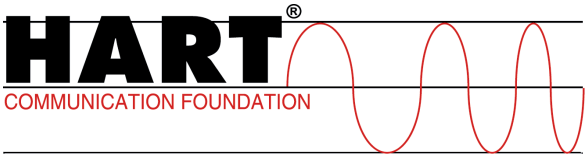
HART Protocol Specification

Field Communications




# Common Practice Command Specification

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## Preface

This preface is included for informational purposes only.

The popularity of the HART protocol has encouraged the development of a variety of HART capable devices. Devices such as multiplexers, repeaters, positioners, PID controllers, and calibrators put new demands on the Protocol. Consequently, a number of areas of the HART Protocol have been enhanced and updated to meet these new demands. This document contains the following additions and enhancements to the Common Practice Command set as approved by the HART Communication Foundation Membership:

The format of the *Common Practice Command Specification* was updated. Over time, Common Practice Commands are added when widely-used, common applications of the HART Protocol are identified. In this version of the specification, these groups of common applications have been identified. In addition, descriptions of how related commands work together are included. The accompanying procedures are for use by Host applications.

Two bytes were added to Command 54 to support Unit Code Expansion, Device Variable Status and Device Families. Conceptually, Device Variables belong to a family of process-related connections, such as pressure, temperature, and actual valve position. Command 54 uses the additional bytes to classify the Device Variable based on its connection to the process. This classification along with the second byte indicating whether the Device Family Commands are supported indicates the Device Family and which Unit Code and Device Variable Status Common Table to use. Commands specific to Device Families will be added to the *Device Families Specification*.

Transducer trim commands were added. These commands allow one or two point calibration of Device Variables. While not intended to replace factory characterization of transducers, these commands are useful for field calibration. Implementation of transducer trim commands is strongly recommended.

Two commands, Squawk and Find Device, were added to assist in installation troubleshooting. Consider the process of commissioning a number of HART devices during plant start-up. Frequently, multi-conductor cables and/or multi-dropped loops are used in the construction of a plant. As a result, verification of correct wiring and correct instrument placement can be tedious. Identification of a device by its Tag or Long Tag can also be inconclusive because any device on a multi-dropped loop could answer the Master regardless of its location of the device on the loop.

Find Device allows the technician to press a button to arm the device. The HART capable Master sends the Find Device command. The Slave device answers the command once and disarms itself allowing the technician to verify the device is installed in the correct plant location and on the correct wire pair.

Squawk causes the addressed device to signal when it receives the command. A Master can repeatedly issue this command. The correct installation of the device "Squawking" can then be verified.

The Write Device Variable command was added to allow digital readings to be forced to assist in testing DCS's, SCADA systems or other Hosts. The commissioned system can be tested to ensure alarms, set points, and other functions operate correctly. This function is similar to Command 40 that allows 4-20mA values to be forced while performing a loop test.

The Lock Device command was added to allow Masters to ensure proper, uninterrupted configuration of a Field Device. Once a device receives the Lock Device command, a configuration cannot be modified by another Master or the device's front panel. The Master issuing the command has exclusive access until another Lock Device command is issued or the device is reset.

A new command, Catch Device Variable, allows simple peer-to-peer communication of Device Variable data. Using this command, a measurement employed in a complex calculation can be captured from another Field Device as a Master polls the network or it can be transmitted continuously using burst mode.

In addition to functional changes, the document as a whole has been reformatted to include new sections: Preface, Introduction, Scope, References, Definitions, Symbols/Abbreviations, and Data Format. The additional sections and the new format improves the clarity and consistency of the specifications.

The document was prepared, edited and reviewed by the HART PSK Working Group in the effort of creating HART Revision 6. The following persons actively served in this working group:

| ***Name*** | ***Company*** |
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| *Daniel Lazari* | *SMAR Research* |

# Introduction

The principle objective of the HART Protocol is to establish standards that allow Master and Slave devices from differing companies to work with each other as a system. Furthermore, even if a system component is replaced with a similar device from another company, the system should still function properly, there should be no loss of System functionality. Accordingly, HART promotes interoperability in many ways:

- Compatibility with the 4-20mA loop allows a HART device to work with existing plant systems;
- Providing a well defined Physical Layer for devices to communicate over;
- Specifying Data Link Layer framing, error detection and bus arbitration requirements to ensure the integrity of communications; and
- Requiring all devices to support all Universal Commands

The HART Common Practice Commands enhance interoperability by providing additional standardized, commands for Common Functions. These commands are optional and some, all, or none may be implemented in a Field Device. Common Practice Commands provide a set of functions that are widely applicable to many devices (unlike Universal Commands, which must be implemented by all devices). Some Common Practice Commands are used by nearly all devices, while some are used only by certain classes of devices.

Designers of Field Devices have the choice of using device-specific or Common Practice Commands for some of their features. Designers are strongly encouraged to use Common Practice Commands rather than device-specific commands wherever possible. Common Practice Commands are preferable over device-specific commands in that they allow Hosts to create one common interface supporting many Field Devices instead of a custom interface for every Field Device. Using Common Practice Commands allows a Slave to communicate with a larger number and many more types of Host applications.

# 1. SCOPE

The *Common Practice Command Specification* is an Application Layer specification and, accordingly, builds on the Application Layer Requirements found in the *Command Summary Specification*. Conformance to all requirements of the *Command Summary Specification* is a prerequisite to conforming to this specification.

This specification contains both the definitions and the recommended usage of Common Practice Commands. Common Practice Commands, if used, must be implemented exactly as specified. Many Common Practice Commands refer to tables from the *Common Tables Specification*. When Common Tables are referenced, the tables must be used exactly as specified. This document supersedes all previous revisions.

# 2. REFERENCES

## 2.1 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*

*Universal Command Specification. HCF_SPEC-127*

*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 manufacturers' 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:

*Field Device Specification Guide. HCF_LIT-18*

# 3. DEFINITIONS

Definitions for terms can be found in *HART Field Communications Protocol Specification*. Terms used throughout the *Common Practice Command Specification* include: Analog Channel, ASCII, Bridge Device, Data Link Layer, Delayed Response, Delayed Response Mechanism, Device Variable, Busy, DR_CONFLICT, DR_DEAD, DR_INITIATE, DR_RUNNING, Dynamic Variable, Fixed Current Mode, Floating Point, Host, ISO Latin-1, Master, Multidrop, Not-A-Number, Packed ASCII, Preamble, Request Data Bytes, Response Data Bytes, Response Message, Slave, Slave Time-Out, Sub-Device, Time Constant, Trim, Units Code

Some other terms used only within the context of the *Common Practice Command Specification* are:

**Analog Channel Number** — A number that refers to a particular analog input or output channel. Analog Channel Numbers start at 0. The first analog channel corresponds to the Primary Variable.

**Slot** — A place holder to which is assigned a Device Variable.

# 4. SYMBOLS/ABBREVIATIONS

**ADC** — **A**nalog-to-**D**igital **C**onverter

**DAC** — **D**igital-to-**A**nalog **C**onverter.

**DAQ** — **D**ata **Ac**quisition. This reefers to a devices specific ADC or DAC

**DR** — **D**elayed **R**esponse.

**EEPROM** — **E**lectrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory. Non-volatile memory that is alterable by the Field Device without the use of external programming apparatus.

**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 command specifications, the following key words are used to refer to the data formats. For more information about these formats, see 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.

**Enum** An enumerated value. 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.

**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. APPLICATION OF COMMON PRACTICE COMMANDS

## 6.1 Data Link Layer Commands

Implementation of all commands in this section is recommended.

Some commands within the Common Practice Command set that support Data Link Layer operation. These commands support the establishment of a communication connection between the Master and the Field Device, and modifying the FSK preamble length. Commands in this group include:

- Command 59 Write Number Of Response Preambles
- Command 72 Squawk
- Command 73 Find Device
- Command 74 Read I/O System Capabilities
- Command 75 Poll Sub-Device

Note: Commands 74 and 75 are only applicable to Field Devices supporting Sub-Devices (see *Command Summary Specification*)

## 6.2 Primary Variable Range Commands

Implementation of Command 35, Write Primary Variable Range Values, is recommended.

The Primary Variable is always associated with the first Analog Channel of a device. Since the 4-20mA signal conveys a single dynamic value using the analog signal, these Common Practice Commands allow the relationship between the analog signal and the Primary Variable digital value to be defined. The commands in this group are:

- Command 35 Write Primary Variable Range Values
- Command 36 Set Primary Variable Upper Range Value
- Command 37 Set Primary Variable Lower Range Value

### 6.2.1 Rerange Procedures

These Common Practice Commands support two methods for setting the Primary Variable URV and LRV.

- The first technique uses Command 35, Write Primary Variable Range Values, to set the URV and LRV. The engineering units need not be the same as the Primary Variable units, and this command does not change the Primary Variable Units.

- The second technique re-ranges the Field Device based on process conditions:

    1. Adjust the process until the Primary Variable matches the desired LRV (the zero). Use Command 37, Set Primary Variable Lower Range Values, to set the LRV.

    2. Adjust the process until the Primary Variable matches the desired URV (the span). Use Command 36, Set Primary Variable Upper Range Value, to set the URV.

## 6.3 Loop Current Commands

Implementation of all commands in this section is recommended.

Supporting the analog 4-20mA Loop Current is a fundamental requirement for HART compatible Field Devices. The commands in this section allow loop current values to be simulated and allows the Field Device's perceived loop current value to be calibrated.

Commands in this section should be used by both transmitters and actuators since both devices:

- Connect to the analog current loop;

- Need to simulate or force a Loop Current value; and

- Should support the calibration of their Loop Current value.

With respect to the Loop Current, the only difference between a transmitter and an actuator is that the Loop Current value is what a transmitter thinks it is outputting and what an actuator believes it is measuring.

The following are the Loop Current related commands:

- Command 40 Enter/Exit Fixed Current Mode

- Command 45 Trim Loop Current Zero

- Command 46 Trim Loop Current Gain

### 6.3.1 Loop Current Trim Procedure

The 4-20mA loop transmits a single Dynamic Variable value (the Primary Variable) using an analog signal. As a result, there must be agreement between the Master and Slave Loop Current values. The Loop Current commands allow the Master to force a Loop Current value in the Field Device and to perform a two point (zero and span) calibration of the Field Device's Loop Current value. Since the procedure for calibrating a transmitter is slightly different from actuator, the procedures for each are listed separately.

**Procedure for Transmitters**

In this procedure, the transmitter controls the Loop Current generally using a DAC. A suitable reference, like a digital multi-meter, is used to calibrate the transmitter's output. The Master's Loop Current measurement could be used as the reference.

1. Use Command 40, Enter/Exit Fixed Current Mode, to set the current to the device's minimum value. 4.00mA is usually used as the zero trim point.

2. Using the reference instrument's measured value, set the zero trim of the device using Command 45, Trim Loop Current Zero. The device trims its calibration and returns its Loop Current value. This may be slightly different from the value the Master sent the device due to rounding or truncation.

3. Use Command 40, Enter/Exit Fixed Current Mode, to set the current to the device's maximum value. 20.00mA is normally used as the span trim point.

4. Using the value measured by the reference, trim the span of the device with Command 46, Trim Loop Current Gain.

5. Repeat steps 1-4 as needed to gain the accuracy desired. Once the Loop Current is calibrated, return the device to normal operation by issuing Command 40, Enter/Exit Fixed Current Mode with a value of 0.0. This takes the device out of fixed current mode.

**Procedure for Actuators**

In this procedure, the Master or a reference controls the Loop Current and the actuator measures that current. A suitable reference, like a digital multi-meter, is used to calibrate the actuator input. Alternatively, the Master's Loop Current value could be used as the reference.

1. Using the appropriate Loop Current source, set the current to the device's minimum value, usually 4.00mA as the zero trim point.

2. Using the reference instrument's measurement value, set the zero trim of the device using Command 45, Trim Loop Current Zero. The device trims its calibration and returns its Loop Current value. This may be slightly different from the value the Master sent the device due to rounding or truncation.

3. Using the appropriate Loop Current source, set the current to the device's maximum value, normally 20.00mA is used as the span trim point.

4. Using the value measured by the reference, trim the span of the device using Command 46, Trim Loop Current Gain.

5. Repeat steps 1-4 until the desired accuracy is achieved.

## 6.4 Device Management Commands

Implementation of all commands in this section is recommended.

The Common Practice Commands support routine device management functions, like forcing a self test or performing a device reset. Commands in this group include:

- Command 38 Reset Configuration Changed Flag
- Command 41 Perform Self Test
- Command 42 Perform Device Reset
- Command 48 Read Additional Device Status
- Command 71 Lock Device
- Command 76 Read Lock Device State

### 6.4.1 Performing Self Test

Occasionally an operator may want to perform a self test on a device to confirm the devices integrity. The procedure is:

1. The Host sends Command 41, Perform Self Test, to initiate the self test. The Slave must answer within the Slave Time Out.

2. The Slave must answer Command 41, Perform Self Test, and begin its self test. Self test may take a relatively long time to complete. As a result, during the self test, the Slave may not answer any HART commands. The Master must not disconnect from the device as the result of issuing Command 41.

3. Once the Master has confirmed the completion of the self test, the Master should send a Command 48, Read Additional Device Status, to return diagnostics information generated by the Self Test.

A Master must be prepared for the device's reaction to this command. The Field Device may not respond during the Self Test. This may look like communications with the Field Device was lost. In addition, the Loop Current may not reflect the process while the Self test is executing. A master must not generate spurious error messages or disconnect from the Field Device while the Self Test is in progress.

### 6.4.2 Locking The Device To Allow Exclusive Access

In some cases, technicians have been using the local panel on a Field Device simultaneous to a HART Master configuring the Field Devices. When this happens, the HART Master cannot guarantee the accuracy of the data items presented to the user. This command allows a HART Master to have exclusive access while configuring or calibrating a Field Device. The normal use of Command 71, Lock Device is:

1. Issue Command 71 to ensure exclusive access during configuration.

2. Configure the device as needed. While locked the device returns Response Code 16, Access Restricted, to any write commands from the other Master.

3. Issue Command 38, Reset Configuration Changed Flag. This will allow the Master to easily determine if the device configuration is ever changed by monitoring the Device Status Byte.

4. Issue Command 71 to restore access to the other Master and the device's front panel.

## 6.5 Transducer Trim Commands

Implementation of all commands in this section is recommended.

This section includes four commands to allow the adjustment or "trim" of a Device Variable. This allows a measurement to be trimmed linearly, assuming the measurement has already been corrected for the transducer characteristics. Transducer characterization is considered a device-specific operation and is beyond the scope of this Specification. Furthermore, transducer and device characterization is not generally possible in a field environment. Commands in this group include:

- Command 80 Read Device Variable Trim Points
- Command 81 Read Device Variable Trim Guidelines
- Command 82 Write Device Variable Trim Point
- Command 83 Reset Device Variable Trim

### 6.5.1 Transducer Trim Procedure

Adjustment of a Device Variable reading is one of the most common functions that instruments must support. The commands in this section constitute a trim procedure that is applicable to a variety of instruments, both transmitters and actuators.

1. Issue Command 81, Read Device Variable Trim Guidelines, to determine the number of applicable trim points and their acceptable limits.
2. Issue Command 80, Read Device Variable Trim Points, to retrieve the last trim points used. These should be used as default values for a new trim operation. If the value supports a two point trim, then perform the low trim first (step 3-6).
3. Prompt the user to set the variable input to a value within acceptable limits for the trim point.
4. Once set and stable, obtain the exact process variable value from either a calibrator or the user.
5. Issue Command 82, Write Device Variable Trim Point. Inform user of any errors.
6. If a DR_INITIATE response is received, then resend the identical trim command until the operations is completed. Once completed, inform the user of the results.
7. If the variable supports a two-point trim and the low trim is completed successfully, repeat steps 3 through 6 for the upper trim point.

Note: Some devices may only support an upper trim point (see Common Table 22, Trim Point Codes)

## 6.6 Mapping Process Variables Commands

Implementation of Command 50 is recommended.

All HART compatible Field Devices are required to return the Primary, Secondary, Tertiary, and Quaternary Variables. These are collectively called the Dynamic Variables. In addition, all HART compatible Field Devices contain Device Variables. Simple Field Devices may use only Dynamic Variables and not expose the underlying Device Variables at the Protocol Application Layer interface. In simple devices the mapping of Device Variables to Dynamic Variables is fixed. More sophisticated devices allow this mapping to be configured (see Figure 1).

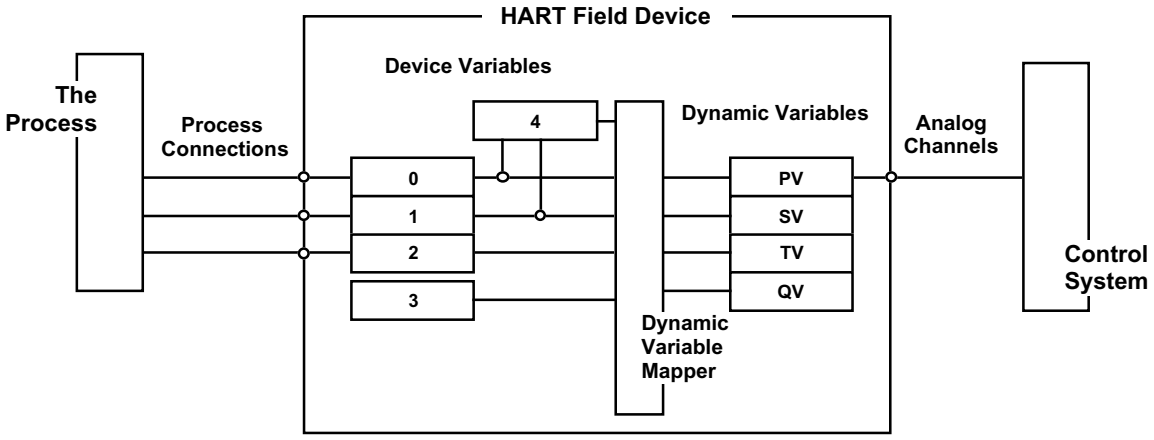


**Figure 1. Device Variables and Dynamic Variables**

In effect, a Dynamic Variable is convenient way to access a collection of data items comprised of an Analog Channel connected to a Device Variable. The following commands manage the mapping of the connection between the Device Variable and a Dynamic Variable (i.e., an Analog Channel). They allow the mapping to be read and, if supported by the device, changed. The commands in this section are:

- Command 50 Read Dynamic Variable Assignments
- Command 51 Write Dynamic Variable Assignments

## 6.7 Primary Variable Commands

Implementation of Commands 34 and 44 is recommended.

Due to its connection to Loop Current, the Primary Variable is an essential Application Layer data item. Consequently, there are Common Practice Commands supporting the configuration of the Primary Variable. Commands in this group include:

- Command 34 Write Primary Variable Damping Value
- Command 43 Set Primary Variable Zero

- Command 44 Write Primary Variable Units
- Command 47 Write Primary Variable Transfer Function
- Command 49 Write Primary Variable Transducer Serial Number

## 6.8 Device Variable Commands

Implementation of Commands 33, 53-55, and 79 is recommended.

Device Variables represent the device's connection to the process. While simple devices may not expose their Device Variables, all HART compatible Field Devices contain them. Several important features of the HART Protocol rely on Device Variables:

1. Device Families and engineering units codes are based on information returned by Command 54, Read Device Variable Information.

2. Many Masters prefer to use Command 33, Read Device Variables, to avoid tracking the Dynamic Variable map (see Command 51).

Note: Command 9 returns Device Variable Status and Classification. As a result, HART 6 compatible Hosts should use Command 9 whenever possible.

3. Command 79, Write Device Variable Command, allows Device Variables to be forced. This is used to test data acquisition and control in Master applications.

The commands in this section are:

- Command 33 Read Device Variables
- Command 52 Set Device Variable Zero
- Command 53 Write Device Variable Units
- Command 54 Read Device Variable Information
- Command 55 Write Device Variable Damping Value
- Command 56 Write Device Variable Transducer Serial No.
- Command 79 Write Device Variable
- Command 113 Catch Device Variable
- Command 114 Read Caught Device Variable

## 6.9 Burst Mode Commands

Implementation of these commands is optional.

The protocol supports the publishing of cyclical process data via burst mode operation. In this mode, a Field Device is instructed to publish the response to a command continuously without any further Master action. If a Field Device supports Burst Mode, then all commands in this section must be implemented. The commands in this section are:

- Command 105 Read Burst Mode Configuration
- Command 107 Write Burst Device Variables
- Command 108 Write Burst Mode Command Number
- Command 109 Burst Mode Control

### 6.9.1 Configuring A Device For Burst Mode Operation

The procedure a Master should follow to place a Field Device into burst mode is as follows:

1. If Command 9 is the command selected to burst, then use Command 107, Write Burst Device Variables, to assign Device Variables to the four response data slots.
2. The command response is configured using Command 108, Write Burst Mode Command Number. Commands 1, 2, 3, and 9 are always available and Command 33 is normally available as well.
3. Issuing Command 109, Burst Mode Control, will enter or exit Burst Mode. While in Burst Mode, the Slave will begin transmitting the responses to the command number set by Command 108.
4. Once the device is in burst mode, Command 108 is used to change the burst command response. A device may take one burst response before the response changes to the new command number.

## 6.10 Analog Channel Support Commands

Implementation of these commands is optional.

All HART devices support Analog Channel 0 corresponding to the Loop Current. However, some devices support several Analog Channels (inputs to or outputs from the Field Device). The following commands should be used if the Field Device supports additional Analog Channels:

- Command 60 Read Analog Channel And Percent Of Range
- Command 62 Read Analog Channels
- Command 63 Read Analog Channel Information
- Command 64 Write Analog Channel Additional Damping Value
- Command 65 Write Analog Channel Range Values
- Command 66 Enter/Exit Fixed Analog Channel Mode
- Command 67 Trim Analog Channel Zero
- Command 68 Trim Analog Channel Gain
- Command 69 Write Analog Channel Transfer Function
- Command 70 Read Analog Channel Endpoint Values

### 6.10.1 Using Analog Trim Commands

Some devices support more Analog Channels then just the Loop Current. The Analog Channel may be an input to or output from the Field Device. For these devices, the Analog Trim Commands allow Master to calibrate individual Analog Channels. The trim procedure is similar to the one used in Section 6.3.1.

1. Use Command 66, Enter/Exit Fixed Analog Output Mode, to set the analog output to the lower endpoint value.
2. Command 67, Trim Analog Output Zero, can then be used to send the Zero value.
3. Use Command 66 to set the analog output to the upper end point value.
4. Command 68, Trim Analog Output Gain, can then be used to send the gain value.
5. Exit Fixed Output Mode by resending Command 66 with the analog output value of "0x7F, 0xA0, 0x00, 0x00" and any Units Code.

# 7. COMMANDS

## 7.1 Command 33 Read Device Variables

This is a Device Variable Command.

This command allows a Master to request the value of up to four Device Variables. In other words, a Master may request only 1, 2, 3 or 4 Device Variables. Each slot will accept any Device Variable supported by the device. 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 or 3 Request Data Bytes, it must return only the corresponding number of Device Variables (see Table 1).

**Table 1. Command 33 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 | 6 |
| 2 | 2 | 12 |
| 3 | 3 | 18 |
| 4 | 4 | 24 |

Other command requirements include:

- When a Device Variable requested is not supported in the Field Device, then the corresponding Value must be set to "0x7F, 0xA0, 0x00, 0x00", and the Units Code must be set to "250", Not Used.
- This command is capable of Burst Mode Operation and is configured with Command 107, Write Burst Mode Device Variables.

**Request Data Bytes**

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

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Slot 0: Device Variable Code (see Device Variable Code Table in appropriate device-specific document) |
| 1 | Enum | Slot 0: Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Slot 0: Device Variable Value |
| 6 | Unsigned-8 | Slot 1: Device Variable Code (see Device Variable Code Table in appropriate device-specific document) |
| 7 | Enum | Slot 1: Units Code (refer to *Common Tables Specification*) |
| 8 - 11 | Float | Slot 1: Device Variable Value |
| 12 | Unsigned-8 | Slot 2: Device Variable Code (see Device Variable Code Table in appropriate device-specific document) |
| 13 | Enum | Slot 2: Units Code (refer to *Common Tables Specification*) |
| 14 - 17 | Float | Slot 2: Device Variable Value |
| 18 | Unsigned-8 | Slot 3: Device Variable Code (see Device Variable Code Table in appropriate device-specific document) |
| 19 | Enum | Slot 3: Units Code (refer to *Common Tables Specification*) |
| 20 - 23 | Float | Slot 3: Device Variable Value |

**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 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 -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.

## 7.2 Command 34 Write Primary Variable Damping Value

This is a Primary Variable Command.

The Primary Variable Damping Value represents one time constant. In other words, the output response to a step input reaches 63% of final steady-state value after this time has elapsed. The damping value written by this command affects the PV Transducer Domain's digital value (see the *Command Summary Specification*).

Depending on the role of PV in the Field Device, the associated values in the Analog Channel Domain may be affected as well. For a transmitter, both the Loop Current and digital values of the Primary Variable utilize this time constant. For an actuator, only the response of the Primary Variable digital value is damped. The damping applied to these values may be also effected by other commands (See Command 64).

Some devices implement only discrete damping values (e.g., 1, 2, 4). The value received with the command may be rounded or truncated by the device. The response message will return the actual value used by the device. A warning is issued if value is truncated or rounded.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Primary Variable Damping Value (units of seconds) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Actual Primary Variable Damping Value (units of seconds) |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | Warning | Set To Nearest Possible Value |
| 9 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.3 Command 35 Write Primary Variable Range Values

This is a Primary Variable Range Command.

Defines the relationship between the Loop Current 4.00 and 20.0mA points and the Primary Variable value. The Upper Range Value of the Primary Variable is independent of the Lower Range Value. Most devices allow the Upper Range Value of the Primary Variable to be lower than its Lower Range Value, enabling the device to be operated with reverse action. The device-specific document will indicate if this capability has not been implemented.

The Primary Variable Range Units received with this command do not effect the Primary Variable Units of the device. The range values will be returned in the same units as received.

For a transmitter, the Range Values allow the Primary Variable value to be converted to a percent for transmission via the Loop Current. For an actuator, the Range Values allow the Loop Current to be converted to a percent for use by the actuator (e.g., to use as the actuator setpoint).

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Upper and Lower Range Values Units Code (refer to *Common Tables Specification*) |
| 1 - 4 | Float | Upper Range Value |
| 5 - 8 | Float | Lower Range Value |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Upper and Lower Range Values Units Code (refer to *Common Tables Specification*) |
| 1 - 4 | Float | Upper Range Value |
| 5 - 8 | Float | Lower Range Value |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**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 | Error | In Write Protect Mode |
| 8 | Warning | Set To Nearest Possible Value (Upper or Lower Range Pushed) |
| 9 | Error | Lower Range Value Too High |
| 10 | Error | Lower Range Value Too Low |
| 11 | Error | Upper Range Value Too High |
| 12 | Error | Upper Range Value Too Low |
| 13 | Error | Upper and Lower Range Values Out Of Limits |
| 14 | Warning | Span Too Small (Device Accuracy May Be Impaired) |
| 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 | | Undefined |
| 18 | Error | Invalid Units Code |
| 19 - 28 | | Undefined |
| 29 | Error | Invalid Span |
| 30 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.4 Command 36 Set Primary Variable Upper Range Value

This is a Primary Variable Range Command.

The current Primary Variable value is written to the Upper Range Value. A change in the Upper Range Value must not effect the Lower Range Value. This action is identical to pushing the SPAN button on many Field Devices.

Most devices allow the Upper Range Value of the Primary Variable to be lower than its Lower Range Value, enabling the device to be operated with a reversed output. The device-specific document will indicate if this capability has not been implemented.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**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 | Warning | Set To Nearest Possible Value (Upper Range Value Pushed) |
| 9 | Error | Applied Process Too High |
| 10 | Error | Applied Process Too Low |
| 11 - 13 | | Undefined |
| 14 | Warning | Span Too Small (Device Accuracy May Be Impaired) |
| 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 28 | | Undefined |
| 29 | Error | Invalid Span |
| 30-31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.5 Command 37 Set Primary Variable Lower Range Value

This is a Primary Variable Range Command.

The current Primary Variable value is written to the Lower Range Value. A change in the Lower Range Value will shift the Upper Range Value proportionately so that the span remains constant. This action is identical to pushing the ZERO button on many Field Devices.

When a change pushes the Upper Range Value past either transducer limit, the Upper Range Value saturates and Response Code 14, Warning: New lower range value pushed upper range value over transducer limit, is returned. When the Lower Range Value pushes the Upper Range Value over the transducer limit and the resulting span is less than the Minimum Span, either Response Code 9, Applied Process Too High, or 10, Applied Process Too Low, is returned.

Most devices allow the Upper Range Value to be lower than the Lower Range Value, enabling the device to be operated with a reversed output. The device-specific document will indicate if this capability has not been implemented.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**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 | Applied Process Too High |
| 10 | Error | Applied Process Too Low |
| 11 - 13 | | Undefined |
| 14 | Warning | New Lower Range Value Pushed |
| 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 28 | | Undefined |
| 29 | Error | Invalid Span |
| 30-31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.6 Command 38 Reset Configuration Changed Flag

This is a Device Management Command.

A Field Device must contain a configuration changed bit for both the primary and the secondary Master. Both bits are set when any configuration item in a Field Device is modified. This command resets the bit associated with the Master issuing this command. Bit 6 of the Device Status Byte is immediately reset for the current Master 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 Master not issuing this command is unaffected by this command and remains set until the other Master issues this command.

. **Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**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 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 -127 | | Undefined |

## 7.7 Command 39 EEPROM Control (Not Recommended)

***THIS COMMAND IS NOT RECOMMENDED FOR NEW DESIGNS.***

This command causes data to be transferred from shadow RAM to nonvolatile memory (burn) or from nonvolatile memory to shadow RAM (restore). Shadow RAM is volatile memory that holds a copy of EEPROM. It is used as a temporary staging area for writing to and reading from EEPROMs.

The Field Device Malfunction Bit, Bit 7 of the Device Status Byte, will be set if an EEPROM checksum error is detected. When this occurs, Command 48, Read Additional Device Status, should be used to obtain specific information. Refer to the device-specific document to determine the error checking implemented by each device type.

A Master should only burn the EEPROM after a session rather then after every write command issued. For burn requests, the burn may not begin until the response that acknowledges the receipt of the command has been sent. When errors occur in these cases, Bit 7 of the Device Status Byte, will be set in the response of subsequent commands.

Note: This command does not increment the Configuration Change Counter because this command only stores the configuration into non-volatile memory. This command (in of itself) does not change the Field Devices configuration.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | EEPROM Control Code<br>0 Burn EEPROM<br>1 Restore Shadow RAM<br>2 - 249 Undefined |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | EEPROM Control Code<br>0 Burn EEPROM<br>1 Restore Shadow RAM<br>2 - 249 Undefined |

**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 | Error | In Write Protect Mode |
| 8 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.8 Command 40 Enter/Exit Fixed Current Mode

This is a Loop Current Command.

The device is placed in Fixed Current Mode with the Loop Current set to the value received. The value returned in the response data bytes reflects the rounded or truncated value actually used by the device. A level of '0' exits the FixedCurrent Mode. Fixed Current Mode is also exited when power is removed from device.

The Response Data Bytes always indicates the actual current level used by the Field Device.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Fixed Current Level (units of milliamperes) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Actual Current Level (units of milliamperes) |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 - 10 | | Undefined |
| 11 | Error | Loop Current Not Active (Device in Multidrop Mode) |
| 12 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.9 Command 41 Perform Self Test

This is a Device Management Command.

Initiates the Self Test function in the device. Refer to the device-specific document for the diagnostics performed and the results available through Command 48, Read Additional Device Status. The execution of this command may take a relatively long time to complete.

If the device cannot respond to commands during Self Test then the device must respond immediately to the command before beginning the Self Test. The device may not respond to subsequent commands until Self test is complete.

A Master must be prepared for the device's reaction to this command. The Field Device may not respond during the Self Test. This may look like communications with the Field Device was lost. In addition, the Loop Current may not reflect the process while the Self test is executing. A master must not generate spurious error messages or disconnect from the Field Device while the Self Test is in progress.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 5 | | Undefined |
| 6 | Error | Device-Specific Command Error |
| 7 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.10 Command 42 Perform Device Reset

This is a Device Management Command.

The device must respond to this command immediately and within the Slave Time Out and then reset the microprocessor. This is equivalent to cycling the power off and then back on to the Field Device.

The execution of this command may take a relatively long period of time to complete. The device may not respond to subsequent commands until the reset is complete. Refer to the device-specific document for specific implementation details.

A Master must be prepared for the device's reaction to this command. The Field Device may not respond during the Device Reset. This may look like communications with the Field Device was lost. In addition, the Loop Current may not reflect the process while the Device Reset is executing. A master must not generate spurious error messages or disconnect from the Field Device while the Device Reset is in progress.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 5 | | Undefined |
| 6 | Error | Device-Specific Command Error |
| 7 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 -127 | | Undefined |

## 7.11 Command 43 Set Primary Variable Zero

This is a Primary Variable Command.

Trim the Primary Variable so that it reads zero with the existing process applied to the device. The resulting offset must be within limits defined by each device. The span of the Primary Variable remains constant. This command does not affect or interact with the Upper or Lower Range Values. Figure 2 depicts the effect of this command on the Primary Variable.

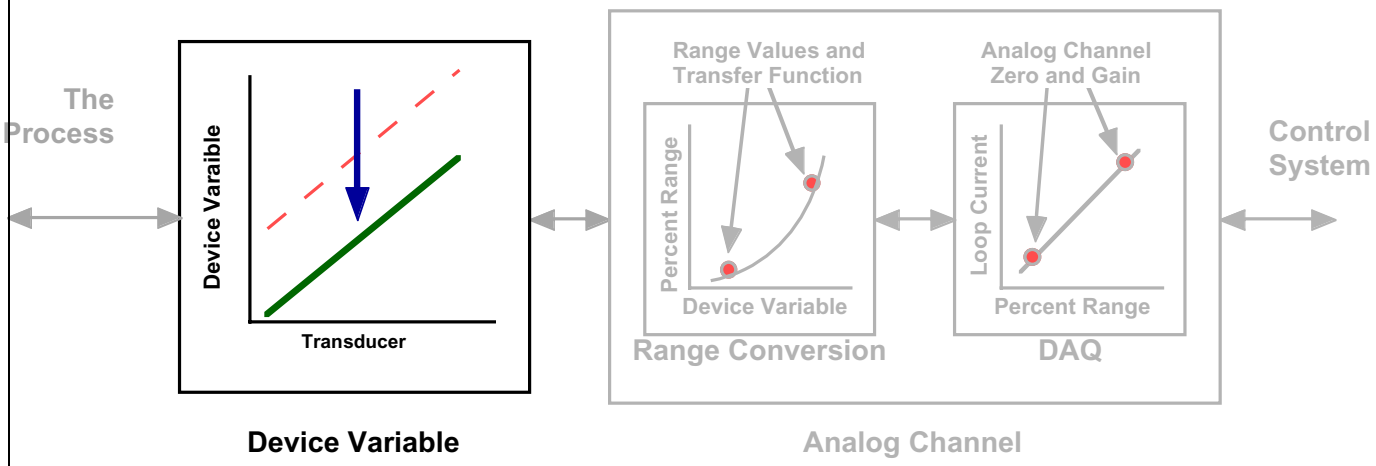


**Figure 2. Effect of Set PV Zero Command**

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**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 | Applied Process Too High |
| 10 | Error | Applied Process Too Low |
| 11 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.12 Command 44 Write Primary Variable Units

This is a Primary Variable Command.

Selects the units in which the Primary Variable and its range will be returned. This command also selects the units for transducer limits and minimum span.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Primary Variable Units Code (refer to *Common Tables Specification*) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Primary Variable Units Code (refer to *Common Tables Specification*) |

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

**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 | Error | In Write Protect Mode |
| 8 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.13 Command 45 Trim Loop Current Zero

This is a Loop Current Command.

Trim the zero or lower endpoint value of the Loop Current exactly to its minimum. This trim is typically performed by adjusting the Loop Current to 4.00 milliamperes and sending the measured value to the Field Device. In response the Field Device trims its calibration of the Loop Current to match the value received from the Master. The value sent with the command may be rounded or truncated by the device. The response data bytes contain the value from the request as used by the device.

Response Code 9, Incorrect Loop Current Mode or Value, will be returned if the device is not in the proper mode to allow the Loop Current to be calibrated or if the current is not set to exactly the minimum value.

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

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Externally Measured Loop Current Level, units of milliamperes |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Actual Measured Loop Current Level, units of milliamperes |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | | Undefined |
| 9 | Error | Incorrect Loop Current Mode or Value |
| 10 | | Undefined |
| 11 | Error | Loop Current Not Active (Device in Multidrop Mode) |
| 12 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.14 Command 46 Trim Loop Current Gain

This is a Loop Current Command.

Trim the gain or upper endpoint value of the Loop Current exactly to its maximum. This trim is typically performed by adjusting the Loop Current to 20.00 milliamperes. In response, the Field Device trims its calibration of the Loop Current to match the value received from the Master. The value sent with the command may be rounded or truncated by the device. The response data bytes contain the value from the request as used by the device.

Response Code 9, Incorrect Loop Current Mode or Value, will be returned if the device is not in the proper mode to allow the Loop Current to be calibrated or if the current is not set to exactly the maximum value.

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

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Externally Measured Loop Current Level (units of milliamperes) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 3 | Float | Actual Measured Loop Current Level (units of milliamperes) |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | | Undefined |
| 9 | Error | Incorrect Loop Current Mode or Value |
| 10 | | Undefined |
| 11 | Error | Loop Current Not Active (Device in Multidrop Mode) |
| 12 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.15 Command 47 Write Primary Variable Transfer Function

This is a Primary Variable Command.

Selects the transfer function to be used between the Loop Current and the Primary Variable's digital value.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Transfer Function Code (see Common Table 3, Transfer Function Codes) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Transfer Function Code (see Common Table 3, Transfer Function Codes) |

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

**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 | Error | In Write Protect Mode |
| 8 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.16 Command 48 Read Additional Device Status

This is a Device Management Command.

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 and Device Operating Status contains 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 24. 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 24$^{th}$ 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.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**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 - 10 | Bits | Analog Channel Saturated (MSB-LSB) |
| 11 - 13 | Bits | Analog Channel Fixed (MSB-LSB) |
| 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 0-7 including Extended Device Status, and Device Operating Mode. If the Field Device supports more than one Analog Channel, then bytes 8-13 (Analog Channel Saturated, and Analog Channel Fixed) 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 |

## 7.17 Command 49 Write Primary Variable Transducer Serial Number

This is a Primary Variable Command.

Writes the transducer serial number associated with the Primary Variable.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 2 | Unsigned-24 | Primary Variable Transducer Serial Number |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 2 | Unsigned-24 | Primary Variable Transducer Serial Number |

Note: The value returned in the response data bytes reflects value actually used by the 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 |

## 7.18 Command 50 Read Dynamic Variable Assignments

This is a Process Variable Mapping Command.

Responds with the Device Variable Numbers that are assigned to the Primary, Secondary, Tertiary, and Quaternary Variables. The Field Device must return all Response Data Bytes. Unsupported Dynamic Variables return "250" (Not Used) as the Device Variable assigned

Note: When a Field Device allows the Device Variable returned as PV to be changed (i.e., mapped) then this command must be supported.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable assigned to the Primary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Device Variable assigned to the secondary variable (see Device Variable Code Table in appropriate device-specific document) |
| 2 | Unsigned-8 | Device Variable assigned to the tertiary variable (see Device Variable Code Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Device variable assigned to the quaternary variable (see Device Variable Code Table in appropriate device-specific document) |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 5 | | Undefined |
| 6 | Error | Device-Specific Command Error |
| 7 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 -127 | | Undefined |

## 7.19 Command 51 Write Dynamic Variable Assignments

This is a Process Variable Mapping Command.

Assigns Device Variables to the Primary, Secondary, Tertiary, and Quaternary Variables. Each Dynamic Variable will accept any Device Variable Code defined by the device.

### 7.19.1 Backward Compatibility Requirements

Previously this command was truncatable. In other words, an older Master may only map 1, 2, 3 or 4 Dynamic Variables. 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 or 3 Request Data Bytes, it must return all Response Data Bytes. The slots unspecified by the Master request may return any valid Device Variable in the Field Device. Unsupported Dynamic Variables return "250" (Not Used) as the Device Variable assigned.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable assigned to the Primary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Device Variable assigned to the Secondary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 2 | Unsigned-8 | Device Variable assigned to the Tertiary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Device Variable assigned to the Quaternary Variable (see Device Variable Code Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable assigned to the Primary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Device Variable assigned to the Secondary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 2 | Unsigned-8 | Device Variable assigned to the Tertiary Variable (see Device Variable Code Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Device Variable assigned to the Quaternary Variable (see Device Variable Code Table in appropriate device-specific document) |

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

**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 | Error | In Write Protect Mode |
| 8 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.20 Command 52 Set Device Variable Zero

This is a Device Variable Command.

Trim the selected Device Variable so that it reads zero with the existing process applied to the device. The resulting offset must be within the limits assigned to each variable.

Note: Depending on the device's configuration the Device Variable being zeroed may be the Primary Variable.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable to be zeroed (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable to be zeroed (see Device Variable Codes Table in appropriate device-specific document) |

**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 | Error | In Write Protect Mode |
| 8 | | Undefined |
| 9 | Error | Applied Process Too High |
| 10 | Error | Applied Process Too Low |
| 11 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.21 Command 53 Write Device Variable Units

This is a Device Variable Command.

Selects the units in which the selected Device Variable will be returned.

Note: Depending on the device's configuration the Device Variable may be mapped to the Primary Variable.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Device Variable Units Code (refer to *Common Tables Specification*). |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Device Variable Units Code (refer to *Common Tables Specification*). |

Note: The value returned in the response data bytes reflects the value actually used by the 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 - 10 | | Undefined |
| 11 | Error | Invalid Device Variable Code |
| 12 | Error | Invalid Units Code |
| 13 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.22 Command 54 Read Device Variable Information

This is a Device Variable Command.

Responds with the transducer serial number, the Limits, Damping Value, and Minimum Span of the selected Device Variable along with the corresponding engineering units. The engineering units returned by this command will be the same as the Device Variable's engineering units .

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 - 3 | Unsigned-24 | Device Variable Transducer Serial Number |
| 4 | Enum | Device Variable Limits/Minimum Span Units Code (refer to *Common Tables Specification*). |
| 5 - 8 | Float | Device Variable Upper Transducer Limit |
| 9 - 12 | Float | Device Variable Lower Transducer Limit |
| 13 - 16 | Float | Device Variable Damping Value |
| 17 - 20 | Float | Device Variable Minimum Span |
| 21 | Enum | Device Variable Classification (see Common Table 21, Device Variable Classification Codes) |
| 22 | Enum | Device Variable Family (see Common Table 20, Device Variable Family Codes). |

Note 1: The Transducer Serial Number will be set to zero when it does not apply to the selected Device Variable. The other parameters will be set to "0x7F, 0xA0, 0x00, 0x00" or "250" (Not Used) when they are not applicable.

Note 2: If the Device Variable Classification is not supported by this Device Variable, then the Field Device must return "250" (Not Used)

Note 3: If the Device Variable Family is not supported by this Device Variable, then the Field Device must return "250" (Not Used) and the least significant bits of Device Variable Status must be set to 0 (see the *Command Summary Specification*).

**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 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.23 Command 55 Write Device Variable Damping Value

This is a Device Variable Command.

Writes the damping value controlling the response rate of the selected Device Variable. The damping value represents one time constant. In other words, the output response to a step input reaches 63% of final steady-state value after this time has elapsed. For a transmitter, the analog output channel values (e.g. the Loop Current) are damped as well as the Device Variable's digital value. For an actuator, only the response of the Device Variable's digital value is damped. The damping applied to these values may be also affected by other commands.

Note: Command 64 may be used to provide additional damping directly on the analog channel signal itself.

Some devices implement only discrete damping values (e.g., 1, 2, 4). The value received with the command may be rounded or truncated by the device. The response message will return the actual value used by the device. A warning is issued if value is truncated or rounded.

Note: Depending on the device's configuration the Device Variable may be mapped to the Primary Variable (see Command 34)

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 - 4 | Float | Device Variable Damping Value (units of seconds) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 - 4 | Float | Device Variable Damping Value (units of seconds) |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 | | Undefined |
| 2 | Error | Invalid Selection |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | Warning | Set to Nearest Possible Value |
| 9 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.24 Command 56 Write Device Variable Transducer Serial No.

This is a Device Variable Command.

Writes the transducer serial number associated with a particular Device Variable.

Note: Depending on the device's configuration, the Device Variable may be mapped to the Primary Variable.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 - 3 | Unsigned-24 | Device Variable Transducer Serial Number |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 - 3 | Unsigned-24 | Device Variable Transducer Serial Number |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**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 | Error | In Write Protect Mode |
| 8 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.25 Command 57 Read Unit Tag, Descriptor, Date (Not Recommended)

***THIS COMMAND IS NOT RECOMMENDED FOR NEW DESIGNS.***

This command reads the tag, descriptor, and date of the unit device and not that of an individual transducer. A unit device is typically common hardware that supports multiple transducers.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 5 | Packed | Unit Tag |
| 6 - 11 | Packed | Unit Descriptor |
| 18 - 20 | Unsigned-24 | Unit Date (respectively day, month, year-1900) |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 5 | | Undefined |
| 6 | Error | Device-Specific Command Error |
| 7 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 -127 | | Undefined |

## 7.26 Command 58 Write Unit Tag, Descriptor, Date (Not Recommended)

***THIS COMMAND IS NOT RECOMMENDED FOR NEW DESIGNS.***

This command writes the tag, descriptor, and date to the unit device and not an individual transducer. A unit device is typically common hardware that supports multiple transducers.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 5 | Packed | Unit Tag |
| 6 - 11 | Packed | Unit Descriptor |
| 18 - 20 | Date | Unit Date Code |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 - 5 | Packed | Unit Tag |
| 6 - 11 | Packed | Unit Descriptor |
| 18 - 20 | Date | Unit Date Code |

Note: The value returned in the response data bytes reflects the value actually used by the 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 |

## 7.27 Command 59 Write Number Of Response Preambles

This is a Data Link Layer Management Command. Command 59 only applies to asynchronous Physical Layers like the HART FSK Physical Layer.

This command sets the number of asynchronous 0xFF preamble bytes to be sent by a device before the start of a response message. This number includes the two preambles used to detect the start of message. This value may be set to no smaller then 5 and no greater then 20.

Note: Field devices must answer all messages and meet the requirements in the *Data Link Layer Specification* even if the Master Request contains more than 20 Preambles.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Number of preambles to be sent with the response message from the Slave to the Master |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Number of preambles to be sent with the response message from the Slave to the Master |

Note: The value returned in the Response Data Bytes reflects the value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | Warning | Set To Nearest Possible Value |
| 9-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.28 Command 60 Read Analog Channel And Percent Of Range

This is an Analog Channel Support Command.

Read the Analog Level and Percent of Range of the selected Analog Channel. The Analog Level always matches the associated physical Analog Channel of the device, including alarm conditions and set values. The Analog Level always matches the value that can be measured by an externally connected reference meter.

### 7.28.1 Percent of Range (Transmitters)

Percent of Range always follows the associated Device Variable value, including alarm conditions and set values. The Upper and Lower Range Values maps the Dynamic Variable value to the Percent of Range. Percent of Range is not limited to values between 0% and 100%, but tracks the Device Variable to the Transducer Limits.

### 7.28.2 Percent of Range (Actuators)

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

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Analog Channel Level |
| 6 - 9 | Float | Analog Channel Percent of Range (units of percent) |

**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 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 -127 | | Undefined |

## 7.29 Command 61 Read Dynamic Variables And Primary Variable Analog Channel (Not Recommended)

***THIS COMMAND IS NOT RECOMMENDED FOR NEW DESIGNS.***

Read the Primary Variable's Analog Channel Level and up to four predefined Dynamic Variables. The Primary Variable Analog Channel Level always matches the physical Primary Variable Analog Channel of the device including alarm conditions and set values. The Secondary, Tertiary, and Quaternary Variables are defined by each device type.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Primary Variable Analog Channel Units Code (refer to *Common Tables Specification*) |
| 1-4 | Float | Primary Variable Analog Level |
| 5 | Enum | Primary Variable Units Code (refer to *Common Tables Specification*) |
| 6-9 | Float | Primary Variable |
| 10 | Enum | Secondary Variable Units (refer to *Common Tables Specification*) |
| 11-14 | Float | Secondary Variable |
| 15 | Enum | Tertiary Variable Units Code (refer to *Common Tables Specification*) |
| 16-19 | Float | Tertiary Variable |
| 20 | Enum | Quaternary Variable Units Code (refer to *Common Tables Specification*) |
| 21-23 | Float | Quaternary 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 |

## 7.30 Command 62 Read Analog Channels

This is an Analog Channel Support Command.

Read selected Analog Channel Levels. Each slot will accept any Analog Channel Number Code defined by the device.

### 7.30.1 Backward Compatibility Requirements

Previously this command was truncatable. In other words, an older Master may only request 1, 2, 3 or 4 Analog Channels. 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 or 3 Request Data Bytes, it must return all Response Data Bytes. The slots unspecified by the Master request may return any valid Analog Channel in the Field Device even if it duplicates information from a previous slot.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code assigned to Slot 0 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Analog Channel Number Code assigned to Slot 1 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 2 | Unsigned-8 | Analog Channel Number Code assigned to Slot 2 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Analog Channel Number Code assigned to Slot 3 (see Analog Channel Number Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code in Slot 0 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Slot 0 Units Code (refer to *Common Tables Specification*) |
| 2-5 | Float | Slot 0, Level of selected Analog Channel |
| 6 | Unsigned-8 | Analog Channel Number Code in Slot 1 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 7 | Enum | Slot 1 Units Code (refer to *Common Tables Specification*) |
| 8-11 | Float | Slot 1, Level of selected Analog Channel |

| Byte | Format | Description |
|---|---|---|
| 12 | Unsigned-8 | Analog Channel Number Code in Slot 2 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 13 | Enum | Slot 2 Units Code (refer to *Common Tables Specification*) |
| 14-17 | Float | Slot 2, Level of selected Analog Channel |
| 18 | Unsigned-8 | Analog Channel Number Code in Slot 3 (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 19 | Enum | Slot 3 Units Code (refer to *Common Tables Specification*) |
| 20-23 | Float | Slot 3, Level of selected Analog Channel |

**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 - 7 | | Undefined |
| 8 | Warning | Update Failure |
| 9 - 127 | | Undefined |

## 7.31 Command 63 Read Analog Channel Information

This is an Analog Channel Support Command.

Read the configuration of the Analog Channel including: the Alarm Selection Code, Transfer Function Code, Range Units Code, Upper Range Value, Lower Range Value, and Damping Value.

The damping value is applied to the Analog Channel in addition to the damping of the associated Device or Dynamic Variable.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Alarm Selection Code (see Common Table 6, Alarm Selection Codes) |
| 2 | Enum | Analog Channel Transfer Function Code (see Common Table 3, Transfer function Codes) |
| 3. | Enum | Analog Channel Upper and Lower Range Values Units Code (refer to *Common Tables Specification*) |
| 4 - 7 | Float | Analog Channel Upper Range Value |
| 8 - 11 | Float | Analog Channel Lower Range Value |
| 12 - 15 | Float | Analog Channel Damping Value (units of seconds) |
| 16 | Bits | Analog Channel Flags (see Common Table 26, Analog Channel Flags) |

**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 - 15 | | Undefined |

| Code | Class | Description |
|---|---|---|
| 16 | Error | Access Restricted |
| 17-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.32 Command 64 Write Analog Channel Additional Damping Value

This is an Analog Channel Support Command.

Write the additional damping value for the selected Analog Channel.

The additional damping value represents one time constant. In other words, the output response to a step input is 63% of final steady-state value after this time has elapsed. For a transmitter, only the response of the analog output (e.g. the Loop Current) is damped. For an actuator, the response of the associated Device Variable or Dynamic Variable (e.g. the Primary Variable's digital value) is damped as well. The damping applied to these values may be also affected by other commands.

Some devices implement only discrete damping values (e.g., 1, 2, 4). The value received with the command may be rounded or truncated by the device. The response message will return the actual value used by the device. A warning is issued if value is truncated or rounded.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 - 4 | Float | Analog Channel Additional Damping Value (units of seconds) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 - 4 | Float | Analog Channel Additional Damping Value (units of seconds) |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 | | Undefined |
| 2 | Error | Invalid Selection |
| 3 | | Passed Parameter Too Large |
| 4 | | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | Warning | Set to Nearest Possible Value |
| 9 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.33 Command 65 Write Analog Channel Range Values

This is an Analog Channel Support Command.

Write the Range Values for the selected Analog Channel. The Upper Range Value is independent of the Lower Range Value.

The units of the range received with this command do not effect the units of Dynamic or Device Variables. The Range Values will be returned in the same units as received.

Most devices allow the Upper Range Value to be lower than the Lower Range Value, enabling the device to be operated with a reversed output. The device-specific document will indicate if this capability has not been implemented.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Upper and Lower Range Values Units Codes (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Analog Channel Upper Range Value |
| 6 - 9 | Float | Analog Channel Lower Range Value |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Upper and Lower Range Values Units Codes (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Analog Channel Upper Range Value |
| 6 - 9 | Float | Analog Channel Lower Range Value |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the 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 | Warning | Set To Nearest Possible Value (Upper or Lower Range Pushed) |
| 9 | Error | Lower Range Value Too High |
| 10 | Error | Lower Range Value Too Low |
| 11 | Error | Upper Range Value Too High |
| 12 | Error | Upper Range Value Too Low |
| 13 | Error | Upper And Lower Range Values Out Of Limits |
| 14 | Warning | Span Too Small (Device Accuracy May Be Impaired) |
| 15 | Error | Invalid Analog Channel Code Number |
| 16 | Error | Access Restricted |
| 17 - 27 | | Undefined |
| 28 | Error | Invalid Range Units Code |
| 29 | Error | Invalid Span |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.34 Command 66 Enter/Exit Fixed Analog Channel Mode

This is an Analog Channel Support Command.

The device's Analog Channel level is fixed to the value received. The value returned in the response data bytes reflects the rounded or truncated value actually used by the device. A level containing "0x7F, 0xA0, 0x00, 0x00" with any Units Code exits the Fixed Analog Channel Mode. Fixed Analog Channel Mode is also exited when power is removed from device.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Fixed Analog Channel Level |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Fixed Analog Channel Level |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 - 10 | | Undefined |
| 11 | Error | In Multidrop Mode |
| 12 | Error | Invalid Units Code |
| 13 - 14 | | Undefined |
| 15 | Error | Invalid Analog Channel Code Number |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.35 Command 67 Trim Analog Channel Zero

This is an Analog Channel Support Command.

This command trims the zero or lower endpoint value of the selected Analog Channel so that the Analog Channel value matches the connected meter reading. The value sent with the command may be rounded or truncated by the device. The Response Data Bytes contain the value from the request as used by the device.

Use Command 66, Enter/Exit Fixed Analog Channel Mode, to set the Analog Channel exactly to the lower endpoint value before using this command. Response Code 9, Not in Proper Analog Channel Mode, will be returned if the Fixed Analog Channel Mode has not been entered or the Analog Channel is not set exactly to the lower endpoint value.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Externally Measured Analog Channel Level |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Actual Analog Channel Level |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | | Undefined |
| 9 | Error | Not In Proper Analog Channel Mode |
| 10 | | Undefined |
| 11 | Error | In Multidrop Mode |
| 12 | Error | Invalid Units Code |
| 13 - 14 | | Undefined |
| 15 | Error | Invalid Analog Channel Code Number |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.36 Command 68 Trim Analog Channel Gain

This is an Analog Channel Support Command.

This command trims the gain or upper endpoint value of the selected Analog Channel so that the Analog Channel value matches the connected meter reading. The value that is sent with the command may be rounded or truncated by the device. The response data bytes contain the value from the request as used by the device.

Use Command 66, Enter/Exit Fixed Analog Channel Mode, to Set the Analog Channel exactly to the upper endpoint value before using this command. Response Code 9, Not In Proper Analog Channel Mode, will be returned if the Fixed Analog Channel Mode has not been entered or the Analog Channel is not set exactly to the upper endpoint value.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Externally Measured Analog Channel Level |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Externally Measured Analog Channel Level |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the device.

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 2 | | Undefined |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device-Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | | Undefined |
| 9 | Error | Not In Proper Analog Channel Mode |
| 10 | | Undefined |
| 11 | Error | In Multidrop Mode |
| 12 | Error | Invalid Units Code |
| 13 - 14 | | Undefined |
| 15 | Error | Invalid Analog Channel Code Number |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.37 Command 69 Write Analog Channel Transfer Function

This is an Analog Channel Support Command.

Select the transfer function for the selected Analog Channel of the device.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Transfer Function Code (see Common Table 3, Transfer Function Codes) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Transfer Function Code (see Common Table 3, Transfer Function Codes) |

Note: The value returned in the response data bytes reflects the rounded or truncated value actually used by the 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 - 12 | | Undefined |
| 13 | Error | Invalid Transfer Function Code |
| 14 | | Undefined |
| 15 | Error | Invalid Analog Channel Code Number |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.38 Command 70 Read Analog Channel Endpoint Values

This is an Analog Channel Support Command.

Read the endpoint values for the selected Analog Channel.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Analog Channel Number Code (see Analog Channel Number Codes Table in appropriate device-specific document) |
| 1 | Enum | Analog Channel Upper and Lower Endpoint Values Units Code (refer to *Common Tables Specification*) |
| 2 - 5 | Float | Analog Channel Upper Endpoint Value |
| 6 - 9 | Float | Analog Channel Lower Endpoint Value |

**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 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.39 Command 71 Lock Device

This is a Device Management Command.

This command locks a device preventing any changes being made from a local panel or from another Master.

This command allows a Master to prevent another Master or the Local Operator Interface from changing an instruments configuration or calibration. This lock can be temporary (i.e. the lock is released when power is removed from device or upon performing a device reset) or permanent (i.e., a power cycle will not remove the lock).

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Lock Code (see Common Table 18, Lock Device Codes) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Lock Code (see Common Table 18, Lock Device Codes) |

**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 |
| 7-9 | | Undefined |
| 10 | Error | Invalid Lock Code |
| 11 | Error | Cannot Lock Device |
| 12-15 | | 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 |

## 7.40 Command 72 Squawk

This is a Data Link Layer Management Command.

This command causes the addressed device to visually, audibly or mechanically indicate the reception of this command. Masters should repeatedly issue this command to allow technicians to identify the actual device being addressed.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Command Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1-5 | | Undefined |
| 6 | Error | Device Specific Command Error |
| 7-8 | | Undefined |
| 9 | Error | Unable to Squawk (e.g., no local operator interface) |
| 10-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.41 Command 73 Find Device

This is a Data Link Layer Management Command and 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. Slaves implementing this command must only respond when physically/mechanically armed. For example, the technician presses a special button or combination of buttons that indicate the Slave is to answer 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.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

*Same as Command 0.*

**Command Specific Response Codes**

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

## 7.42 Command 74 Read I/O System Capabilities

This is a Data Link Layer Management Command and an Identity Command (see the *Command Summary Specification*).

This command reads the guidance a Host needs to identify an I/O systems sub-devices. Devices supporting this command must have byte 8 (Flags), bit #2 (Protocol Bridge Device) of the Identity Commands set in there response.

I/O systems may contain one or more I/O Cards. Each I/O Card may in turn support one or more Channels with, possibly, several sub-devices. The data items in this command should contain information allowing Masters to minimize the time necessary to identify sub-devices.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Maximum Number of I/O Cards (must be greater then or equal to 1). |
| 1 | Unsigned-8 | Maximum Number of Channels per I/O Card (must be greater then or equal to 1). |
| 2 | Unsigned-8 | Maximum Number of Sub-Devices Per Channel (must be greater then or equal to 1). |

**Command Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 - 5 | | Undefined |
| 6 | Error | Device-Specific Command Error |
| 7 - 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.43 Command 75 Poll Sub-Device

This is a Data Link Layer Management Command and an Identity Command (see the *Command Summary Specification*).

This command is issued to identify an I/O system's sub-devices. The I/O System's long frame address is used and the I/O Card, Channel and Sub-Device Polling Address is included in the request data bytes.

Returns identity information about the sub-device including: the Device Type, revision levels, and Device ID. The address in the Response Message is the same as the request. Further communication to the sub-device uses the sub-device's Unique ID in the address field. The I/O System or bridge device must route commands using the sub-device's long frame address. Sub-device response times must adhere to the Data Link Layer requirements. Sub-devices Universal Command Major Revision Number (response byte 4) must be 5 or greater.

When possible, the I/O System should use Response Code 9, "No Sub-Device Found" to expedite sub-device identification and minimize Master polling time.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | I/O Card |
| 1 | Unsigned-8 | Channel |
| 2 | Unsigned-8 | Sub-Device Polling Address |

**Response Data Bytes**

*Same as Command 0.*

**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 |
| 6-8 | | Undefined |
| 9 | Error | No Sub-Device Found |
| 10-31 | | 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 |

## 7.44 Command 76 Read Lock Device State

This is a Device Management Command.

This command reads the current state of the Lock Device. Lock Device allows a Master to prevent another Master or the Local Operator Interface from changing an instruments configuration or calibration.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Bits | Lock Status (see Common Table 25, Lock Device Status) |

**Command Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1-5 | | Undefined |
| 6 | Error | Device Specific Command Error |
| 7-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.45 Command 79 Write Device Variable

This is a Device Variable Command.

This command allows a Device Variable to be temporarily forced to a fixed value.

The Host selects the Device Variable and Engineering Value to write. The Write Device Variable Code controls the operation of the Field Device either forcing the engineering value or allowing normal operation. For Device Variables automatically calculated by the Field Device, normal operation is resumed when power is removed from the device or upon performing a device reset.

Note 1: A Field Device must initiate a Delayed Response if the change in the Device Variable's value exceeds the Rate-of-Change Limit. This DR will continue until the new Device Variable value can be reached. See the PID Device Family for more information.

Note 2: While the Device Variable remains forced Response Code 8, "Update Failure" must be returned whenever the forced value is read by a host. This signals (e.g., a HART 5) master to detect this condition.

Note 3: Forcing a Device Variable value may affect bits in the device status byte. For example, the Loop Current may become fixed when using this command to force the Device Variable mapped to the Primary Variable in a transmitter.

The Device Variable Units Code received with this command does not effect the Device Variable Units of the Field Device. The Device Variable value will be returned in the same units as received.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Write Device Variable Command Code (see Common Table 19, Write Device Variable Codes) |
| 2 | Enum | Units Code (refer to *Common Tables Specification*) |
| 3-6 | Float | Device Variable value |
| 7 | Bits | Device Variable status |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Write Device Variable Command Code (see Common Table 19, Write Device Variable Codes) |
| 2 | Enum | Units Code (refer to *Common Tables Specification*) |
| 3-6 | Float | Device Variable value |
| 7 | Bits | Device Variable status |

**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 | Error | In Write Protect Mode |
| 8-9 | | Undefined |
| 10 | Error | Invalid Write Device Variable Code |
| 11-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | Error | Invalid Units Code |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | 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 |

## 7.46 Command 80 Read Device Variable Trim Points

This is a Transducer Trim Command.

This command reads the last successful trim points. If this Device Variable does not support a trim operation, then both the upper and lower trim points will be set to "0x7F, 0xA0, 0x00, 0x00". If the Device Variable supports only a single trim point, then the upper trim point will be set to "0x7F, 0xA0, 0x00, 0x00".

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Trim Points Units Code (refer to *Common Tables Specification*) |
| 2 -5 | Float | Lower or Single Trim Point (the most recent value used for the lower trim point) |
| 6 - 9 | Float | Upper Trim Point (the most recent value used for the upper trim point) |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1-4 | | Undefined |
| 5 | Error | Too Few Data Bytes Received |
| 3-16 | | Undefined |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | | Undefined |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.47 Command 81 Read Device Variable Trim Guidelines

This is a Transducer Trim Command.

This command reads the information that a Host will need to guide a user through a correct selection of trim points. If the Device Variable supports only a single trim point, the lower trim point values are interpreted as the single trim point. The limits of the upper trim point and the minimum differential must be set to "0x7F, 0xA0, 0x00, 0x00".

If the Device Variable cannot be trimmed, the device should implement this command with Byte 1 (number of trim points supported) set to 0. The floating point values must then be set to "0x7F, 0xA0, 0x00, 0x00" and the Units Code set to Not Used.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable guidelines to read (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable guidelines to read (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Trim points supported (see Common Table 22, Trim Point Codes). |
| 2 | Enum | Trim Points Units Code (refer to *Common Tables Specification*) |
| 3 - 6 | Float | Minimum Lower Trim Point Value (no value lower than this will be accepted by the instrument during a low trim procedure) |
| 7 - 10 | Float | Maximum Lower Trim Point Value (no value higher than this will be accepted by the instrument during a low trim procedure) |
| 11 - 14 | Float | Minimum Upper Trim Point Value (no value lower than this will be accepted by the instrument during a high trim procedure) |
| 15 - 18 | Float | Maximum Upper Trim Point Value (no value higher than this will be accepted by the instrument during a high trim procedure) |
| 19 - 22 | Float | Minimum Differential (minimum acceptable difference between upper and lower trim points) |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1-4 | | Undefined |
| 5 | Error | Too Few Data Bytes Received |
| 3-16 | | Undefined |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | | Undefined |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.48 Command 82 Write Device Variable Trim Point

This is a Transducer Trim Command.

This command performs a calibration adjustment for the indicated Device Variable. The trim point that is sent in this command must represent the presently applied process variable value. On receipt of this command, the device will check the value for validity (within acceptable limits), then attempt to adjust the indicated point in its calibrated calculation so that the resulting digital process value matches the value supplied in the command.

If the device cannot complete the trim calculation within the time allowed by the Data Link Layer for a response, the device must use the delayed response mechanism to inform the Master that calibration is proceeding.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable to trim (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Trim Point (see Common Table 22, Trim Point Codes) |
| 2 | Enum | Trim Point Units Code (refer to *Common Tables Specification*) |
| 3 - 6 | Float | Trim Point Value (the presently applied process value for this Device Variable) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable to trim (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Trim Point (see Common Table 22, Trim Point Codes) |
| 2 | Enum | Trim Point Units Code (refer to *Common Tables Specification*) |
| 3 - 6 | Float | Trim Point Value (the presently applied process value for this Device Variable) |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1 | | Undefined |
| 2 | Error | Invalid Selection |
| 3 | Error | Passed Parameter Too Large |
| 4 | Error | Passed Parameter Too Small |
| 5 | Error | Too Few Data Bytes Received |
| 6 | Error | Device Specific Command Error |
| 7 | Error | In Write Protect Mode |
| 8 | | Undefined |
| 9 | Error | Applied Process Too High |
| 10 | Error | Applied Process Too Low |
| 11 | Error | Trim Error, Excess Correction Attempted |
| 12 | | Undefined |
| 13 | Error | Computation Error, Trim Values Were Not Changed |
| 14 | Warning | Span Too Small |
| 15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | Error | Invalid Units Code |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | 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 |

## 7.49 Command 83 Reset Device Variable Trim

This is a Transducer Trim Command.

This command allows the user to reset the Device Variable to the default factory trim.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable trim to reset (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable trim to reset (see Device Variable Codes Table in appropriate device-specific document) |

**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 | Undefined |
| 7 | Error | In Write Protect Mode |
| 8-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | | Undefined |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | 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 |

## 7.50 Command 105 Read Burst Mode Configuration

This is a Burst Mode Command.

This command allows the Burst Mode configuration to be read. The Field Device responds with whether the Field Device is in Burst Mode, the command to be burst, and a list of Device Variables to be transmitted.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Burst Mode Control Code (see Common Table 9, Burst Mode Control Codes) |
| 1 | Unsigned-8 | Command Number of the response message to be transmitted |
| 2 | Unsigned-8 | Device Variable Code assigned to Slot 0 (see Device Variable Codes Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Device Variable Code assigned to Slot 1 (see Device Variable Codes Table in appropriate device-specific document) |
| 4 | Unsigned-8 | Device Variable Code assigned to Slot 2 (see Device Variable Codes Table in appropriate device-specific document) |
| 5 | Unsigned-8 | Device Variable Code assigned to Slot 3 (see Device Variable Codes Table in appropriate device-specific document) |

Note: If a slot is not configured to transmit a Device Variable the that slot must return "250" (Not Used). If Command 9 is to be burst then the slot's Device Variable code must meet the requirements found in Command 9.

**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 |
| 7-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-31 | | Undefined |
| 32 | Error | Busy |
| 33-127 | | Undefined |

## 7.51 Command 106 Flush Delayed Responses

This command clears all pending delayed responses for the Master that issues the command. Delayed responses currently running that must not be interrupted or aborted may be completed (see the manufacturer's device specific document for details). If this is the case, then the Slave must respond with Response Code 8, Warning: All but running delayed responses flushed.

***THIS COMMAND MUST BE IMPLEMENTED IF THE DELAYED RESPONSE MECHANISM IS SUPPORTED.***

Note: Devices should always support a minimum of two DR buffers (one for each Master). If only one DR buffer is supported then this command must flush the DR buffer even if it is in use by the other Master.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Command-Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors, All Flushed |
| 1-7 | | Undefined |
| 8 | Warning | All but running delayed responses flushed |
| 9-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 - 31 | | Undefined |
| 32 | Error | Busy |
| 33 - 127 | | Undefined |

## 7.52 Command 107 Write Burst Device Variables

This is a Burst Mode Command.

This command s.elects the Device Variables that will be returned by Command 9 or 33 in Burst Mode. The Master may request only 1, 2, 3 or 4 Device Variables. 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 or 3 Request Data Bytes it must return only the corresponding number of Device Variables.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code assigned to Slot 0 (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Device Variable Code assigned to Slot 1 (see Device Variable Codes Table in appropriate device-specific document) |
| 2 | Unsigned-8 | Device Variable Code assigned to Slot 2 (see Device Variable Codes Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Device Variable Code assigned to Slot 3 (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Device Variable Code assigned to Slot 0 (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Unsigned-8 | Device Variable Code assigned to Slot 1 (see Device Variable Codes Table in appropriate device-specific document) |
| 2 | Unsigned-8 | Device Variable Code assigned to Slot 2 (see Device Variable Codes Table in appropriate device-specific document) |
| 3 | Unsigned-8 | Device Variable Code assigned to Slot 3 (see Device Variable Codes Table in appropriate device-specific document) |

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

**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 | Error | In Write Protect Mode |
| 8-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-127 | | Undefined |

## 7.53 Command 108 Write Burst Mode Command Number

This is a Burst Mode Command.

This command selects the response message that the device transmits while in Burst Mode. Command 1, 2, 3, and 9 must be supported in all devices implementing Burst Mode. Refer to the device-specific document to determine if additional commands are supported for a specific device type.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Command Number of the response message to be transmitted |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Command Number of the response message to be transmitted |

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

**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 | Error | In Write Protect Mode |
| 8-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-127 | | Undefined |

## 7.54 Command 109 Burst Mode Control

This is a Burst Mode Command.

This command is used to enter and exit the Burst Mode. The response data bytes for Command 1, Read Primary Variable, or the command number selected with Command 108, Write Command Number To Burst, will be transmitted while in Burst Mode.

Note: This command affects Data Link Layer operation. All Data Link Layer requirements for entering and exiting burst mode must be met.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Burst Mode Control Code (see Common Table 9, Burst Mode Control Codes) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Burst Mode Control Code (see Common Table 9, Burst Mode Control Codes) |

**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 | Error | In Write Protect Mode |
| 8-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17-127 | | Undefined |

## 7.55 Command 110 Read All Dynamic Variables (Not Recommended)

***THIS COMMAND IS NOT RECOMMENDED FOR NEW DESIGNS.***

Read up to four predefined Dynamic Variables. The Secondary, Tertiary, and Quaternary Variables are defined by each device type.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| None | | |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Enum | Primary Variable Units Code (refer to *Common Tables Specification*) |
| 1-4 | Float | Primary Variable |
| 5 | Enum | Secondary Variable Units Code (refer to *Common Tables Specification*) |
| 6-9 | Float | Secondary Variable |
| 10 | Enum | Tertiary Variable Units Code (refer to *Common Tables Specification*) |
| 11-14 | Float | Tertiary Variable |
| 15 | Enum | Quaternary Variable Units Code (refer to *Common Tables Specification*) |
| 16-19 | Float | Quaternary Variable |

Note: Response Data Bytes are truncates after last variable supported by each device type.

**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 | Warning | Update Failure |
| 9-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17- 27 | | Undefined |

## 7.56 Command 111 Transfer Service Control

See Block Transfer Specification

## 7.57 Command 112 Transfer Service

See Block Transfer Specification

## 7.58 Command 113 Catch Device Variable

This is a Device Variable Command.

This command instructs a Field Device to listen to command responses from another Slave device. Data from the specified device and command is captured and mapped to a local Device Variable. This allows data from a specific Slave to be used as an input to calculations being performed in another device.

The Master supplies the receiving Slave device with the source Slave address, the command number and the slot number of the variable to read. When a response is observed, matching the specified address and command number, the value captured is stored into the specified Device Variable and used for internal calculations. Table 2 shows the Slot Code assignments for command 1, 2, 3, 9 and 33 responses.

**Table 2 Slot Code Mappings for Common Burst Commands**

| | Command | | | | |
|---|---|---|---|---|---|
| **Slot** | **1** | **2** | **3** | **9** | **33** |
| 1 | PV | Loop mA | PV | Slot 1 | Slot 1 |
| 2 | | Pct Range | SV | Slot 2 | Slot 2 |
| 3 | | | TV | Slot 3 | Slot 3 |
| 4 | | | QV | Slot 4 | Slot 4 |

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Destination Device Variable (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Capture Mode Code (see Common Table, 23 Capture Mode Codes). |
| 2 | Unsigned-8 | Source Slave Manufacturer ID (Slave Address Byte 0) |
| 3 | Unsigned-8 | Source Slave Device Type (Slave Address Byte 1) |
| 4-6 | Unsigned-24 | Source Slave Device ID (Slave Address Byte 2-4) |
| 7 | Unsigned-8 | Source Command Number |
| 8 | Unsigned-8 | Source Slot Number |
| 9-12 | Float | Shed Time (in Seconds) for this mapping. |

Note 1: The Source Slave Device ID may be set to all 0x00's to indicate any Field Device matching the Manufacturer ID and Device Type is to act as the data source.

Note 2: Source Slave Address must be ignored if the Capture Mode Code is set to "2" (Catch data from BACK message)

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Destination Device Variable |
| 1 | Enum | Capture Mode Code |
| 2-6 | Unsigned-8 | Source Slave Address |
| 7 | Unsigned-8 | Source Command Number |
| 8 | Unsigned-8 | Source Slot Number |
| 9-12 | Float | Shed Time (in Seconds) for this mapping. |

**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 |
| 7-9 | | Undefined |
| 10 | Error | Invalid Capture Mode Code |
| 11 | Error | Invalid Slot Number |
| 12 | Error | Command Number Not Supported |
| 13-15 | | Undefined |
| 16 | Error | Access Restricted |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | | Undefined |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | 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 |

## 7.59 Command 114 Read Caught Device Variable

This is a Device Variable Command.

This command reads the current Catch Device Variable settings for a Device Variable.

If this Device Variable is not being caught from the HART network, then the Capture Mode Code must return 0x00 ("Normal Device Variable Operation"). The other data items must return the last value written by the Host.

The Source Slave Address, Source Command Number, Source Slot Number default to zero if never written by the Master. The Shed Time defaults to 0x7F, 0xA0, 0x00, 0x00 if never written by a Master.

**Request Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Destination Device Variable (see Device Variable Codes Table in appropriate device-specific document) |

**Response Data Bytes**

| Byte | Format | Description |
|---|---|---|
| 0 | Unsigned-8 | Destination Device Variable (see Device Variable Codes Table in appropriate device-specific document) |
| 1 | Enum | Capture Mode Code (see Common Table 23, Capture Mode Codes). |
| 2-6 | Unsigned-8 | Source Slave Address |
| 7 | Unsigned-8 | Source Command Number |
| 8 | Unsigned-8 | Source Slot Number |
| 9-12 | Float | Shed Time (in Seconds) for this mapping. |

**Command Specific Response Codes**

| Code | Class | Description |
|---|---|---|
| 0 | Success | No Command-Specific Errors |
| 1-4 | | Undefined |
| 5 | Error | Too Few Data Bytes Received |
| 6-16 | | Undefined |
| 17 | Error | Invalid Device Variable Index. The Device Variable does not exist in this Field Device. |
| 18 | | Undefined |
| 19 | Error | Device Variable index not allowed for this command. |
| 20-31 | | 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 |

# ANNEX A. REVISION HISTORY

## A1. Changes from Rev 7.1 to Rev 8.0

1. These new sections were added as part of the format revisions for all HART Protocol Specification documents: Scope, Reference, Definitions, Symbols/ Abbreviations, Data Format, Application of Common Practice Commands.
2. Added Recommended Use For HART Common Practice Commands section.
3. Added Common Practice Trim Commands 80, 81, 82, and 83.
4. Added Delayed Response Mechanism Commands 106.
5. The descriptions of Command 111 and 112 were moved to the *Block Transfer Specification.*
6. Added Command 113, Catch Device Variable.
7. Added Delayed Response Error Codes to Commands Number: 34-37, 39, 41, 43-47, 49, 51, 52, 53, 55, 56, 59, 64, 65, 67, 68, 69, 105, 107, 108.
8. Changed Command 41, Perform Self Test, to require use of DRM rather than busy.
9. Reformatted title page and all tables.
10. Changed "BEPROM" to "EEPROM" in Command 39.
11. Changed "units as receivei" to "units as received" in Command 35.
12. Changed "rounded dr" to "rounded or" in Command 40.
13. Replaced all occurrences of "units of mifliampres" with "units of milliamperes".
14. Changed "Slot *0, 3-bit" to "Slot 0, 8-bit" in Command 62.
15. Replaced all occurrences of "Slot *2" with "Slot 2" and "Slot *3" with "Slot 3".
16. Replaced "Table III" with "Table 3", "Table VI" with "Table 6", "Table X" with "Table 10", "Table XII" with "Table 12", "Table XIII" with "Table 13", and "Table XIV" with "Table 14" in all applicable commands.
17. Replaced "Primary Variable Analog Output" with either "Loop Current" or "Analog Channel' as was appropriate in Commands 40, 45, 46, 69 and 70. The universality of these substitutions merited change bars only appear when the command name was affected.
18. Replaced "Enter/Exit Fixed Primary Variable Current Mode" with "Enter/Exit Fixed Current Mode" in Commands 40, 45, 46, 69 and 70. The universality of these substitutions merited change bars only appear when the command name was affected.
19. Replaced "transmitter" with "device" to demonstrate applicability of commands to many device types. The universality of this substitution merited change bars only appear when the command name was affected.
20. Added recommendation for number of preambles to Command 59 and the warning that this command only applies to HART FSK.
21. Fixed incorrectly scanned characters in Revision Notes.
22. "This is a Data Link Layer command" was added to the description of Command 59.

23. "This is a Primary Variable Range command" was added to the descriptions of Commands 35,36, and 37.
24. "This is a Loop Current command" was added to the descriptions of Commands 40, 45 and 46.
25. "This is a Device Management command" was added to the descriptions of Commands 38, 41, 42 and 48.
26. "This is a Process Variable Mapping command" was added to the descriptions of Commands 50 and 51.
27. "This is a Primary Variable command" was added to the descriptions of Commands 34, 43, 44 and 47.
28. "This is a Device Variable command" was added to the descriptions of Commands 33, 52, 53 54, 55, 56, and 79.
29. "This is an Analog Channel Support command" was added to the descriptions of Commands 60 and 62-70.
30. "This is a Device Variable command" was added to the descriptions of Commands 33, 52, 53 54, 55, 56, and 79.
31. Included Response Data Byte 21, Variable Classification, to Command 54 as part of Unit Codes expansion.

## A2. Changes from Rev 7.0 to Rev 7.1

The document was translated from an ASCII text document to Microsoft Word. As a result of this translation the document format was altered. No changes were made to document content.

## A3. Changes from Rev 6.0 to Rev 7.0

1. This revision adds commands for devices with Multiple Analog Outputs and Analog Outputs other than Current.

2. Added Changes Pending note to the beginning of the document and "CHANGES PENDING" to the Transfer Service Commands.

3. Summarized Release Notes from Rev 5 to Rev 6.0 - Final.

| Page | Line | Change | Text |
|---|---|---|---|
| TP | 4 | Replace | "6.0 - Final" by "7.0 - Final" |
| TP | 5 | Replace | "8 February" by "3 May" |
| TP | 6 | Replace | "8 February" by "3 May" |
| 1 | 7 | Replace | "15 February" by "3 May" |
| 1 | 7 | Insert | "This command is capable of Burst Made " |
| 5 | 4 | Insert | "Primary Variable" |
| 5 | 7 | Insert | "The damping applied to these outputs may be " |
| 5 | 19 | Insert | "PV PV" |
| 5 | 24 | Insert | "Primary Variable" |
| 5 | 24 | Replace | "IEEE 754" by "IEEE 754" |
| 5 | 32 | Insert | "PV PV" |
| 5 | 37 | Insert | "Primary Variable" |
| 6 | 2 | Replace | "RANGE VALUES" by "PRIMARY VARIABLE RANGE VALUES" |
| 6 | 4 | Insert | "The Primary Variable Upper Range Value is " |
| 6 | 46 | Delete | "RANGE UPPER UPPER UNITS RANGE RANGE VALUE " |
| 7 | 10 | Replace | "Data Byte 5 - 8." by "Data Byte 5 - 8." |
| 8 | 2 | Insert | "PRIMARY VARIABLE" |
| 8 | 2 | Delete | "Push SPAN Button)" |
| 8 | 5 | Insert | "to the Primary Variable" |
| 8 | 6 | Insert | "Primary Variable" |
| 8 | 7 | Insert | "primary Variable" |
| 8 | 7 | Insert | "Primary Variable" |
| 8 | 11 | Insert | "Primary Variable" |
| 8 | 12 | Insert | "Primary Variable" |
| 9 | 2 | Insert | "PRIMARY VARIABLE" |
| 9 | 2 | Delete | "(Push ZERO Button)" |
| 9 | 6 | Insert | "to the Primary Variable" |
| 9 | 7 | Insert | "Primary Variable" |
| 9 | 8 | Insert | "Primary Variable" |
| 9 | 9 | Insert | "Primary Variable" |
| 9 | 10 | Insert | "Primary Variable" |
| 9 | 11 | Insert | "Primary Variable" |
| 9 | 12 | Insert | "Primary Variable" |
| 9 | _4 | Insert | "Primary Variable" |
| 9 | 15 | Insert | "Primary Variable" |
| 9 | 16 | Insert | "Primary Variable" |
| 9 | 17 | Insert | "Primary Variable" |
| 9 | 20 | Insert | "Primary Variable" |

| Page | Line | Change | Text |
|---|---|---|---|
| 9 | 21 | Insert | "Primary Variable" |
| 11 | 9 | Replace | "checksum"' by "checkless" |
| 13 | 2 | Insert | "PRIMARY VARIABLE" |
| 13 | 4 | Insert | "Primary Variable" |
| 13 | 5 | Replace | "Analog Out put" by "Primary Variable Current" |
| 13 | 8 | Replace | "Level" by "A level" |
| 13 | 9 | Insert | "Primary Variable" |
| 13 | 9 | Insert | "Primary Variable" |
| 13 | 15 | Replace | "CURR CURR" by "PV PV CURR CURR LEVEL LEVEL" |
| 13 | 21 | Replace | "Output" by "Primary Variable" |
| 13 | 30 | Replace | "CURR CURR" by "PV PV CURR CURR LEVEL LEVEL" |
| 13 | 36 | Replace | "Output" by "Primary Variable" |
| 17 | 4 | Insert | "Primary Variable" |
| 17 | 6 | Insert | "Primary Variable" |
| 17 | 6 | Insert | "Primary Variable" |
| 18 | 2 | Insert | "PRIMARY VARIABLE CURRENT" |
| 18 | 4 | Replace | "4 milliampere point" by "Lower Endpoint" |
| 18 | 4 | Insert | "Primary Variable Analog output so that the 13 |
| 18 | 7 | Replace | "so that the " by "of a 4 to 20 (milliampere " |
| 18 | 12 | Insert | "Primary Variable" |
| 18 | 13 | Replace | "4.0 milliamperes" by "the minimum value of " |
| 18 | 13 | Insert | "Primary Variable" |
| 18 | 17 | Rep Lace | "4.0 milliamperes." by "the minimum value." |
| 18 | 23 | Rep Lace | "CURR CURR" by "p" PV CIRR CRIR LEVEL LEVEL" |
| 18 | 31 | Replace | "Output Current1 IEEE " by "Primary Variable " |
| 18 | 38 | Replace | "CURR CURR" by "PV PV CURR CURR LEVEL LEVEL" |
| 18 | 43 | Replace | "0utput Current, IEEE" by "Primary Variable" |
| 20 | 2 | Insert | "PRIMARY VARIABLE CURRENT |
| 20 | 4 | Replace | "20 milliampere point" by "Upper Endpoint" |
| 20 | 4 | Insert | "Primary Variable Analog Output so that the " |
| 20 | 7 | Replace | "so that the " by "0f a 4 to 20 milliampere " |
| 20 | 12 | Insert | "Primary Variable" |
| 20 | 13 | Replace | "20.0 milliamperes" by "the maximum value of " |
| 20 | 13 | Insert | "Primary Variable" |
| 20 | 17 | Replace | "20.0 milliamperes." by "the maximum value " |
| 20 | 25 | Replace | "CURR CURR" by "PV PV CURR CURR LEVEL LEVEL" |
| 20 | 31 | Replace | "Output Current 1" by "Primary Variable Current " |
| 20 | 41 | Replace | "CURR CURR" by "PV PV CURR CURR LEVEL LEVEL" |
| 20 | 47 | Replace | "Output Current," by "Primary Variable Current " |
| 22 | 2 | Insert | "PRIMARY VARIABLE" |
| 22 | 4 | Replace | "output" by "Primary Variable Analog output" |
| 22 | 10 | Insert | "PV" |
| 22 | 15 | Insert | "Primary Variable" |
| 22 | 25 | Insert | "PV" |
| 22 | 30 | Insert | "Primary Variable" |
| 23 | 5 | Replace | "Code Bytes." by "Codes." |
| 23 | 8 | Insert | "Transmitter-Specific" |
| 23 | 22 | Replace | '#24" by "95" |

| Page | Line | Change | Text |
|---|---|---|---|
| 23 | 23 | Insert | "XMTR XMTR SPEC SPEC" |
| 23 | 27 | Replace | "#0 #24" by "#0 #5 #7 OPER OPER MODE MODE # " |
| 24 | 2 | Replace | '#24 Additional " by "#5 Transmitter- " |
| 24 | 7 | Insert | "#24 Additional " by "#5 Transmitter" |
| 25 | 10 | Insert | "PV PV". |
| 25 | _6 | Insert | "Primary Variable" |
| 25 | 23 | Insert | "PV PV". |
| 25 | 29 | Insert | "Primary Variable" |
| 31 | 10 | Insert | "Code". |
| 31 | 11 | Insert | "Code" |
| 32 | 5 | Delete | "and" |
| 32 | 5 | Replace | "Value" by "Value, and Minimum Span". |
| 33 | 13 | Replace | "XMTR UPPER UPPER VAR " by XMTR XMTR XMTR " |
| 33 | 50 | Insert | "#17 #18 #19 #20 XMTR XMTR VAR VAR MIN MIN " |
| 34 | 10 | Replace | "Limits" by "Limit/Minimum Span" |
| 34 | 15 | Delete | "Upper" |
| 34 | 15 | Insert | "Upper" |
| 34 | 18 | Delete | "Lower" |
| 34 | 18 | Insert | "Lower" |
| 34 | 24 | Insert | "Data Byte #17 - #20 Transmitter Variable |
| 40 | 4 | Replace | "Writes" by "writes" |
| 42 | 4 | Insert | 'This is a Data Link Layer Management Command." |
| 43 | 2 | Insert | "COMMAND #60 READ ANALOG OUTPUT AND PERCENT OF " |
| 43 | 4 | Insert | "Read the Analog output Level and Percent of " |
| 45 | 2 | Insert | "COMMAND #61 READ DYMAMIC VARIABLES AND P. V." |
| 45 | 4 | Insert | "Read the Primary Variable Analog Output Level " |
| 45 | 13 | Replace | "DATA BYTES #0 BURST " by "NONE" |
| 45 | 18 | Insert | "#1 #2 #3 #4" |
| 45 | 19 | Replace | "BURST MODE SELECT " by "PV PV PV ANALOG " |
| 46 | 37 | Replace | "1 Undefined 2 " by "1 - 5 Undefined" |
| 46 | 43 | Replace | "7 In Write Protect Mode " by "7 Undefined 8 " |
| 46 | 46 | Replace | "8" by "9" |
| 47 | 2 | Insert | "COMMAND #62 READ ANALOG OUTPUTS" |
| 47 | 4 | Insert | "Read selected Analog Output Levels. Each slot " |
| 52 | 2 | Insert | "COMAND #63 READ ANALOG OUTPUT INFORMATION" |
| 52 | 4 | Insert | "Read the Alarm Selection Code, Transfer " |
| 55 | 2 | Insert | "COMMAND #64 WRITE ANALOG OUTPUT ADDITIONAL |
| 55 | 4 | Insert | "Write the Additional Damping Value for the " |
| 57 | 2 | Insert | "COMMAND #65 WRITE AMOG OUPUT RANGE VALUES" |
| 57 | 4 | Insert | "Write the Range Values for the selected " |
| 57 | 6 | Move | "The Upper Range Value is independent of the " from page 6 Line 4 |
| 57 | 8 | Replace | "Primary" by "Dynamic or Transmitter" |
| 57 | 24 | Delete | "#1 #2 #3 #4" |
| 57 | 25 | Insert | "ANALOG OUTPUT NUMBER CODE #1 #2 #3 #4 #5 ANALOG " |
| 59 | 42 | Replace | "17" by "29" |
| 60 | 2 | Insert | "COMMAND #66 ENTER/EX1T FIXED ANALOG OUTPUT MODE" |

| Page | Line | Change | Text |
|---|---|---|---|
| 60 | 4 | Insert | "The device is placed in the Fixed Analog " |
| 62 | 1 | Insert | "COMMAND #67 TRIM ANALOG OUTPUT ZERO" |
| 62 | 3 | Insert | "Trim the Zero of the selected Analog Output " |
| 64 | 2 | Insert | "COMMAND #68 TRIM ANALOG OUTPUT GAIN" |
| 64 | 4 | Insert | "'Trim the Gain of the selected Analog Output |
| 66 | 2 | Insert | "COMMAND #69 WRITE ANALOG OUTPUT TRANSFER " |
| 66 | 4 | Insert | "Select the Transfer Function for the selected " |
| 72 | 2 | Move | "CDMMAND #108 WRITE BURST MODE COMAND NUMBER" from page 41 line 2 |
| 72 | 2 | Insert | "40." |
| 72 | 4 | Insert | "This is a Data Link Layer Management Command." |
| 73 | 2 | Move | "COMMAND #109 BURST MODE CONTR0L This command " from page 42 line 2 |
| 73 | 2 | Insert | "41." |
| 73 | 5 | Replace | "response message" by "Response Data Bytes" |
| 73 | 9 | Insert | "REQUEST DATA BYTES DATA BYTES #0 BURST MODE " |
| 74 | 2 | Move | "COMMAND #110 READ ALL DYNAMIC VARIABLES Read " from page 43 line 2 |
| 74 | 2 | Insert | "42." |
| 76 | 2 | Move | "COMMAND #111 TRANSFER SERVICE CONTROL This is " from page 45 line 2 |
| 76 | 4 | Replace | "command" by "Command." |
| 76 | 2 | Insert | "43." |
| 76 | 12 | Insert | "#2 #31" |
| 76 | 33 | Insert | "OPT OPT" |
| 76 | 34 | Insert | "DATA DATA" |
| 76 | 35 | Insert | "BYTE BYTE" |
| 76 | 36 | Insert | "#0 #29" |
| 76 | 46 | Insert | "Data Byte #2 - #31 Optional Data as required " |
| 77 | 5 | Replace | "transmission (Slave/ " by "Transmission" |
| 77 | 6 | Insert | "(Slave/Host) [See Note]" |
| 77 | 11 | Insert | "17 - 29 Undefined 30 Warning: End of " |
| 78 | 2 | Move | "COMMAND #112 TRANSFER SERVICE This is a Data " from page 46 line 2 |
| 78 | 2 | Insert | "44" |
| 78 | 4 | Replace | "command." by "Command." |
| 70 | 13 | Replace | "transmission (Slave/ " by "Transmission" |
| 79 | 15 | Replace | "2 Control frame pending by "(Slave to Master) " |
| 79 | 22 | Insert | "17 - 29 Undefined 30 Warning: End of Transmission " |

## A4. Major Modifications from Rev. 5 to Rev. 6.0 - Final

1. A decimal point and integer was added to the HART document number.
2. This revision adds Burst Mode and Unit Device commands.
3. This revision also adds a command to write the Device Identification Number for Extended Frame Format and a command to select the Number of Response Preamble
4. Added Command #57, Read Unit Tag, Descriptor, Date.
5. Added Command #58, Write Unit Tag, Descriptor, Date.
6. Added Command #59, Write Number of Response Preamble
7. Added Command #108, Write Burst Mode Command Number.
8. Added Command #109, Burst Mode Control
9. Added Command #110, Read All Dynamic Variables.
10. Added Command #111, Transfer Service Control.
11. Added Command #112, Transfer Service.
12. Increased the maximum Command-Specific Response Code number from 15 to 127 for all commands
13. Moved Transmitter Fault from Command Error Summary Bit #4 to Command-Specific Response Code #16 and renamed it Access Restricted.
14. Changed Command-Specific Response Code #5 from Invalid Byte Count to Too Few Data Bytes Received and removed it from commands with no Request Data Bytes.
15. Changed most occurrences of "transmitter" to "device". (Refer to document Revision 6, D8900072, for detailed information).

## A5. Major Modifications from Rev. 4 to Rev. 5

1. This Revision incorporates Write Protect Mode and adds Transmitter Variable Commands

2. Added Command 50, Read Dynamic Variable Assignments.

3. Added Command #51, Write Dynamic Variable Assignments.

4. Added Command #5l, Set Transmitter Variable Zero.

5. Added Command #53, Write Transmitter Variable Units.

6. Added Command #54, Read Transmitter Variable Damping Value.

7. Added Command #55, Write Transmitter Variable Damping Value.

8. Added Command #56, Write Transmitter Variable Sensor Serial Number.

## A6. Major Modifications from Initial Rev. 3 to Rev. 4

1. This revision adds Update in Progress to Command #48 and adds a command to write the Transducer Serial Number.