 16, Loop Current Modes)

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Polling Address of Device (refer to the *Data Link Layer Specification*).
1	Enum	Loop Current Mode (refer to Common Table 16, Loop Current Modes)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Poll Address Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-11		Undefined
12	Error	Invalid Mode Selection
13-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.8 Command 7 Read Loop Configuration

Read polling address and the loop current mode.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Polling Address of Device (refer to the *Data Link Layer Specification*)
1	Enum	Loop Current Mode (refer to Common Table 16, Loop Current Modes)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-127		Undefined

6.9 Command 8 Read Dynamic Variable Classifications

Reads the Classification associated with the Dynamic Variables. The Classification determines the Unit Code Expansion Table that must be used by a Host.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	Primary Variable Classification (see Common Table 21, Device Variable Classification Codes)
1	Enum	Secondary Variable Classification (see Common Table 21, Device Variable Classification Codes)
2	Enum	Tertiary Variable Classification (see Common Table 21, Device Variable Classification Codes)
3	Enum	Quaternary Variable Classification (see Common Table 21, Device Variable Classification Codes)

Note: Dynamic Variables not supporting a Device Variable Classification must return 0 ("Not Yet Classified").

Note: For Dynamic Variables not supported a Device Variable Classification must return 250 ("Not Used").

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-127		Undefined

6.10 Command 9 Read Device Variables with Status

This command allows a Master to request the value and status of up to eight Device or Dynamic Variables. In other words, a Master may request any number of Device Variables between 1 and 8. The Field Device must answer these Master requests without returning Response Code 5, Too Few Data Bytes Received. If the Field Device receives 1, 2, 3, 4, 5, 6, or 7 Request Data Bytes it must return only the corresponding number of Device Variables (see Table 2).

Table 2. Command 9 Response Based on Number of Device Variables Requested

No. of Device Variables Requested	No. of Request Data bytes	No. of Response Data Bytes
1	1	13
2	2	21
3	3	29
4	4	37
5	5	45
6	6	53
7	7	61
8	8	69

If the Field Device does not support Device Variables, then the Field Device must return: PV when Device Variable zero is requested; SV for Device Variable one; TV for Device Variable two; and QV for Device Variable three. In addition, the field device must return "Dynamic Variables Returned for Device Variables" (see Common Table 34). Other command requirements include:

- When a Dynamic or Device Variable requested is not supported in the Field Device, then the corresponding Value must be set to "0x7F, 0xA0, 0x00, 0x00"; the Status must be set to 0x30, (i.e., Status = "Bad" and Limit = "Constant"); the Units Code. must be set to "250" Not Used; and the Device Variable Classification set to "0", Not Yet Classified.
- When the Device Variable Classification is not supported for a requested Dynamic or Device Variable, then "0", Not Yet Classified, must be returned in that field of the response .
- This command is capable of Burst Mode Operation and is configured with Command 107, Write Burst Mode Device Variables.
- In addition to supporting access to the Device Variables all field devices must support access the Dynamic Variables and the Loop Current. In other words, the Device Variable Code Table found in the manufacturer's device-specific document always includes the codes found in Common Table 34, Device Variable Code Table.
- Devices must support at least 4 slots in Command 9. If the device truncates a host response after 4 slots it must return "Command Response Truncated". The device must support at least 4 slots or as many slots as it has Device Variables whichever is larger (not to exceed 8).
- Devices are not required to support a settable Real-Time Clock. However, the time stamp must be monotonic and rollover every 24 hours.

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Slot 0: Device Variable Code (see Device Variable Code Table in appropriate device-specific document)
1	Unsigned-8	Slot 1: Device Variable Code
2	Unsigned-8	Slot 2: Device Variable Code
3	Unsigned-8	Slot 3: Device Variable Code
4	Unsigned-8	Slot 4: Device Variable Code
5	Unsigned-8	Slot 5: Device Variable Code
6	Unsigned-8	Slot 6: Device Variable Code
7	Unsigned-8	Slot 7: Device Variable Code

Response Data Bytes

Byte	Format	Description
0	Bits	Extended Field Device Status (refer to Common Table 17, Extended Field Device Status)
1	Unsigned-8	Slot 0: Device Variable Code (refer to Common Table 34, Device Variable Code Table and the appropriate device-specific document)
2	Enum	Slot 0: Device Variable Classification
3	Enum	Slot 0: Units Code (refer to *Common Tables Specification*)
4 - 7	Float	Slot 0: Device Variable Value
8	Bits	Slot 0: Device Variable Status (see the appropriate Device Family Status Common Table)
9	Unsigned-8	Slot 1: Device Variable Code
10	Enum	Slot 1: Device Variable Classification
11	Enum	Slot 1: Units Code (refer to *Common Tables Specification*)
12 - 15	Float	Slot 1: Device Variable Value
16	Bits	Slot 1: Device Variable Status
17	Unsigned-8	Slot 2: Device Variable Code
18	Enum	Slot 2: Device Variable Classification
19	Enum	Slot 2: Units Code (refer to *Common Tables Specification*)
20 - 23	Float	Slot 2: Device Variable Value
24	Bits	Slot 2: Device Variable Status

Byte	Format	Description
25	Unsigned-8	Slot 3: Device Variable Code
26	Enum	Slot 3: Device Variable Classification
27	Enum	Slot 3: Units Code (refer to *Common Tables Specification*)
28 - 31	Float	Slot 3: Device Variable Value
32	Bits	Slot 3: Device Variable Status
33	Unsigned-8	Slot 4: Device Variable Code
34	Enum	Slot 4: Device Variable Classification
35	Enum	Slot 4: Units Code (refer to *Common Tables Specification*)
36 - 39	Float	Slot 4: Device Variable Value
40	Bits	Slot 4: Device Variable Status
41	Unsigned-8	Slot 5: Device Variable Code
42	Enum	Slot 5: Device Variable Classification
43	Enum	Slot 5: Units Code (refer to *Common Tables Specification*)
44 - 47	Float	Slot 5: Device Variable Value
48	Bits	Slot 5: Device Variable Status
49	Unsigned-8	Slot 6: Device Variable Code
50	Enum	Slot 6: Device Variable Classification
51	Enum	Slot 6: Units Code (refer to *Common Tables Specification*)
52 - 55	Float	Slot 6: Device Variable Value
56	Bits	Slot 6: Device Variable Status
57	Unsigned-8	Slot 7: Device Variable Code
58	Enum	Slot 7: Device Variable Classification
59	Enum	Slot 7: Units Code (refer to *Common Tables Specification*)
60 - 63	Float	Slot 7: Device Variable Value
64	Bits	Slot 7: Device Variable Status
65 - 68	Time	Slot 0 data time stamp

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3 - 4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7		Undefined
8	Warning	Update Failure
9-13		Undefined
14	Warning	Dynamic Variables Returned for Device Variables
15		Undefined
16	Error	Access Restricted
17-29		Undefined
30	Warning	Command Response Truncated.
31 -127		Undefined

Note: When a Field Device receives 1, 2, or 3 request data bytes it must answer the Master request without returning Response Code 5, Too Few Data Bytes Received.

6.11 Command 11 Read Unique Identifier Associated With Tag

This is an Identity Command (see the *Command Summary Specification*).

This command may be issued using either the device's long frame address or the Broadcast Address. No response is made unless the Tag matches that of the device. When the device's long frame address is used, no response is made unless the address and Tag matches that of the device.

This command returns identity information about the field device including: the Device Type, revision levels, and Device ID. The address in the Response Message is the same as the request.

Only the Tag (6-byte Packed ASCII) may be passed with this command. See Command 21 identify the device using the Long Tag (32-byte ISO Latin-1).

Request Data Bytes

Byte	Format	Description
0-5	Packed	Tag

Response Data Bytes

Same as Command 0 Read Unique Identifier.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

6.12 Command 12 Read Message

Reads the Message contained within the device.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-23	Packed	Message

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.13 Command 13 Read Tag, Descriptor, Date

Read the Tag, Descriptor, and Date contained within the device. Only the Tag (6 Bytes or 8 Packed ASCII characters) is read here (see Command 20 Read Long Tag). The Tag and Long Tag are completely separate data items.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-5	Packed	Tag
6-17	Packed	Descriptor
18-20	Date	Date Code

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.14 Command 14 Read Primary Variable Transducer Information

Reads the Transducer Serial Number, Limits/Minimum Span Units Code, Upper Transducer Limit, Lower Transducer Limit, and Minimum Span for the Primary Variable transducer.

The transducer limits and minimum span units code must be the same as the Primary Variable units code.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-2	Unsigned-24	Transducer Serial Number
3	Enum	Transducer Limits and Minimum Span Units Code (refer to *Common Tables Specification*)
4-7	Float	Upper Transducer Limit
8-11	Float	Lower Transducer Limit
12-15	Float	Minimum Span

Note: When the Transducer Serial Number is not applicable to the device or Primary Variable, it will be set to "0". The other parameters will be set to "0x7F, 0xA0, 0x00, 0x00" or "250", Not Used, when they are not applicable.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.15 Command 15 Read Device Information

Reads the alarm selection code, transfer function code, range values units code upper range value, Primary Variable lower range value, damping value, and write protect code, .

The damping value is applied to the Primary Variable. In addition, the damping value applies to the Percent Range and Loop Current for transmitters.

6.15.1 Write Protect Mode

The Write Protect Mode provides a method for preventing changes to the device's configuration. This mode can be enabled and disabled using hardware jumpers or under software control via Device-Specific Commands. Write Protect Mode may also prevent changes done from local operator panels (e.g., zero and span buttons). Different levels of write protection are possible. Independent of the Write Protect level, all Read Commands must operate normally.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0	Enum	PV Alarm Selection Code (see Common Table 6, Alarm Selection Codes). The Alarm Selection Code indicates the action taken by the device under error conditions. For transmitters, the code indicates the action taken by the Loop Current. For Actuators, the action taken by the positioner is indicated.
1	Enum	PV Transfer Function Code (see Common Table 3, Transfer Function Codes). The Transfer Function Code must return "0", Linear, if transfer functions are not supported by the device.
2	Enum	PV Upper and Lower Range Values Units Code (refer to *Common Tables Specification*)
3-6	Float	PV Upper Range Value
7-10	Float	PV Lower Range Value
11-14	Float	PV Damping Value (units of seconds)
15	Enum	Write Protect Code (see Common Table 7, Write Protect Codes). The Write Protect Code must return "251", None, when write protect is not implemented by a device.
16	Enum	Reserved. Must be set to "250", Not Used.
17	Bits	PV Analog Channel Flags (see Common Table 26, Analog Channel Flags)

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.16 Command 16 Read Final Assembly Number

Read the final assembly number associated with the device. The Final Assembly Number is used for identifying the materials and electronics that comprise the field device. It is normally changed when electronics or other device components are upgraded in the field. In some plants this number references a drawing number (e.g. a PI&D drawing or instrument specification) indicating the installation and application of the instrument.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-2	Unsigned-24	Final Assembly Number

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.17 Command 17 Write Message

Write the Message into the device.

Request Data Bytes

Byte	Format	Description
0-23	Packed	A Message String Used By The Master For Record Keeping

Response Data Bytes

Byte	Format	Description
0-23	Packed	Message String

Note: The value returned in the response data bytes reflects the value actually used by the Field Device.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.18 Command 18 Write Tag, Descriptor, Date

Write the Tag, Descriptor, and Date into the device. Only the Tag (6 Bytes or 8 Packed ASCII characters is written here) (see Command 22 Write Long Tag). The Tag and Long Tag are completely separate data items.

Request Data Bytes

Byte	Format	Description
0-5	Packed	Tag
6-17	Packed	Descriptor Used By The Master For Record Keeping
18-20	Date	A Date Code Used By The Master For Record Keeping (E.G. Last Or Next Calibration Date)

Response Data Bytes

Byte	Format	Description
0-5	Packed	Tag
6-17	Packed	Descriptor
18-20	Date	Date Code

Note: The value returned in the response data bytes reflects the value actually used by the Field Device.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8		Undefined
9	Error	Invalid Date Code Detected
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

Note: Most field devices only store the date. As a result, some field devices may not detect an invalid date code.

6.19 Command 19 Write Final Assembly Number

Write Final Assembly Number into the device. The Final Assembly Number is used for identifying the materials and electronics that comprise the field device. It is normally changed when electronics or other device components are upgraded in the field. In some plants this number references a drawing number (e.g. a PI&D drawing or instrument specification) indicating the installation and application of the instrument.

Request Data Bytes

Byte	Format	Description
0-2	Unsigned-24	Final Assembly Number

Request Data Bytes

Byte	Format	Description
0-2	Unsigned-24	Final Assembly Number

Note: The value returned in the response data bytes reflects the value actually used by the Field Device.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
17-127		Undefined

6.20 Command 20 Read Long Tag

Reads the 32-byte Long Tag. Only the Long Tag (32 ISO Latin-1 characters) is read here (see Command 13 Read Tag, Descriptor, Date). The Tag and Long Tag are completely separate data items.

Request Data Bytes

Byte	Format	Description
None		

Response Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33-127		Undefined

6.21 Command 21 Read Unique Identifier Associated With Long Tag

This is a Identity Command (see the *Command Summary Specification*).

This command may be issued using either the device's long frame address or the Broadcast Address. No response is made unless the Long Tag matches that of the device. This comparison is sensitive to character case. When the long frame address is used no response is made unless the address and Long Tag matches that of the device.

This command returns identity information about the field device including: the Device Type, revision levels, and Device ID. The address in the Response Message is the same as the request.

Only the Long Tag (32-byte ISO Latin 1 strings) may be passed with this command. See Command 11 to identify the device using the Tag (6-byte Packed ASCII).

Request Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

Response Data Bytes

Same as Command 0 Read Unique Identifier.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

6.22 Command 22 Write Long Tag

Writes the 32-byte Long Tag. Only the Long Tag (32 ISO Latin-1 characters) is written here (see Command 22 Write Long Tag). The Tag and Long Tag are completely separate data items.

Request Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

Response Data Bytes

Byte	Format	Description
0-31	Latin-1	Long Tag

Note: The value returned in the response data bytes reflects the value actually used by the Field Device.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data bytes received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy (A DR Could Not Be Started)
33	Error	DR Initiated
34	Error	DR Running
35	Error	DR Dead
36	Error	DR Conflict
37-127		Undefined

6.23 Command 38 Reset Configuration Changed Flag

This command must be implemented by all devices.

A Field Device must contain a configuration changed bit for both the primary and the secondary Master (and the Gateway and Network Manager if supporting WirelessHART). All bits are set when any configuration item in a Field Device is modified. This command resets the bit associated with the device issuing this command. Bit 6 of the Device Status Byte is immediately reset for the current device and stays reset until another change is made to the device's configuration. The value of this bit must be maintained even if power is removed from the device or a device reset is performed. Bit 6 of the Device Status Byte for the device not issuing this command is unaffected by this command and remains set until the other device issues this command.

Upon receiving this command the device shall compare the Configuration Change Counter received in this command with the device's current value. If they do not match then the device must return "Configuration Change Counter Mismatch" and not reset the Configuration Changed bit.

6.23.1 Backward Compatibility Requirements

Field devices receiving Command 38 with no data bytes must assume the Master is HART Revision 6 (or earlier) and reset the appropriate configuration changed bit.

Request Data Bytes

Byte	Format	Description
0 - 1	Unsigned-16	Configuration Change Counter

Response Data Bytes

Byte	Format	Description
0 - 1	Unsigned-16	Configuration Change Counter

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 5		Undefined
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8		Undefined
9	Error	Configuration Change Counter Mismatch
10 - 15		Undefined
16	Error	Access Restricted
17 -127		Undefined

6.24 Command 48 Read Additional Device Status

This command must be implemented by all devices.

Returns device status information not included in the Response Code or Device Status Byte. This command also returns the results of Command 41, Perform Self Test. Response Bytes 0-5 and 14-24 may contain Device-Specific Status information. Extended Device Status, Device Operating Mode, and Standardized Status 0-3 contain commonly used status information. See the appropriate Common Tables for more information.

In addition, this command contains status information regarding Analog Channel 1 through Analog Channel 8. Bits in Analog Channel Saturated are set when the electrical limits established by the Field Device are exceeded for the corresponding Analog Channel. Bits in Analog Channel Fixed are set when the corresponding Analog Channel is directly (e.g, using Command 40 or 66) or indirectly (e.g., using Command 79) being manually controlled. In both of these data items the Least Significant Bit (i.e., Bit 0) refers to the Analog Channel 1 (i.e. the Secondary Variable) and the Most Significant Bit refers to the 8th Analog Channel (if available in the Field Device).

Refer to the device-specific document for the information contained in each Device-Specific Status Byte. All Device-Specific Status Bytes must contain individual status bits or enumerations (e.g., operating modes). Arithmetic data (i.e., floating point or integer data) must not be included in this command.

> Note: Masters will issue this command whenever More Status Available (Bit 4 of the device status byte) is set. In addition, many Masters will issue this command when Device Malfunction (Bit 7 of the device status byte) is set. As a result, the Field Device must carefully define and control the events and status information in this command that affect these two device status bits. If the More Status Available bit is always asserted, then communication bandwidth is effectively cut in half.

Response Code 8, Warning: Update in Progress, will be returned whenever a response can be made and the status information is pending the completion of a command that requires a relatively long time to complete. Refer to the device-specific document for specific implementation details.

The Device shall use the standardized status whenever possible.

When the device receives a Command 48 request containing Request Data Bytes they must be compared to the current value contained in the device. If there is an exact match then the More Status Available bit corresponding to the requesting device (Primary Master, Secondary Master, Gateway, etc.) shall be reset. If there is not an exact match or too few bytes are received then the More Status Available bit remains unchanged. Extra Bytes beyond those supported by the device are ignored.

Irrespective of the contents of the Request Data Bytes the device must return the current values of the fields contained in the Response Data Bytes.

6.24.1 Backward Compatibility Requirements

For backward compatibility, a field device must assume that it is configured by a HART 5 or HART 6 host when it receives no Request Data Bytes. In this case the device must answer indicating "Success" and include all Response Data Byte supported by the device's implementation of Command 48.

Request Data Bytes

Byte	Format	Description
0 - 5	Bits or Enum Only	Device-Specific Status (refer to appropriate device-specific document for detailed information)
6	Bits	Extended Device Status (refer to Common Table 17, Extended Device Status Information)
7	Bits	Device Operating Mode (refer to Common Table 14, Operating Mode Codes)
8	Bits	Standardized Status 0 (refer to Common Table 29)
9	Bits	Standardized Status 1 (refer to Common Table 30)
10	Bits	Analog Channel Saturated (refer to Common Table 27)
11	Bits	Standardized Status 2 (refer to Common Table 31)
12	Bits	Standardized Status 3 (refer to Common Table 32)
13	Bits	Analog Channel Fixed (refer to Common Table 28)
14 - 24	Bits or Enum Only	Device-Specific Status (refer to appropriate device-specific document for detailed information)

Response Data Bytes

Byte	Format	Description
0 - 5	Bits or Enum Only	Device-Specific Status (refer to appropriate device-specific document for detailed information)
6	Bits	Extended Device Status (refer to Common Table 17, Extended Device Status Information)
7	Bits	Device Operating Mode (refer to Common Table 14, Operating Mode Codes)
8	Bits	Standardized Status 0 (refer to Common Table 29)
9	Bits	Standardized Status 1 (refer to Common Table 30)
10	Bits	Analog Channel Saturated (refer to Common Table 27)
11	Bits	Standardized Status 2 (refer to Common Table 31)
12	Bits	Standardized Status 3 (refer to Common Table 32)
13	Bits	Analog Channel Fixed (refer to Common Table 28)
14 - 24	Bits or Enum Only	Device-Specific Status (refer to appropriate device-specific document for detailed information)

Note: The Response Data Bytes returned are truncated after the last status byte supported by the Field Device. All devices must support at least bytes 0-8 including Extended Device Status, Device Operating Mode and Standardized Status 0. If the Field Device supports more than one Analog then bytes 9-13 must be returned as well.

Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 5		Undefined
6	Error	Device-Specific Command Error
7		Undefined
8	Warning	Update In Progress
9 - 15		Undefined
16	Error	Access Restricted
17 -127		Undefined

ANNEX A. REVISION HISTORY

A1. Changes from Revision 7.0 to Revision 7.1

The changes in this revision include adding an addendum and reformatting the front page of the document to reflect the new HCF logo.

A2. Changes from Revision 6.1 to Revision 7.0

- Incorporated the Addendum from Revision 6.1 into the body of the specification.
- Added time stamp to Command 9
- Command 9 now allows up to 8 Device Variables to be read in one transaction.
- Command 38 and 48 moved to this specification from *Common Practice Command Specification*

A3. Changes from Revision 6.0 to Revision 6.1

- The only change to the document in this revision is adding an addendum for 16-bit Manufacturer ID Codes.

A4. Changes from Revision 5.2 to Revision 6.0

- General reformatting and addition of new sections: Preface, Introduction, Scope, References, Definitions, Symbols/Abbreviations, and Data Format added.
- The whole document was edited to replace "transmitter" with "device". "Analog Output" was replaced with "Loop Current". In general, the descriptions were made more generic to enfranchise actuator devices. The changes are global in nature and corresponding change bars are not included. These changes have no impact on transmitter designs.
- The entire document was reviewed to ensure the use of phrases were consistent with definitions defined in the HART Smart Communications Protocol Specification. For example, 4th Variable has been replaced with Quaternary Variable throughout out the document. The changes are global in nature and corresponding change bars are not included.
- Command 0. Two bytes were added: the number of response preambles and the number of Device Variables. Minor clarifications to the descriptions of command data items.
- Command 1. Added status byte for the Primary Variable and the Extended Device Status Byte.
- Command 2. Added status byte for the Primary Variable and the Extended Device Status Byte. Added description of relationship between the Primary Variable and Percent Range (for transmitters). Added description of Percent Range and Loop Current (for actuators).
- Command 3. Added status bytes for all Dynamic Variables and the Extended Device Status Byte. Command 3 is no longer truncatable.
- Command 6. Specification of the number of polling addresses delegated to the Data Link Layer. Loop Current allowed to be active at polling addresses other then zero.
- Command 7. A new command to allow the configuration of the loop to be read.

- Command 8. A new command to read the Device Family of the Dynamic Variables to permit the decoding of the Unit Codes and Dynamic Variable status byte.
- Command 11. Reference made to the Response Data and Command-Specific Response Codes in Command 0 to eliminate specification redundancy. Description harmonized with other Identity Commands.
- Commands 20-22. These three new commands support a new 32-byte, ISO Latin-1 Long Tag. They read and write the Long Tag and support polling via the Long Tag.
- Revision History moved to Annex A.

A5. Changes from Revision 5.1 to Revision 5.2

The document was translated from a MultiMate document to Microsoft Word. As a result of this translation the document format was altered. No other modifications were made to the document.

A6. Changes from Revision 5.0 to Revision 5.1

- This revision includes modifications for devices with Multiple Analog Outputs and Analog Outputs other than Current.
- Summarized Release Notes from Rev 4 to Rev 5.0 .

Page	Line	Change	Text
TP	4	Replace	"5.0" by "5.1"
TP	6	Replace	"8 February 1990" by "18 October 1990"
TP	7	Replace	"12 February 1990" by "18 October 1990"
TP	8	Replace	"A" by "8"
5	2	Insert	"P. V."
5	5	Insert	"Primary Variable"
5	8	Insert	"Primary Variable"
5	20	Insert	"PV PV"
5	25	Insert	"PV PV"
5	30	Replace	"Analog Output" by "Primary Variable"
5	34	Insert	"Primary Variable"
5	35	Replace	"IEEE 754," by "IEEE 754,"
6	2	Delete	"ALL"
6	2	Insert	"P. V."
6	4	Insert	"Primary Variable"
6	5	Insert	"Primary Variable"
6	18	Insert	"PV PV"
7	2	Replace	"Analog Output" by "Primary Variable"
10	7	Insert	"Primary Variable"
10	10	Insert	"Primary Variable"
10	14	Replace	"current" by "Analog Output"
10	15	Replace	"4 milliamperes;" by "its minimum"
10	16	Replace	"4," by "3, Primary Variable Analog"
10	17	Delete	"Current"
10	18	Insert	"Primary Variable"

Page	Line	Change	Text
14	6	Insert	"[See Note]"
14	13	Insert	"Note: This Response Code uas placed here in..."
17	4	Insert	"Primary Variable"
17	4	Insert	"Primary Variable"
17	5	Insert	"Primary Variable"
17	6	Insert	"Primary Variable"
17	7	Insert	"Primary Variable"
17	7	Insert	"sensor."
17	9	Replace	"sensor associated..." by "The"
17	9	Delete	"Variable."
17	9	Replace	"The" by "Variable"
17	20	Insert	"PV PV"
17	27	Insert	"PV PV PV"
17	35	Insert	"PV PV"
17	42	Insert	"PV PV"
18	2	Insert	"Primary Variable"
18	5	Insert	"Data Byte 3 Primary Variable Sensor Limits..."
18	21	Delete	"Data Byte 4 - 7 Upper Sensor Limit, IEEE..."
18	25	Insert	"Primary Variable"
19	2	Insert	"PRIMARY VARIABLE"
19	4	Insert	"Primary Variable"
19	4	Insert	"Primary Variable"
19	5	Replace	"Variable/Range" by "Variable Range Values"
19	6	Insert	"Primary Variable"
19	7	Insert	"Primary Variable"
19	7	Insert	"Primary Variable"
19	11	Insert	"Primary Variable"
19	11	Insert	"Primary Variable"
19	21	Insert	"PV PV PV"
19	22	Replace	"PV/" by "RANGE"
19	23	Replace	"RANGE" by "VALUES"
19	28	Insert	"PV PV"
19	35	Insert	"PV PV"
19	42	Insert	"PV PV"
20	2	Insert	"Primary Variable"
20	6	Delete	"Data Byte 1 Transfer Function Code, 8-bit..."
20	19	Move	"Data Byte" from page 18 line 17
20	19	Replace	"3 Sensor Limits and..." by "1 Primary..."
20	22	Replace	"II; Unit" by "III; Transfer Function"
20	25	Insert	"Data Byte 2 Primary Variable Upper and Lover..."
20	35	Insert	"Primary Variable"
24	10	Replace	"16 Transmitter-..." by "16 Access Restricted"

A7. Major Modifications from Revision 4 to Revision 5.0 - Final

1. A decimal point and integer has been added to the HART document revision numbering system. This minor revision number is incremented each time corrections or changes are made to a previously approved document.

2. Changed Rosemount Document Number from D8700028; Revision C to D8900038; Revision A. A different Rosemount Document Number is assigned to each major HART Document Revision Number.

3. Increased the maximum Command-Specific Response Code number from 15 to 127 for all commands.

4. This revision adds the Extended Frame Format and creates a separate command for each Block of Command 4 and 5.

5. Added Commands 11-19

A8. Major Modifications from Initial Revision 3 to Revision 4

1. This Revision incorporates the Write Protect Mode.

2. This Revision adds the Private Labeling capability (refer to document Revision 3, D8700028, and Revision 4, D8900037 for detailed information).