



**PID Control Device Family  
Specification**

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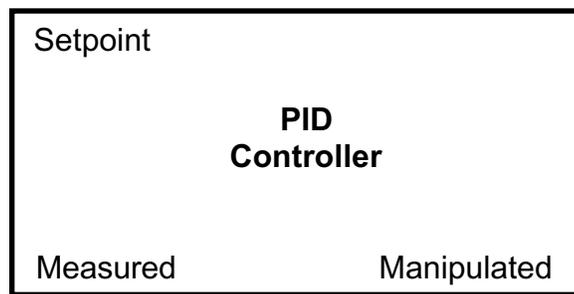
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## 1. SCOPE

This Device Family defines the mandatory and optional properties required to configure and operate a simple PID controller remotely in a HART field device. The PID Device Family contains all the properties necessary to perform closed loop control in the field. This Device Family does not support the Advanced PID Control functions necessary for Feed Forward, Cascade or Ratio Control.

The PID Control Device Family requires three Device Variables as shown in Figure 1. In many cases these may be connected to another Device Variable internal to the field device. However, all three of these Device Variables must exist as part of this Device Family. This allows for PID Device Family interoperability testing and allows any of the Device Variables to be mapped using [Command 51 Write Dynamic Variable Assignments](#).



**Figure 1. PID Device Variables**

This Device Family defines properties that:

- Configure the Controller operating modes (e.g., Auto/Manual, Direct/ Reverse Acting);
- Tune the Controller (e.g., Proportional Band, Integral, Derivative and, optionally, Derivative Gain, Output Bias, Error Deadband);
- Set Controller limits (e.g., Manipulated Variable Rate-of-Change, Setpoint Rate-of-Change, and, optionally, Setpoint and Manipulated Variable Limits); and
- Configure exception handling (e.g., Power-Up Mode and Setpoint, Failure Action and Output Level).

This is a partial list of the PID Device Family capabilities. The PID Device Family Commands should be reviewed to learn the full capabilities.

## 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

*Command Summary Specification*. HCF\_SPEC-99

*Device Families Command Specification*. HCF\_SPEC-160

*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

### 2.3 Related Documents

The following documents provide background information relevant to PID Control and this device family:

*Meeting Minutes, HART PID Working Group, 30 October 1991*

*Meeting Minutes, HART Technology Working Group, 18 June 1997*

*Proposed Proportional Integral Derivative Common Practice Commands, Smar Research Corp., 5 June 1991, Revision #1*

### 3. DEFINITIONS, ACRONYMS AND SYMBOLS

- Advanced control** This term refers to multiple-loop control strategies like cascade control, feed-forward control or ratio control. These control techniques require controller-to-controller communication, and most require a feedback loop to give better control and prevent side effects like primary controller integral windup. Most references to advanced control in this document imply masterless (control-in-the-field), multiple loop control techniques.
- Connected** The establishment of a data communication path between two Device Variables. This may be either an analog or a digital channel. This topic is discussed in the communication section below.
- Downstream** Data flow in the forward control direction, from the primary controller's measured process variable transmitter towards the loop's final output device.
- Upstream** Data flow in the feedback direction, from the final loop output device towards the primary transmitter.
- Measured** The *Measured* device variable reflects the controlled variable value input from the process sensor. The difference between this and the setpoint is the error value. The measured value is sometimes called PV. When the PID controller is located in a transmitter, this device variable will probably be connected internally to the sensor output.
- Manipulated** The *Manipulated* device variable is the output of the PID algorithm and transfers a new value to the downstream device setpoint. In order to meet the criteria of interfacing with non-HART devices, this data flow has no status other than the noticeable existence or non-existence. When the PID controller is located in a valve this device variable will probably be connected internally to the valve setpoint device variable.
- Setpoint** The user normally sets this input in a simple PID loop using a HART Master. This input is also known as the Cascade Input when used in an advanced, cascade controller configuration and is usually mapped to a caught variable or to a cyclic master in this configuration.

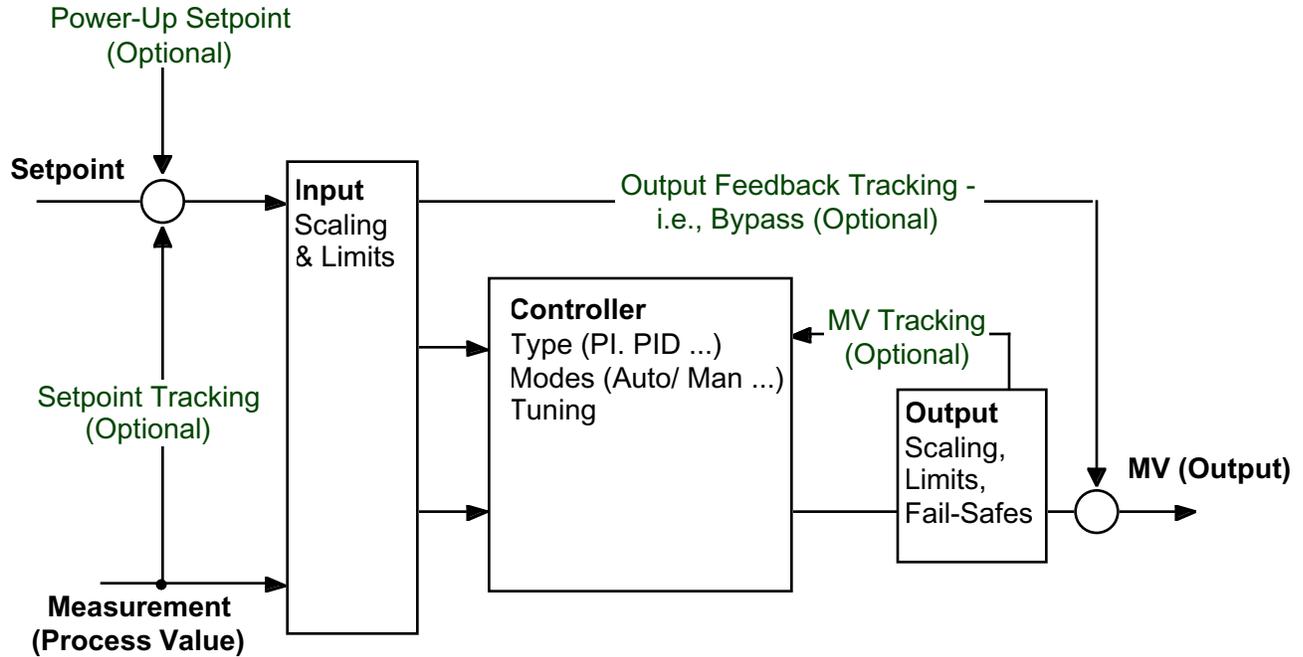
**Error** The PID working group has designated the Error variable as a Required Device Variable. It is normally used as a Device Attribute for diagnostics in stand-alone PID devices but may, possibly, be used in a master controlled balancing algorithm. Error is normally defined as the difference between the *Measured* and the *Setpoint* Device Variables inside the PID algorithm. Since this value may be derived from other Device Variables, it has minimal use external to the PID, and is potentially disruptive when written. This property is assumed to be read-only and not mentioned further.

#### 4. OVERVIEW

The PID Device Family supports simple three mode control in HART compatible field devices. In addition, the Device Family is designed to be compatible with the Actuator Device Family and normal HART conventions. Other objectives of the PID Device Family include:

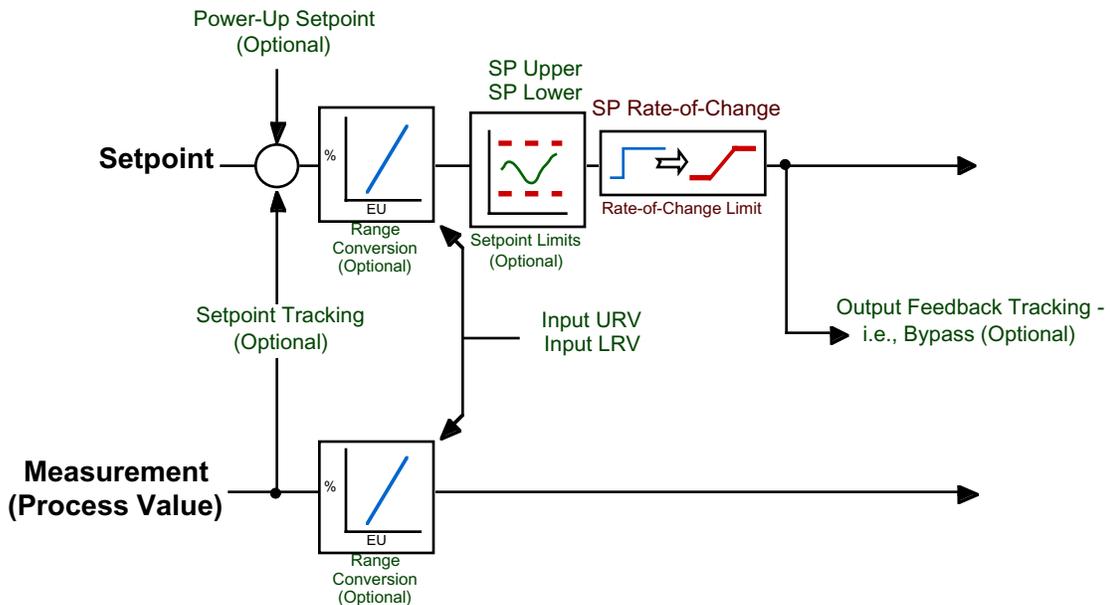
- The Controller must appear logically the same regardless whether it is physically located in an Actuator or a Transmitter.
- Wherever the PID is located, it must be able to adequately perform its control function when the other element (Transmitter or Positioner) is not a HART (or even a smart) 4-20mA device.
- The Device Family must not preclude Control-In-The-Field (i.e., a masterless control loop) or Advanced Control applications.
- Existing HART capabilities are used whenever possible (e.g. using Command 79 to write Device Variable values and Command 51 to map the PID Device Variables to the Primary Variable or another Dynamic Variable).
- This specification must be useful in multi-variable field devices whether loop or line powered; with one or more current loop connections; or containing any combination of measurement inputs and actuator outputs.
- In order to keep this Device Family as simple as possible, Advanced Control capabilities (e.g. cascade, feed-forward or ratio control) are deferred to the Advanced PID Control Device Family.

Figure 2 provides an block diagram of the PID Device Family. There are three major blocks in the PID Device Family: the input; the output; and the controller. Each of these sections contain mandatory and optional properties.



**Figure 2. PID Device Family Block Diagram**

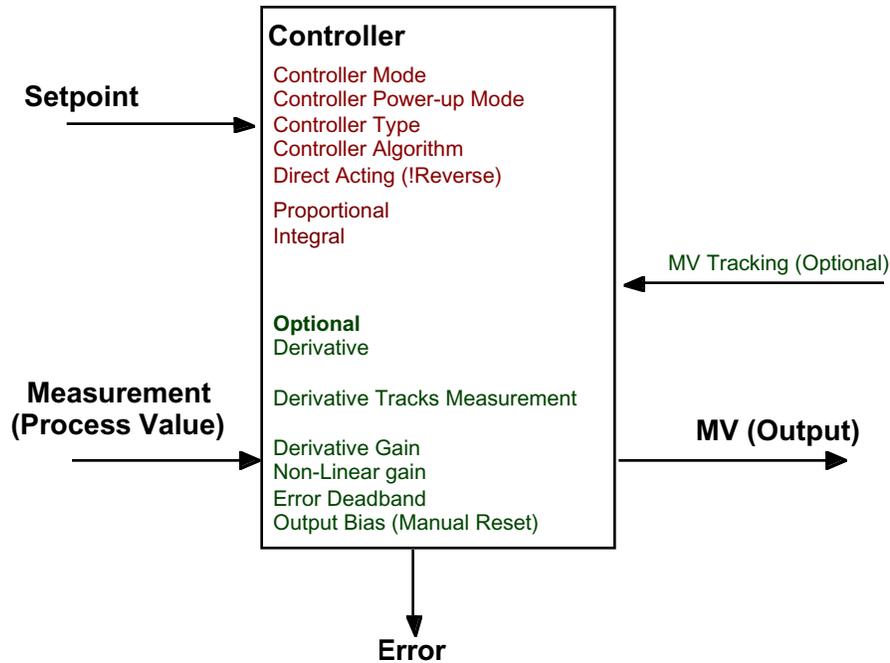
The input section is responsible for providing the Measurement and the Setpoint to the controller in units of percent. While some devices may perform the functions in a different order, Figure 3 shows the functions performed by the PID Input section. The property "Setpoint Rate-Of-Change Limit" is required while Setpoint limits and ranging are optional. For example, the Setpoint for a PID in a temperature transmitter is entered in Celsius but must be converted to percent for use by the Controller section. On the other hand, a setpoint for a valve may be received as a percent via the Loop Current and thus ranging would not be needed.



**Figure 3. Controller Input Preprocessing**

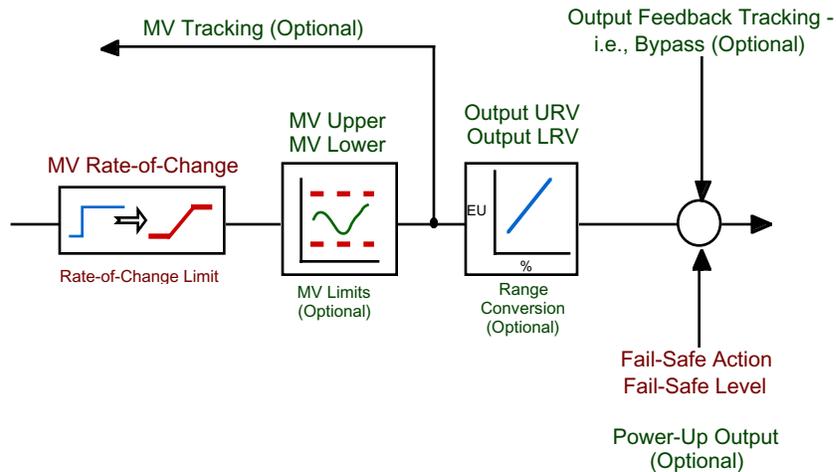
The controller's mandatory and optional properties are shown in Figure 4. All inputs (Setpoint, Measurement, Manipulated Variable Tracking) and Outputs (Error, Manipulated Variable) are in Percent. Normal properties like Mode (Auto/Manual) and PID Type (PID, PI) are required along with the Proportional, Integral and Derivative tuning constants. The Error value is calculated from the Setpoint and Measurement and is available for diagnostics. The Error calculation is controlled by the "Direct Acting" property. If this bit is reset (i.e., zero) then the controller is "Reverse Acting".

The controller also allows for optional properties that are useful in some applications such as whether the Derivative tracks the Error or Measurement values and Error Deadband.



**Figure 4. Controller Properties**

The Output section performs a similar process for the Manipulated Variable (see Figure 5) in that Rate-Of-Change and Manipulated Variable Upper and Lower Limits are supported as well as performing range conversion. The objective of Figure 5 is to show the processing steps, the actual order performed in a real device may vary. For example, the Manipulated Variable limits may be applied before applying the rate-of-change limit.



**Figure 5. Controller Output Processing**

### 4.1 Basic Operation

The PID is tuned by writing the proportional, integral and (optionally) derivative constants. The Setpoint is written by a host application using [Command 79 Write Device Variable](#). Once the controller is placed in Automatic, the Manipulated Variable is varied to control the Measurement to the Setpoint. While in Automatic, the host application needs only to monitor the process and display the process data to the user.

The Setpoint is generally written by the host application. However, the Measurement can be provided several ways: the Measurement could come from an internal source; be communicated to the field device via the Loop Current; or the Measurement could be acquired from periodic burst mode messages using [Command 113 Catch Device Variable](#).

The Manipulated Variable can be communicated using similar means: it could be provided to an internal destination to accomplish the control; or the Manipulated Variable can be mapped to the Primary Variable and signaled using the Loop Current.

#### 4.1.1 PID in Transmitters

In general, a transmitter will supply one of its measurements to the PID's Measurement input. This internal measurement source will need to be scaled from some physical engineering units to percent before it can be used by the Controller. The Manipulated Variable will be transmitted using the Loop Current to the control element.

Depending on the application, [Command 51 Write Dynamic Variable Assignments](#) can be used to map either a process measurement or the Manipulated Variable to the Primary Variable.

#### 4.1.2 PID in Actuators

In general, an actuator will receive the PID's Measurement input via the Loop Current, using the standard Primary Variable range commands to convert the Loop Current to a percent. The Setpoint can be written in percent by the host application and the Manipulated Variable can be used internally by the actuator.

### 4.2 Operating Modes

The PID Device Family defines three distinct modes of operation. These are **Disabled** (Off), **Manual** (Man), and **Automatic** (Auto).

- In the **Disabled** mode, the PID controller is not performing any calculations and not producing any status information from its inputs.
- In **Manual** mode, the host application controls the Manipulated Variable (either directly or via the Setpoint if Output Feedback Tracking is set).
- In **Automatic** mode, the controller's internal calculations, based on its inputs, modifies the Manipulated Variable and its status.

Three inputs may modify the operating mode of the controller: Setpoint status, Measurement status and Mode. When a Automatic Mode is requested, internal conditions may cause the write to fail. Example conditions that will prevent Automatic operation include:

- The Controller is in Fail-Safe;
- An input Device Variable has Bad status (see [Device Variable Status in the Command Summary Specification](#)); or
- If the Shed Time has elapsed (Note: Shed Time is an optional property);

### 4.3 Writing Setpoints & Manipulated Variable

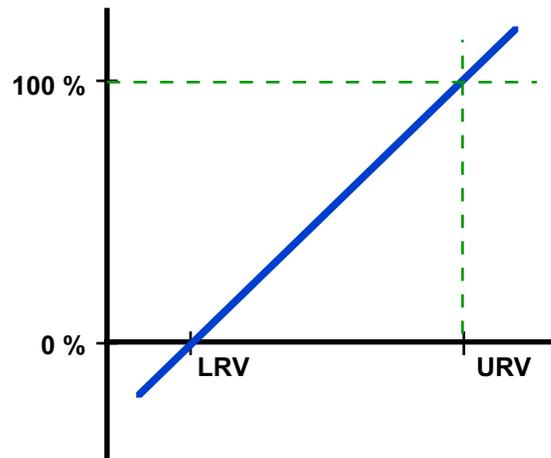
Common Practice [Command 79](#) Write Device Variable is used by host applications to write the Setpoint or manually control the Manipulated Variable. However, the PID's mode controls access to these Device Variables (see Table 1).

**Table 1. Affect of PID Modes on the Setpoint and Manipulated Variable**

Mode	Affect
PID in Auto	The PID is controlling the Manipulated Variable. The host cannot write directly to the Manipulated Variable.
PID in Manual and Setpoint Tracking Enabled	The Measurement is controlling the Setpoint. The host can write a Setpoint but, the Setpoint will be overwritten the next time the Measurement is updated.
PID in Manual and Output Feedback Tracking Enabled (i.e., Bypass)	The Setpoint is controlling the Manipulated Variable. The host cannot write directly to the Manipulated Variable.
PID in Manual and No Output Feedback Tracking	The Manipulated Variable output is held at the last value produced by the PID in Auto or the last value written by the host.
PID Disabled	The Manipulated Variable is set to 0x7F, 0xA0, 0x00, 0x00 and status is set to "Bad".

#### 4.4 Unit Codes and Scaling

All Device Variables have a Unit Code implicitly or explicitly associated with their value. As a result, the PID inputs and Outputs may need conversion to or from units of percent. The PID Device Family provides optional commands to perform this conversion. Figure 6 provides an example of how an engineering value is scaled into a percent. The Lower Range Value (LRV) sets the value corresponding to 0% and the Upper Range Value (URV) sets the 100% value.



**Figure 6. Conversion from an Engineering Value with Units to Percent**

This is similar to the technique used to scale the Primary Variable's percent range (see [Commands 2, 15 and 35](#)). One set of range values is supplied in the PID Device Family for the Setpoint and measurement inputs and another is supplied for the Manipulated Variable. Supporting the scaling functions is optional.

#### 4.5 Exception Handling

The PID Device Family contains several properties that can be configured by the host application for proper response to exceptions. These properties guide PID Device Family operation under abnormal conditions.

- **Fail Safe Operation.** Mandatory properties dictate Manipulated Variable response when an error condition occurs. This error condition could, for example, be caused by a device malfunction or receipt of a bad measurement.
- **Rate-of-Change Limits.** There are Rate-Of-Change limits on the Setpoint and Manipulated Variable. These prevent large sudden step changes that might adversely effect the process of equipment connected to the field device.
- **Limits.** There are optional properties to limit the Setpoint and Manipulated Variable values.
- **Power On Operation.** Optional properties may be supported to allow configuration of Power-up Setpoints and Manipulated Variable targets.

#### 4.5.1 Communications Support and Shed Time

Device Variables may be communicated in several ways:

- The Loop Current is used to signal one Device Variable either from (transmitter) or to (actuator) a device;
- [Burst mode](#) may be used to transmit up to 4 Device Variables (e.g., by send [Command 3](#), [9](#) or [33](#) responses);
- A Device Variable may be used within the same device (i.e., internally communicated);
- A host application may periodically write a Device Variable (e.g., using [Command 79](#)); and
- A Device Variable may be acquired by monitoring the digital communication as defined using [Command 113](#).

Since digital communications can be disrupted by burst noise on the link, an update to a Device Variable may occasionally be lost. This is generally resolved when the data is either re-transmitted or on the next update. However, there comes a point where the field device must assume that host has stopped functioning and take appropriate actions. The time between the last good message reception and the assumption of digital communication failure is called the Shed Time. Shed Time is an optional property that may be set to allow a loss of communication to be detected.

Shed Time and the shed time processing will vary from installation to installation and will be dependent on communication reliability and the criticality of the process involved.

## 5. STATUS

The PID Control has status included with each Device Variable and additional Controller Status included in [Command 1792](#).

Device Variables always have a status byte associated with them and PID Control Device Variables have three sets of status information: normal [Device Variable Status](#) (see the *Command Summary Specification*) and Controller Mode Status (see [Section 8.4](#)).

The PID Control Family Status provides additional diagnostic information useful for troubleshooting controller operation (See [Command 1792](#) and [Section 8.2](#)).

### 5.1 Limit Status

Two bits of limit status are provided in the Device Variable Status. In the PID Device Family this status is normally used to prevent integral windup or indicate a possible loss of control. However, it may also signal a fault condition in the controller (e.g., Fail-Safe).

- **Upper Limited** status means that an increase in the value of the controlled device's setpoint will not affect the process. In addition, the Device Variable's value is not expected to increase above its current value.
- **Lower Limited** status means that a decrease in the value of the controlled device's setpoint will not affect the process. In addition, the Device Variable's value is not expected to decrease below its current value.
- **Fixed** status indicates a condition inside the controller that prevents the Device Variable from changing.

A mode of manual inside the controlled device would not show a Both Limit since the user could change the settings at any time. A mode of Fail-Safe inside the controlled device should show a Both Limit since the condition is frozen until the user intervenes.

## 5.2 Setpoint and Measured Status

The Device Variable mapped to the Setpoint or Measured PID Control input may have associated status information depending on the source of the Setpoint.

**Digital Source.** If the input is written digitally then the normal Device Variable Status is included (e.g., when a Host uses [Command 79](#)). If supported, Shed Time can elapse and affect status as well.

**Analog Source.** If the input is captured via a 4-20mA input then a simple good or bad status indication can be based on the 4-20mA value. For example, most 4-20mA sources can indicate an alarm condition by setting the 4-20mA signal to be significantly greater than 20mA (e.g., 22mA).

**Internal Source.** The input may be generated inside the Field Device itself (e.g., from the measurement in a transmitter). In this case the normal Device Variable Status is included.

The status of the Setpoint or Measured affects controller operation and the associated Device Variable Status. First, whenever the Setpoint or Measured Device Variable is read (e.g., with [Command 9](#) or [1794](#)) the good or bad status must be indicated. Second, if a bad status is detected for either the Setpoint or Measured input, then the controller will switch to manual and the Manipulated Variable will go into Fail-Safe.

The Limit Status bits for the Setpoint and Measured Device Variables are normally zero. Controller Mode Status is not defined for the Setpoint and Measured Device Variables.

## 5.3 Manipulated Variable

The Manipulated Variable status reflects the operation of the controller. Device Variable Status, Controller Mode Status, and Limit Status are all used for this purpose. In addition to the normal operation of this status several combinations have special significance (see Table 2).

**Table 2. Manipulated Variable Status Combinations**

Device Variable Status	Limit Status	Description
"Good"	"Not Limited"	PID Control is operating normally in automatic.
"Manual/Fixed"	"Not Limited"	PID Control is in Manual
"Manual/Fixed"	"Fixed"	PID Control is in Fail-Safe

The Manipulated Variable's status (including Limit Status) is returned as the PID Control Family Device Variable Status in [Command 1792](#).

## 6. MANDATORY COMMANDS

### 6.1 Command 1792 Read PID Status (Mandatory)

All Device Families allow additional status information to be provided to host applications. This Device Family Status is in addition to the Device Variable Status information provided with all Device Variables and Dynamic Variables.

#### 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
1	Bits	PID Control Device Variable Status (See <a href="#">Section 8.1</a> )
2	Bits	PID Control Family Status 0 (See <a href="#">Section 8.2</a> )
3	Bits	PID Control Family Status 1 (See <a href="#">Section 8.3</a> )

#### 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
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.
20-127		Undefined

## 6.2 Command 1793 Read PID Variable Map (Mandatory)

This command allows the Device Variable codes for all three PID Device Family Device Variables. In other words, this command allows a Host to identify all of the PID Device Variables if it knows any one of them.

Note: All three PID Device Variables return the PID Device Family code.

### 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
1	Unsigned-8	Setpoint Device Variable Code
2	Unsigned-8	Measurement Device Variable Code
3	Unsigned-8	Manipulated Variable Code

### 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
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.
20-127		Undefined

### 6.3 Command 1794 Read PID Variables (Mandatory)

Returns the three PID Device Variables and the Error value calculated by the PID Controller. The Error value is returned for diagnostic purposes.

Note: The Setpoint, Measurement and Error values are all returned in PID Input Units. The simplest PID controllers may only support units of Percent. The Manipulated Variable is returned in PID output 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
1	Enum	PID Input Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Setpoint Value
6	Bits	Setpoint Status
7-10	Float	Measurement Value
11	Bits	Measurement Status
12-15	Float	Error
16	Bits	Error Status
17	Enum	PID Output Units (refer to <i>Common Tables Specification</i> )
18-21	Float	Manipulated Variable (MV) - The controller's output signal
22	Bits	MV Status

Note: When the PID is disabled, the Manipulated Variable and Error must be set to 0x7F, 0xA0, 0x00, 0x00 and their status set to "Bad".

### 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
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.
20-127		Undefined

## 6.4 Command 1795 Read Controller Configuration (Mandatory)

Reads the basic controller configuration including: Controller Mode; Power-Up Mode; Controller Type and Algorithm; and Control Action (Forward/Reverse).

In most cases the Controller’s Measurement Device Variable is connected to an internal Device Variable. This measurement source is indicated in response data byte 2. For simple field devices this connection will always be hard-coded to a single measurement Device Variable. When the Measurement is connected to an internal Device Variable, and [Command 79 Write Device Variable](#) is used to force the PID’s Measurement, the internally connected sourcing Device Variable is also forced.

### 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
1.7-1.6	Enum	(Most Significant 2 Bits) Controller Mode (see <a href="#">Section 8.5</a> )
1.5	Bits	(Bit 5) Direct Acting Control (i.e., Error = Measurement minus Setpoint). If this bit is reset then the Controller is Reverse Acting.
1.4	Bits	Goto to Fail-Safe Level on failure. If this bit is reset then the last good output will be held on failure.
1.3-1.2	Enum	Power-up Controller Mode (see <a href="#">Section 8.6</a> )
1.1	Bits	Auto-Tune Enabled. If Controller does not have Auto-Tune Capability this bit is always reset.
1.0	Bits	(Least Significant Bit) Reserved
2	Unsigned-8	Internal Measurement Source Device Variable Code (250 - Not Used)
3	Enum	Controller Type (see <a href="#">Section 8.7</a> )
4	Enum	Controller Algorithm (see <a href="#">Section 8.8</a> )

### 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
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.
20-127		Undefined

## 6.5 Command 1796 Read PID Tuning Constants (Mandatory)

Reads the current PID tuning constants including:

- Proportional Band ( $K_c$ );
- Integral ( $T_i$ ) in Repeats/Minute; and
- Derivative ( $T_d$ ) in Minutes.

The Proportional Band may be written in Controller Input Units or Percent. If written in Percent, the Input Scaling function (see [Section 4](#)) is bypassed. For units not supporting an Input Scaling function the proportional band must always be written in Percent.

### 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
1	Enum	Controller Input Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Proportional Band ( $K_c$ )
6-9	Float	Integral Time in Repeats/Minute ( $T_i$ )
10-12	Float	Derivative Time in Minutes ( $T_d$ )

### 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
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.
20-127		Undefined

## 6.6 Command 1797 Read Primary PID Limits (Mandatory)

Reads the basic Controller Limits including: Manipulated Variable Rate-of-Change; Setpoint Rate-of-Change; and Fail Safe Output Level.

The Manipulated Variable Rate-of-Change Limit is used in Manual mode to prevent "slamming" by writing large changes to the Manipulated Variable. When large change is written to the Manipulated Variable, the controller moves the Manipulated Variable toward the new value at this limited rate.

Similarly, the Setpoint Rate-of-Change Limit is used when the controller is in Auto and a new Setpoint is written to the Controller. When a large Setpoint change is made, the controller moves the PID Setpoint toward the new value at this limited rate.

### 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
1	Enum	Controller Input Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Setpoint Rate-of-Change Limit (Input units per second)
6	Enum	Controller Output Units (refer to <i>Common Tables Specification</i> )
7-10	Float	Fail-Safe Output Level
11-14	Float	Manipulated Variable Rate-of-Change Limit ( Output units per second)

### 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
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.
20-127		Undefined

## 6.7 Command 1920 Write Controller Mode (Mandatory)

Write the Controller modes. Not all field devices support Auto-Tune mode.

### Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code (see Device Variable Codes Table in appropriate device-specific document)
1.7-1.6	Enum	(Most Significant 2 Bits) Controller Mode (see <a href="#">Section 8.5</a> )
1.5	Bits	(Bit 5) Direct Acting Control (i.e., Error = Measurement minus Setpoint). If this bit is reset then the Controller is Reverse Acting.
1.4	Bits	Goto to Fail-Safe Level on failure. If this bit is reset, then the last good output will be held on failure.
1.3-1.2	Enum	Power-up Controller Mode (see <a href="#">Section 8.6</a> )
1.1	Bits	Auto-Tune Enabled. If Controller does not have Auto-Tune Capability this bit is always reset.
1.0	Bits	(Least Significant Bit) Reserved

Note: The Direct Acting Control may only be changed when the Controller is Disabled or in Manual

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1.7-1.6	Enum	(Most Significant 2 Bits) Controller Mode (see <a href="#">Section 8.5</a> )
1.5	Bits	(Bit 5) Direct Acting Control (i.e., Error = Measurement minus Setpoint). If this bit is reset then the Controller is Reverse Acting.
1.4	Bits	Goto to Fail-Safe Level on failure. If this bit is reset then the last good output will be held on failure.
1.3-1.2	Enum	Power-up Controller Mode (see <a href="#">Section 8.6</a> )
1.1	Bits	Auto-Tune Enabled. If Controller does not have Auto-Tune Capability this bit is always reset.
1.0	Bits	(Least Significant Bit) Reserved

### 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	Auto-Tune not enabled (Auto-Tune not supported).
9	Error	Auto-Balancing mode not supported
10	Error	Cannot change Controller Mode (e.g., due to a bad input Device Variable)
11-15		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

## 6.8 Command 1921 Write Proportional (Mandatory)

Writes Proportional Band. The Proportional Band will be returned in the same units as received.

The Proportional Band Units received with this command do not affect the Controller Inputs Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Setpoint Device Variable Units will change the Controller Input Units. [Command 44](#), Write Primary Variable Units may also have this affect if the Setpoint is connected internally 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	Proportional Band Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Proportional Band ( $K_c$ )

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Proportional Band Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Proportional Band ( $K_c$ )

### 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	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

## 6.9 Command 1922 Write Integral (Mandatory)

Write Integral constant in Repeats per Minute.

### 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	Integral Time in Repeats/Minute ( $T_i$ )

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1-4	Float	Integral Time in Repeats/Minute ( $T_i$ )

### 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	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

### 6.10 Command 1923 Write Manipulated Variable Rate of Change (Mandatory)

Writes Manipulated Variable Rate-of-Change Limit in the specified units (per second). The Manipulated Variable Rate-of-Change Limit will be returned in the same units as received

The Manipulated Variable Units received with this command do not affect the Controller Output Units used by the field device. Only using [Command 53 Write Device Variable Units](#) to change Manipulated Device Variable Units will change the Controller Output Units. [Command 44 Write Primary Variable Units](#) may also have this affect if the Manipulated Variable is connected internally 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	Manipulated Variable Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Manipulated Variable Rate of Change Limit ( Manipulated Variable Units per second)

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Controller Output Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Manipulated Variable Rate of Change Limit ( Output units per second)

### 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	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

### 6.11 Command 1924 Write Setpoint Rate of Change (Mandatory)

Writes Setpoint Rate-of-Change Limit in the specified units (per second). The Setpoint Rate-of-Change Limit will be returned in the same units as received.

The Setpoint Units received with this command do not affect the Controller Inputs Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Setpoint Device Variable units will change the Controller Input Units. [Command 44](#), Write Primary Variable Units may also have this affect if the Setpoint is connected internally 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	Setpoint Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Setpoint Rate-of-Change Limit (Setpoint units per second)

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Setpoint Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Setpoint Rate-of-Change Limit (Setpoint units per second)

### 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	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

### 6.12 Command 1925 Write Fail Safe Output Level (Mandatory)

Writes Fail-Safe Output Level in the specified units (per second). The Fail-Safe Output Level will be returned in the same units as received.

The Fail-Safe Units received with this command do not affect the Controller Output Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Manipulated Device Variable Units will change the Controller Output Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Manipulated Variable is connected internally 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	Fail-Safe Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Fail-Safe Output Level

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Fail-Safe Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Fail-Safe Output Level

### 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	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. OPTIONAL COMMANDS

### 7.1 Command 1798 Read Shed Time (Optional)

Shed Time sets the maximum time between successive digital updates to the Setpoint or Measurement. If Shed Time is exceeded, the device must consider communications to be lost and take the appropriate actions (e.g., perform the specified Fail-Safe actions).

#### 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
1	Enum	Shed Timing Enabled
2-5	Float	Shed Time in seconds.

#### 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
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.
20-127		Undefined

## 7.2 Command 1799 Read Setpoint Source (Optional)

On more sophisticated field devices the Setpoint can be connected to an internal Device Variable (e.g., a ramp and soak generator). This command reads this internal connection.

### 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
1	Unsigned-8	Setpoint Internal Source Device Variable Code (see Device Variable Codes Table in appropriate device-specific document)

Note: When the Setpoint is not connected to an internal Device Variable, the Internal Source Device Variable Code must be set to "250", Not Used.

### 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
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.
20-127		Undefined

### 7.3 Command 1800 Read Input Range Values (Optional)

This command reads the scaling used to convert the Controller inputs into percent range needed by the PID Algorithm. Simple Controllers may only support engineering units of Percent, but more capable Controllers support scaling of the Setpoint and Measurement.

#### 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
1	Enum	Controller Input Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Controller Input Upper Range Value (URV)
6-9	Float	Controller Input Lower Range Value (LRV)

#### 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
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.
20-127		Undefined



### 7.4 Command 1801 Read Output Range Values (Optional)

This command reads the scaling used to convert the Manipulated Variable from the Percent units as output by the PID Algorithm to another engineering scale. A field device may only support outputting the Manipulated Variable in engineering units of Percent. However, more capable controllers allow the Manipulated Variable to be scaled into engineering units (e.g., to provide a Setpoint to another Controller).

#### 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
1	Enum	Controller Output Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Manipulated Variable Output Upper Range Value (URV)
6-9	Float	Manipulated Variable Lower Range Value (LRV)

### 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
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.
20-127		Undefined

### 7.5 Command 1802 Read Controller’s Secondary Settings (Optional)

If supported by the field device, this command reads additional Controller properties, like Setpoint Tracking and Derivative Mode.

#### 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
1.7	Bits	(Most significant bit) Setpoint Tracking. When this bit is set, the Setpoint will be initialized to the Measured Device Variable when changing from Manual to Auto.
1.6	Bits	(Bit 6) Derivative Tracks Measurement. If this bit is reset, the derivative track the Error value.
1.5	Bits	(Bit 5) Output Feedback Tracking (Bypass). When this bit is set, the Manipulated Variable tracks the Setpoint when the Controller is in both Manual and Auto.
1.4	Enum	Manipulated Variable Tracking. When set, the PID tracks the Manipulated Variable when the Controller is in Manual to allow a bumpless transfer from Auto to Manual.
1.3-1.0	Bits	Reserved

Note: When Setpoint Tracking is set, any Setpoint written to the Controller will be overwritten when switching from Manual to Auto.

### 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
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.
20-127		Undefined

## 7.6 Command 1803 Read Additional PID Tuning Constants (Optional)

Reads the secondary tuning constants.

### 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
1	Enum	Controller Input Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Error Deadband. Any Error magnitude less than this value is treated as a zero Error value by the Controller
6	Enum	Non-Linear Gain Units (refer to <i>Common Tables Specification</i> )
7-10	Float	Non-Linear Gain. Amplifies the PID (Proportional Band) as the Error magnitude increases.
11	Enum	Controller Output Units (refer to <i>Common Tables Specification</i> )
12-15	Float	Output Bias (Manual Reset)
16	Enum	Derivative Gain Units (refer to <i>Common Tables Specification</i> )
17-20	Float	Derivative Gain (i.e. DG or 1/Alpha) Limits the Derivative term's contribution to the PID output. In other words, this limits "Derivative Kick".

### 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
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.
20-127		Undefined

## 7.7 Command 1804 Read Secondary PID Limits (Optional)

Reads the Manipulated Variable and Setpoint Limits. Reaching any of the limits will cause the corresponding High or Low Limit status bit to be set.

### 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
1	Enum	Controller Input Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Setpoint High Limit
6-9	Float	Setpoint Low Limit
10	Enum	Controller Output Units (refer to <i>Common Tables Specification</i> )
11-14	Float	Manipulated Variable High Limit
15-18	Float	Manipulated Variable Low Limit

### 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
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.
20-127		Undefined

## 7.8 Command 1805 Read Power-Up Values (Optional)

In some applications it is important for the controller to have special settings to use while the field device is powering up. This command allows these properties to be read.

### 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
1	Enum	Use Power-Up Setpoint (see <a href="#">Section 8.9</a> )
2	Enum	Controller Input Units (refer to <a href="#">Common Tables Specification</a> )
3-6	Float	Power-Up Setpoint Sets the value of the Setpoint used immediately after Power-Up.
7	Enum	Use Power-Up Output Level (see <a href="#">Section 8.9</a> )
8	Enum	Controller Output Units (refer to <a href="#">Common Tables Specification</a> )
9-10	Float	Power-Up Output Level. Specifies the Manipulated Variable value used immediately after Power-Up.

### 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
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.
20-127		Undefined

## 7.9 Command 1926 Write Derivative (Optional)

Writes Derivative constant in units of Minutes.

### 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	Derivative Time in Minutes ( $T_d$ )

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1-4	Float	Derivative Time in Minutes ( $T_d$ )

### 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	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

### 7.10 Command 1927 Write Shed Time (Optional)

Shed Time sets the maximum time between successive digital updates to the Setpoint or Measurement. If Shed Time is exceeded, the device must consider communications to be lost and take the appropriate actions (e.g., perform the specified Fail-Safe actions).

#### Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code (see Device Variable Codes Table in appropriate device-specific document)
1	Enum	Shed Timing Enabled
2-5	Float	Shed Time in seconds

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Shed Timing Enabled
2-5	Float	Shed Time in seconds.

### 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	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

### 7.11 Command 1928 Perform Auto-Tune (Optional)

Automatic Controller tuning is should be performed by only observing the process. In other words tuning should be performed by monitoring the process reaction to normal changes to the Controller output. This reduces the risk of upsetting the process as the result of tuning.

However, some automatic tuning algorithms are implemented by bumping the process and analyzing the resulting response. This command supports such algorithms.

This command uses the Delayed Response to indicate when the tuning is complete. As a result, the procedure for using this command consists of:

1. The Controller must be in Automatic and the process stable.
2. This command is issued and the "DR\_INITIATE" response is generated by the field device
3. This Command is then re-issued to monitor completion of the automatic tuning cycle. While the cycle is in process, the field device returns "DR\_RUNNING".
4. Once the cycle is complete, the field device returns "Success" or another valid response code indicating the results of the automatic tuning cycle.

Generally, if the process bump caused by this type of automatic tuning cycle has an adverse effect on the process, the Controller must be switched to Manual operation. As a result, if the automatic tuning cycle must be canceled for any reason then the Controller must be placed into Manual.

#### 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

### 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	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

### 7.12 Command 1929 Write Measurement Source (Optional)

Allows the internal connection to be specified for the Controller's Measurement Device Variable.

#### Request Data Bytes

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

Note: When the Measurement is not connected to an internal Device Variable (e.g. acquired digitally using Command 113 Catch Device Variable), the Internal Source Device Variable Code must be set to "250", Not Used.

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Unsigned-8	Setpoint Internal Source Device Variable Code

### 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	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

### 7.13 Command 1930 Write Setpoint Source (Optional)

Allows the Setpoint source Device Variable to be specified.

#### Request Data Bytes

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

Note: When the Setpoint is not connected to an internal Device Variable, the Internal Source Device Variable Code must be set to "250", Not Used.

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Unsigned-8	Setpoint Internal Source Device Variable Code

### 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	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

### 7.14 Command 1931 Write Input Range (Optional)

This command writes the scaling used to convert Controller inputs into percent range needed by the PID Algorithm. Simple Controllers may only support engineering units of Percent, but more capable Controllers support scaling of the Setpoint and Measurement.

The Controller Input Units received with this command do not affect the Controller Inputs Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Setpoint Device Variable Units will change the Controller Input Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Setpoint is connected internally 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	Controller Input Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Controller Input Upper Range Value (URV)
6-9	Float	Controller Input Lower Range Value (LRV)

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Controller Input Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Controller Input Upper Range Value (URV)
6-9	Float	Controller Input Lower Range Value (LRV)

### 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 (High or Low Limit Pushed)
9	Error	Controller Input Lower Range Value Too High
10	Error	Controller Input Lower Range Value Too Low
11	Error	Controller Input Upper Range Value Too High
12	Error	Controller Input Upper Range Value Too Low
13	Error	Controller Input Upper and Lower Range Too High or Low
14	Warning	Range Values Too Wide or Narrow (Control Function May Be Impaired)
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 - 28		Undefined
29	Error	Range Values Too Wide or Narrow
30 - 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

### 7.15 Command 1932 Write Output Range Values (Optional)

This command writes the scaling used to convert the Manipulated Variable from the Percent units as output by the PID Algorithm to another engineering scale. A field device may only support outputting the Manipulated Variable in engineering units of Percent. However, more capable controllers allow the Manipulated Variable to be scaled into engineering units (e.g., to provide a Setpoint to another Controller).

The Controller Output Units received with this command do not affect the Controller Output Units used by the field device. Only using Command 53, Write Device Variable Units to change Manipulated Device Variable Units will change the Controller Output Units. Command 44, Write Primary Variable Units may also have this effect if the Manipulated Variable is connected internally 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	Controller Output Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Manipulated Variable Output Upper Range Value (URV)
6-9	Float	Manipulated Variable Lower Range Value (LRV)

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Controller Output Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Manipulated Variable Output Upper Range Value (URV)
6-9	Float	Manipulated Variable Lower Range Value (LRV)

### 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 (High or Low Limit Pushed)
9	Error	Manipulated Variable Lower Range Value Too High
10	Error	Manipulated Variable Lower Range Value Too Low
11	Error	Manipulated Variable Upper Range Value Too High
12	Error	Manipulated Variable Upper Range Value Too Low
13	Error	Manipulated Variable Upper and Lower Range Too High or Low
14	Warning	Range Values Too Wide or Narrow (Control Function May Be Impaired)
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 - 28		Undefined
29	Error	Range Values Too Wide or Narrow
30 - 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

## 7.16 Command 1933 Write Controller Type (Optional)

Writes the Controller Type.

### Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code (see Device Variable Codes Table in appropriate device-specific document)
1	Enum	Controller Type (see <a href="#">Section 8.7</a> )

Note: The Controller Type may only be changed when the Controller is Disabled or in Manual

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Controller Type (see <a href="#">Section 8.7</a> )

### 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	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

### 7.17 Command 1934 Select Controller Algorithm (Optional)

Selects the Controller Algorithm.

#### Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code (see Device Variable Codes Table in appropriate device-specific document)
1	Enum	Controller Algorithm (see <a href="#">Section 8.8</a> )

Note: The Controller Algorithm may only be changed when the Controller is Disabled or in Manual

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Controller Algorithm (see <a href="#">Section 8.8</a> )

### 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	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

## 7.18 Command 1935 Write Controller’s Secondary Settings (Optional)

Writes the Controller’s auxiliary settings.

### Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code (see Device Variable Codes Table in appropriate device-specific document)
1.7	Bits	(Most significant bit) Setpoint Tracking. When this bit is set, the Setpoint will be initialized to the Measured Device Variable when changing from Manual to Auto.
1.6	Bits	(Bit 6) Derivative Tracks Measurement. If this bit is reset, the derivative track the Error value.
1.5	Bits	Output Feedback Tracking (Bypass). When this bit is set, the Manipulated Variable tracks the Setpoint when the Controller is in both Manual and Auto.
1.4	Enum	Manipulated Variable Tracking. When set, the PID tracks the Manipulated Variable when the Controller is in Manual to allow a bumpless transfer from Auto to Manual.
1.3-1.0	Bits	Reserved

Note 1: When Setpoint Tracking is set, any Setpoint written to the Controller will be overwritten when switching from Manual to Auto.

Note 2: Output Feedback Tracking may only be changed when the Controller is Disabled or in Manual.

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1.7	Bits	(Most significant bit) Setpoint Tracking. When this bit is set, the Setpoint will be initialized to the Measured Device Variable when changing from Manual to Auto.
1.6	Bits	(Bit 6) Derivative Tracks Measurement. If this bit is reset, the derivative track the Error value.
1.5	Bits	Output Feedback Tracking (Bypass). When this bit is set, the Manipulated Variable tracks the Setpoint when the Controller is in both Manual and Auto.

Byte	Format	Description
1.4	Enum	Manipulated Variable Tracking. When set the PID tracks the Manipulated Variable when the Controller is in Manual to allow a bumpless transfer from Auto to Manual.
1.3-1.0	Bits	Reserved

### 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	Feature not supported. Bit Reset.
9-15		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

### 7.19 Command 1936 Write Output Bias (Optional)

Writes Output Bias in the specified units. The Output Bias will be returned in the same units as received.

The Output Bias Units received with this command do not affect the Controller Output Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Manipulated Device Variable Units will change the Controller Output Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Manipulated Variable is connected internally 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	Output Bias Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Output Bias (Manual Reset)

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Output Bias Units
2-5	Float	Output Bias

### 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	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

## 7.20 Command 1937 Write Error Deadband (Optional)

Writes Error Deadband in the specified units. The Error Deadband will be returned in the same units as received.

The Error Deadband Units received with this command do not affect the Controller Inputs Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Setpoint Device Variable units will change the Controller Input Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Setpoint is connected internally 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	Error Deadband Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Error Deadband. Any Error magnitude less than this value is treated as a zero Error value by the Controller.

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Error Deadband Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Error Deadband. Any Error magnitude less than this value is treated as a zero Error value by the Controller.

### 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	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

### 7.21 Command 1938 Write Non-Linear Gain (Optional)

Writes Non-Linear Gain in the specified units. The Non-Linear Gain 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	Non-Linear Gain Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Non-Linear Gain. Amplifies the PID (Proportional Band) as the Error magnitude increases.

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Non-Linear Gain Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Non-Linear Gain. Amplifies the PID (Proportional Band) as the Error magnitude increases.

### 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	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

## 7.22 Command 1939 Write Derivative Gain (Optional)

Writes Derivative Gain in the specified units. The Derivative Gain 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	Derivative Gain Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Derivative Gain (i.e. DG or 1/Alpha) Limits the Derivative term's contribution to the PID output. In other words, this limits "Derivative Kick".

### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Derivative Gain Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Derivative Gain (i.e. DG or 1/Alpha) Limits the Derivative term's contribution to the PID output. In other words, this limits "Derivative Kick".

### 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
9-14		Undefined
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 - 231		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

### 7.23 Command 1940 Write Manipulated Variable Limits (Optional)

Writes Manipulated Variable Limits in the specified units (per second). The Manipulated Variable Limits will be returned in the same units as received.

The Manipulated Variable Units received with this command do not effect the Controller Output Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Manipulated Device Variable Units will change the Controller Output Units. [Command 44](#), Write Primary Variable Units may also have this affect if the Manipulated Variable is connected internally 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	Manipulated Variable Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Manipulated Variable High Limit
6-9	Float	Manipulated Variable Low Limit

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Manipulated Variable Units (refer to <a href="#">Common Tables Specification</a> )
2-5	Float	Manipulated Variable High Limit
6-9	Float	Manipulated Variable Low Limit

### 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 (High or Low Limit Pushed)
9	Error	Manipulated Variable Low Limit Value Too High
10	Error	Manipulated Variable Low Limit Value Too Low
11	Error	Manipulated Variable High Limit Value Too High
12	Error	Manipulated Variable High Limit Value Too Low
13	Error	Manipulated Variable High and Low Limit Too High or Low
14	Warning	Limits Too Wide or Narrow (Control Function May Be Impaired)
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 - 28		Undefined
29	Error	Limits to Wide or Narrow
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

### 7.24 Command 1941 Write Setpoint Limits (Optional)

Writes Setpoint Limits in the specified units (per second). The Setpoint Limits will be returned in the same units as received.

The Setpoint Units received with this command do not affect the Controller Inputs Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Setpoint Device Variable units will change the Controller Input Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Setpoint is connected internally 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	Setpoint Units (refer to <i>Common Tables Specification</i> )
2-5	Float	Setpoint High Limit
6-9	Float	Setpoint Low Limit

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Setpoint Units
2-5	Float	Setpoint High Limit
6-9	Float	Setpoint Low Limit

### 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 (High or Low Limit Pushed)
9	Error	Setpoint Low Limit Value Too High
10	Error	Setpoint Low Limit Value Too Low
11	Error	Setpoint High Limit Value Too High
12	Error	Setpoint High Limit Value Too Low
13	Error	Setpoint High and Low Limit Too High or Low
14	Warning	Limits Too Wide or Narrow (Control Function May Be Impaired)
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 - 28		Undefined
29	Error	Limits too Wide or Narrow
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

### 7.25 Command 1942 Write Power-Up Setpoint (Optional)

Writes Power-Up Setpoint in the specified units (per second). The Power-Up Setpoint will be returned in the same units as received.

The Setpoint Units received with this command do not affect the Controller Inputs Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Setpoint Device Variable units will change the Controller Input Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Setpoint is connected internally 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	Use Power-Up Setpoint (see <a href="#">Section 8.9</a> )
2	Enum	Setpoint Units (refer to <a href="#">Common Tables Specification</a> )
3-6	Float	Power-Up Setpoint

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Use Power-Up Setpoint (see <a href="#">Section 8.9</a> )
2	Enum	Setpoint Units
3-6	Float	Power-Up Setpoint

### 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	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

### 7.26 Command 1943 Write Power-Up Output Level (Optional)

Writes Power-Up Output Level in the specified units (per second). The Power-Up Level will be returned in the same units as received.

The Output Units received with this command do not affect the Controller Output Units used by the field device. Only using [Command 53](#), Write Device Variable Units to change Manipulated Device Variable Units will change the Controller Output Units. [Command 44](#), Write Primary Variable Units may also have this effect if the Manipulated Variable is connected internally 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	Use Power-Up Output Level (see <a href="#">Section 8.9</a> )
2	Enum	Output Units (refer to <a href="#">Common Tables Specification</a> )
3-6	Float	Power-Up Output Level

#### Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Device Variable Code
1	Enum	Use Power-Up Output Level (see <a href="#">Section 8.9</a> )
2	Enum	Controller Output Units (refer to <a href="#">Common Tables Specification</a> )
3-6	Float	Power-Up Output Level

### 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	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

## 8. TABLES

### 8.1 Table 1. PID Control Family Device Variable Status

Code	Measurement
0xC0	Data Quality (See <a href="#">Command Summary Specification</a> )
0x30	Limit Status (See <a href="#">Command Summary Specification</a> and <a href="#">Section 5.1</a> )
0x08	More Device Family Status Available
0x01	Controller Mode (See <a href="#">Section 8.4</a> )

### 8.2 Table 2. PID Control Family Status 0

Code	Measurement
0x80	Shed Time Expired
0x40	Auto-Tune in Progress
0x20	In Fail-Safe Mode
0x10	Setpoint Rate of Change Limit
0x08	MV Rate of Change Limit

### 8.3 Table 3. PID Control Family Status 1

Code	Measurement
	<i>Reserved</i>

### 8.4 Table 4. Controller Mode Status

Code	Controller Mode
0	Disabled
1	Enabled

## 8.5 Table 5. Controller Modes

Code	Controller Type
0	Disabled
1	Manual
2	Auto-Balancing (Advanced PID only)
3	Auto

## 8.6 Table 6. Power-Up Controller Modes

Code	Power-up Controller Mode
0	Undefined
1	Manual
2	Last Mode
3	Auto

## 8.7 Table 7. Controller Types

Code	Controller Type
0	Undefined
1	Proportional-Integral(PI)
2	Proportional-Integral-Derivative (PID) <i>Note: If this Controller type is supported, then Command 1926 must be supported.</i>
3	Proportional-Derivative (PD) <i>Note: If this Controller type is supported, then Command 1926 must be supported.</i>
4	Integral Derivative (ID) <i>Note: If this Controller type is supported, then Command 1926 must be supported.</i>
240 - 249	For Manufacturer Specific Types
250	Not Used
251	None
252	Unknown
253	Special

### 8.8 Table 8. Controller Algorithms

Code	Controller Algorithm
0	Parallel or Ideal: $K_c * e(t) + 1/T_i * \int e(t) dt + T_d * de(t)/dt$
1	Non-Interacting or ISA: $K_c * [e(t) + 1/T_i * \int e(t) dt + T_d * de(t)/dt]$
2	Interacting or Series: $K_c * [e(t) + 1/T_i * \int e(t) dt] * [1 + T_d * de(t)/dt]$
239	Proprietary
240 - 249	For Manufacturer Specific Algorithms
250	Not Used
251	None
252	Unknown
253	Special

### 8.9 Table 9. Power-Up Actions

Code	Power-up Controller Mode
0	Use Last Valid Setting
1	Use Special Power-Up Setting
2-255	Undefined

## **ANNEX A. REVISION HISTORY**

### **A1. Revision 1.0**

Initial Revision.