Profibus Supplemental Manual

GF40/GF80 Series
Mass Flow Controllers & Meters

BROOKS® INSTRUMENT

Beyond Measure

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Introduction

Many applications of Flow Controllers/Meters are moving to increasing the use of automation. Automation comes in many forms: PLC's (Programmable Logic Controllers), DCS's (Distributed Control Systems) and PC based solutions (National Instrument's Labview™). Digital communications from these varied systems and the devices they measure and control are a very effective means of not only accomplishing more effective and rapid system integration, but also providing greatly improved system diagnostics and maintainability. Profibus is an open, digital communication system with a wide range of applications, particularly in the fields of factory and process automation. Brooks Instrument has several of its devices available on this universal fieldbus technology and is a member of the Profibus organization.

Definition of Terms

Abbreviation	Description
MFC/MFM	Mass Flow Controller/Mass Flow Meter
MSB	Most Significant Bit
LSB	Least Significant Bit
NA	Not Applicable

Background and Assumptions

This manual is a supplement to the Brooks GF40/GF80 Series installation and operation manual. It is assumed that the owner of this Profibus MFC/ MFM is thoroughly familiar with the theory and operation of this device. If not, it is recommended that the owner reads the installation and operation manual first before continuing with this supplement.

This manual assumes basic knowledge and understanding of Profibus (its topology and its method of logically accessing the data or parameters contained within the device). This manual is not intended to be a replacement to the Profibus specifications. It is recommended but not required for the purposes of this manual, that the user obtains a copy of the Profibus specifications (www.profibus.com).

This manual does not make any assumptions about any particular manufacturer of equipment or custom software used by the user to communicate with the Brooks device, but assumes the user has thorough understanding of such equipment and any configuration software. Application Notes and FAQ's are available at the Brooks Instrument web site (www.BrooksInstrument.com).

Numbers

Numeric values used throughout this manual will be clearly denoted as to the base numeric system it represents. All hexadecimal numbers (base 16) will be prefixed with a 0x, like 0xA4. All binary numbers (base 2) will be suffixed with a "b", (example:1001b). All other numbers not annotated this way will be assumed decimal (base 10).

Assumption

This section assumes the owner of the Digital Series device has a fully operational and trouble-free communications network with appropriate power supplies. This section also assumes that one or two master type of devices are connected to the Profibus network capable of DPV0 cyclic and DPV1 acyclic data communication. Both types of data communication modes are supported by the Brooks GF40/GF80 Profibus device.

Supported Baud Rates

Data communication can be performed at a number of baud rates: 9600, 19.2K, 45.45K, 93.75K, 187.5K, 500K, 1.5M, 3M, 6M and 12M baud. The communication electronics allows for automatic baud rate detection, thus making the need for any hardware baud rate selection methods not required.

Address Selection

A Profibus slave device needs a valid address in order to get into data exchange mode with a Profibus master. The address range is 2..126 and can be configured using 2 rotary switches with an arrow indicator. The MSD (Most Significant Digit) switch supports 16 positions and is used to specify 10, 20, 30..120, the LSD (Least Significant Digit) is used to specify the 0, 1, 2.. 9. Default the address selectors will be set to the P (Programmable) position for the MSB and the 0 position for the LSB, see picture below. The P position allows for using the “Set Slave” functionality of a class 2 master device to change the default address, i.e. 126, to an address in the range of 2..125. If the rotary switches are configured into any other position than P the “Set Slave” functionality cannot be used and the address will be retrieved from the rotary switch positions.

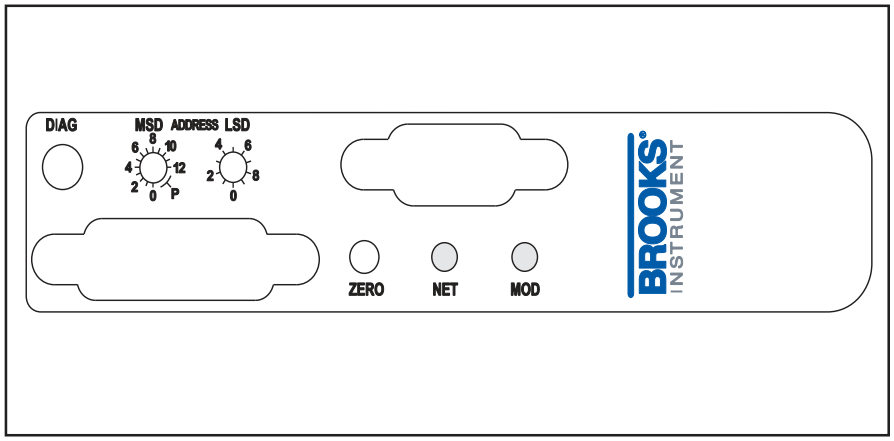

Figure 4-1 Profibus Label on Cover

Table 4-1 Configuring the Address Switches

Scenario	Current Address	New Address	Required Action
1	P (126)	P (2..125)	Default the MSD rotary switch will be set to the P position and the LSD to the 0 position, the selected address will show up as 126 in the Profibus master. This is an invalid address which can not be used to get a device into Profibus data exchange mode. The P (Programmable) position allows for digitally programming the address using the DPV1 “Set Slave Address” functionality. Once this function has been used to change the address to an address in the range of 2..125, the device can be put into data exchange mode using the newly programmed address without a power cycle. Note that the rotary switch position may not be changed.
2	P (126), P (2..125)	2..125	When the rotary switches are changed from a programmable to a hard station address, the power must be cycled on the device in order to recognize the new station address. The new station address is indicated by the rotary switches.
3	2..125	2..125	When the rotary switches are changed from a hard station address to another hard station address, the power must be cycled on the device in order to recognize the new station address. The new station address is indicated by the rotary switches.
4	2..125	P (2..125), P (126)	When the rotary switches are changed from a hard station address to programmable, the power must be cycled on the device in order to recognize that the station address is programmable. The station address will be set to the saved station address (2..125), i.e. saved in non-volatile memory at the point in time when the DPV1 “Set Slave Address” function was executed. In case the DPV1 “Set Slave Address” function has never been used or scenario 5 was used to reset the saved station address, the station address will show up as 126 in the Profibus master. Scenario 1 or 2 can be used to select a valid station address.
5	P (2..125)	P (126)	In case the saved station address needs to be reset to the default 126 value, the following procedure needs to be performed: • Verify that the MSD address switch is in the P position and the device is powered • Turn the MSD switch to a position in the range 1..12 • Turn the MSD switch back to the P position • Power cycle the device The station address will show up as 126 in the Profibus master and scenario 1 or 2 can be used to select a valid station address.

Bus and Device LEDs

The device supports a NET and MOD LED to indicate the status of network communication and the device. The NET LED will indicate the following:

Table 4-2 NET LED Specifications

Flash Code	Description
Off	No Network Connected
Flashing Green	Network Connected
Solid Green	Communications Established (DP and/or V1)
Flashing Red	Configuration Error
Flashing Red/Green	Parameterization Error
Solid Red	Hardware Error

The MOD LED will indicate the following:

Table 4-3 MOD LED Specifications

Flash Code	Description
Flashing Red/Green	The device is in the Self-Test mode
Solid Green	All self-tests have passed. No faults have been detected
Flashing Red	A recoverable fault has been detected or the device has been commanded into the Abort state
Solid Red	An unrecoverable fault has occurred

Power Supply and Analog I/O

Power needs to be supplied via the separate 15 pin D-Sub connector. This connector also provides access to analog I/O signals, see the table below.

Table 4-4 Pin Layout of 15 Pin D-Sub Connector

Pin No.	Function at Remote Connector
1.	Setpoint Signal Ground
2.	Flow Voltage Output
3.	Alarm Output
4.	Flow Current Output
5.	Positive Supply Voltage
6.	Not Used
7.	Setpoint Current Input
8.	Setpoint Voltage Input
9.	Power Supply Common
10.	Flow Signal Ground
11.	Not Used
12.	Valve Override Input
13.	Not Used
14.	Not Used
15.	Not Used

Introduction

The purpose of the Profibus field bus system is to exchange data between the master and its slave devices. In addition to Input/Output data which are exchanged when the slave device is in data exchange mode, also parameter, configuration and diagnostic data is transferred.

Many Profibus masters need a configuration program to setup the Profibus network and configure slave devices, e.g. Siemens Step7 for the S7 controller. These programs require a device configuration file called GSD file and can be retrieved from the www.profibus.com web site.

For the Profibus network configuration of the GF40/GF80 Series Profibus devices the following GSD file is provided:

• BIMFCC00.GSD - GF40/GF80 Series Mass Flow Controller/Meter

Parameterization of the Slave (GF40/GF80 Series Devices)

During the initialization phase of the slave device the master configures the slave with the so called user parameters, this part of the initialization phase is called the parameterization. Using the master configuration program these user parameters can be changed, giving the slave device a different configuration during initialization.

Table 5-1 Complete DP Parameterization

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	...	Byte-n
As defined by DP specification							As defined by DP-V1 specification			DP Oper-ation	Device parameter bytes		

Bit 0 (DP parameterization enable) of Byte 10 (‘DP Operation’) of the DP Parameterization defines if parameterization over DP is enabled, or if the parameterization data is ignored to allow configuration through acyclic data transfer. The structure of the ‘DP operation’ byte is defined as follows.

Bit Field							
Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Reserved							DP param-eterization enable
-							0 = disabled 1 = enabled

Bytes 11 through n (number of parameterization bytes depends on device type) contain the device parameterization data that will configure the device when DP Parameterization is enabled. The bytes are defined as follows.

Table 5-2 User Parameters Passed During Parameterization

Byte	Attrbute Name	Block	Description	Instance	Attrib ID	Size (Bytes)	Default Value	
							Dec	Hex
11-12	Flow Data Units	Analog Sensor FB	Flow Data Units: Parameterizes the Data Units for the Analog Sensor FB. Refer to the Table 8-2 Volumetric Flow Units Table for a list of valid values.	FB_1	2	2	1342	0x053e
13-14	Selected Calibration Instance	TMF Sensor TB	Parameterizes the selected calibration instance. Refer to Table 8-7 Calibration Instance Table for more details	TB_1	4	2	1	0x0001
15-16	Temperature Data Units	TMF Device PB	Defines the engineering units for the temperature. Refer to Table 8-5 Temperature Units Table for more details.	PB_1	2	2	1001	0x03E9
17-18	Not Used	NA	NA	NA	NA	2	0	0x0000
19	Valve Drive Safe State	Actuator FB	In case the device is commanded into safe state, the valve should be put into safe mode indicated by this setting. Refer to Table 8-8 Valve Drive Safe State Table for more details.	FB_3	7	1	1	0x01
20	Flow Control Alarm Enable	Controller FB	Parameterizes the flow control alarm enable. 0 = Disabled 1 = Enabled	FB_2	9	1	0	0x00
21	Flow Meter Alarm Enable	TMF Sensor TB	Parameterizes the flow meter alarm enable. 0 = Disabled 1 = Enabled	TB_1	12	1	0	0x00
22	Drive Valve Alarm Enable	Actuator FB	Parameterizes the drive valve alarm enable. 0 = Disabled 1 = Enabled	FB_3	8	1	0	0x00
23-24	Flow Controller Alarm Error Band	Controller FB	Allows the flow controller alarm error band to be preset in whole numbers from 0 to 32767 (equal to 0..133.33%; 24575=100%)	FB_2	10	2	32767	0x7FFF

Table 5-2 User Parameters Passed During Parameterization (continued)

Byte	Attrbute Name	Block	Description	Instance	Attrib ID	Size (Bytes)	Default Value	
							Dec	Hex
25-26	Flow Meter Alarm Trip Point High	TMF Sensor TB	Allows the flow meter alarm trip point high to be present in whole numbers from 0 to 32767 (equal to 0..133.33%; 24575=100%)	TB_1	13	2	32767	0x7FFF
27-28	Flow Meter Alarm Trip Point Low	TMF Sensor TB	Allows the flow meter alarm trip point low to be preset in whole numbers from 0 to 32767 (equal to 0..133.33%; 24575=100%)	TB_1	14	2	0	0x0000
29-30	Drive Valve Alarm Trip Point High	Actuator FB	Allows the drive valve alarm trip point high to be preset in whole numbers from 0 to 32767 (equal to 0..133.33%; 24575=100%)	FB_3	9	2	32767	0x7FFF
31-32	Drive Valve Alarm Trip Point Low	Actuator FB	Allows the drive valve alarm trip point low to be preset in whole numbers from 0 to 32767 (equal to 0..133.33%; 24575=100%)	FB_3	10	2	0	0x0000
33-36	Flow Control Ramp Time		Parameterizes the flow control ramp time. Refer to Table 8-10 Flow Control Ramp Time Table for more details.			4	0	0x00000000
37	Flow Control Mode	Controller FB	Parameterizes the flow control mode. Refer to Table 8-11 Flow Control Mode Table for more details.	FB_2	8	1	0	0x00
38-39	Flow Totalizer Data Units	TMF Sensor TB	Defines the engineering unit for the flow totalizer. Refer to Table 8-6 Flow Totalizer Data Units Table for more details.	TB_1	16	2	1036	0x040C
40-41	Setpoint Data Units	Controller FB	Defines the engineering unit for the setpoint. Refer to Table 8-2 Volumetric Flow Units Table for more details.	FB_2	2	2	1342	0x053e

Configuration of the Slave

Using the master configuration program the user can select inputs and outputs which define the data to be exchanged in DPV0 data exchange mode. The following table lists the input and output modules which can be selected.

Table 5-3 DPV0 Input/Output Modules for Device Type MFC

Input Data						
Configuration Byte	Attribute Name	Block	Instance	Attrib. ID	Description	Size (Bytes)
0x43,0x03,0xA9,0x06,0x01	Process Variable (PV)	Analog Sensor FB	FB_1	0	The amount of flow going through the device in engineering units.	4
0x43,0x03,0x32,0x06,0x01	Drive Valve Value	Actuator FB	FB_3	2	The value of the analog output signal used to drive the physical actuator.	4
0x43,0x03,0xA4,0xBD,0x01	Temperature	TMF Sensor TB	TB_1	11	Temperature of the device in engineering units. Refer to Table 8-5 Temperature Units Table for more details.	4
0x43,0x03,0x33,0x06,0x01	Setpoint	Controller FB	FB_2	1	The amount of flow that device will control to in engineering units. Refer to Table 8-2 Volumetric Flow Units Table for more details.	4
0x43,0x00,0x32,0x05,0x01	Valve Override	Actuator FB	FB_3	6	The override of the physical actuator. Refer to Table 8-9 Valve Override Table for more details.	1
0x43,0x01,0xA9,0x23,0x01	Selected Calibration Instance	TMF Sensor TB	TB_1	4	The active calibration instance. Refer to the Table 8-7 Calibration Instance Table for more details.	2
0x43,0x03,0xA9,0x5F,0x01	Flow Totalizer	TMF Sensor TB	TB_1	15	The total amount of volume through the device as a long integer in engineering units. Refer to Table 8-6 Flow Totalizer Data Units Table for more details.	4
0x43,0x00,0xA9,0x1C,0x01	Sensor Zero Status	TMF Sensor TB	TB_1	3	Indicates the status of the zero flow meter: 1 = In progress. 0 = Idle.	1
0x43,0x00,0xA9,0x70,0x01	Zero Flow Meter	TMF Sensor TB	TB_1	2	Indicates the zero flow meter state: 1 = Zero adjust initiated. 0 = No zero adjust.	1

Table 5-3 DPV0 Input/Output Modules for Device Type MFC (continued)

Output Data						
Configuration Byte	Attribute Name	Block	Instance	Attrib. ID	Description	Size (Bytes)
0x83,0x03,0x33,0x06,0x01	Setpoint	Controller FB	FB_2	1	The amount of flow the device will control to in engineering units.[1]	4
0x83,0x00,0x32,0x05,0x01	Valve Override	Actuator FB	FB_3	6	Specifies a direct override of the physical actuator. Refer to Table 8-9 Valve Override Table.[1]	1
0x83,0x00,0xA9,0x70,0x01	Sensor Zero Adjust	TMF Sensor TB	TB_1	2	Initiates a Zero Adjust.	1
0x83,0x01,0xA9,0x23,0x01	Selected Calibration Instance	TMF Sensor TB	TB_1	4	Selects the active calibration instance. Refer to Table 8-7 Calibration Instance Table.	2

[1] If the flow controller is set to analog mode, then the setpoint and valve override cannot be written.

Device Diagnostics

The device supports 2 diagnostic bytes, below the layout of these bytes.

Byte nr	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	Reserved	Reserved	Valve High	Valve Low	Flow Controller Error Band	Flow High	Flow Low	Reserved
2	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	DPV0 Calibration Instance

Figure 5-1 Device Diagnostic Byte

In case of a Mass Flow Meter (MFM) the Valve high/low and the Flow Controller Error Band Alarms are disabled.

If the ‘Selected Calibration’ module is used in DPV0 cyclic communication, make sure that it’s set to a valid value, otherwise the ‘DPV0 calibration instance’ diagnostic indication will be raised.

A bit set to 1 indicates that the alarm has occured.

DPV0 Cyclic Data Exchange

Once the device has gone through the parameterization and DPV0 input and output modules have been selected the master will direct the slave into DPV0 cyclic data exchange mode, see Section 5.2 Parameterization of the Slave (GF40/GF80 Series Device) and Section 5.3 Configuration of the Slave. In this mode data is exchanged between master and slave on a periodic basis. The input is data which is going from slave to master and output is data which is going from master to slave.

Device Block Model

The Profibus interface provides access to device data. The device data is grouped in blocks, where each block is comprised of a set of indices that defines the configuration and represents the state of a logical function. An index provides access to specific data within a functional block. The structure of modeling these acyclic parameters is taken from the Profibus PA standard. However the interface is not compliant to this Profibus PA standard but will follow the Profibus DP v1 specifications for acyclic parameter communication.

The following figure provides an overview of blocks, with their relationships, that can exist in a GF40/GF80 Series device.

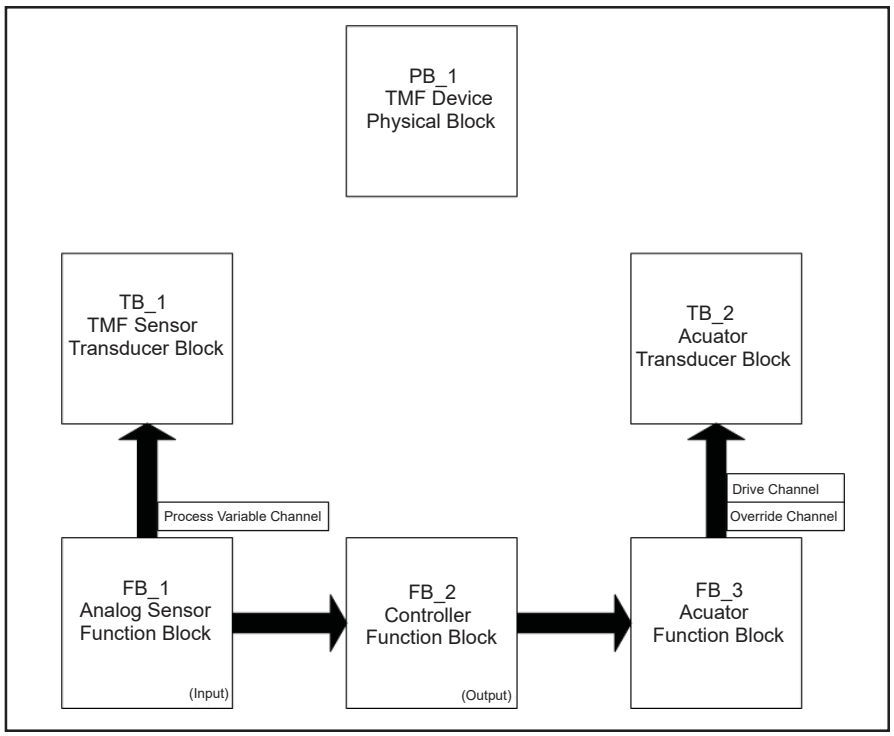

Figure 7-1 Device Block Model

Slot and Index (Attribute) Mapping

The figure below defines the mapping of available blocks for a Mass Flow Controller device into slots and indexes. Indexes are identified by the attribute number. The mapping complies with the PA definition (refer to Section 9.2 Mapping for Acyclic Data Transfer).

One slot will only contain one block. This allows for extension of blocks, without the need to shift other blocks. This will maximize flexibility for future product extensions, while maintaining compatibility (i.e. the absolute address will not change).

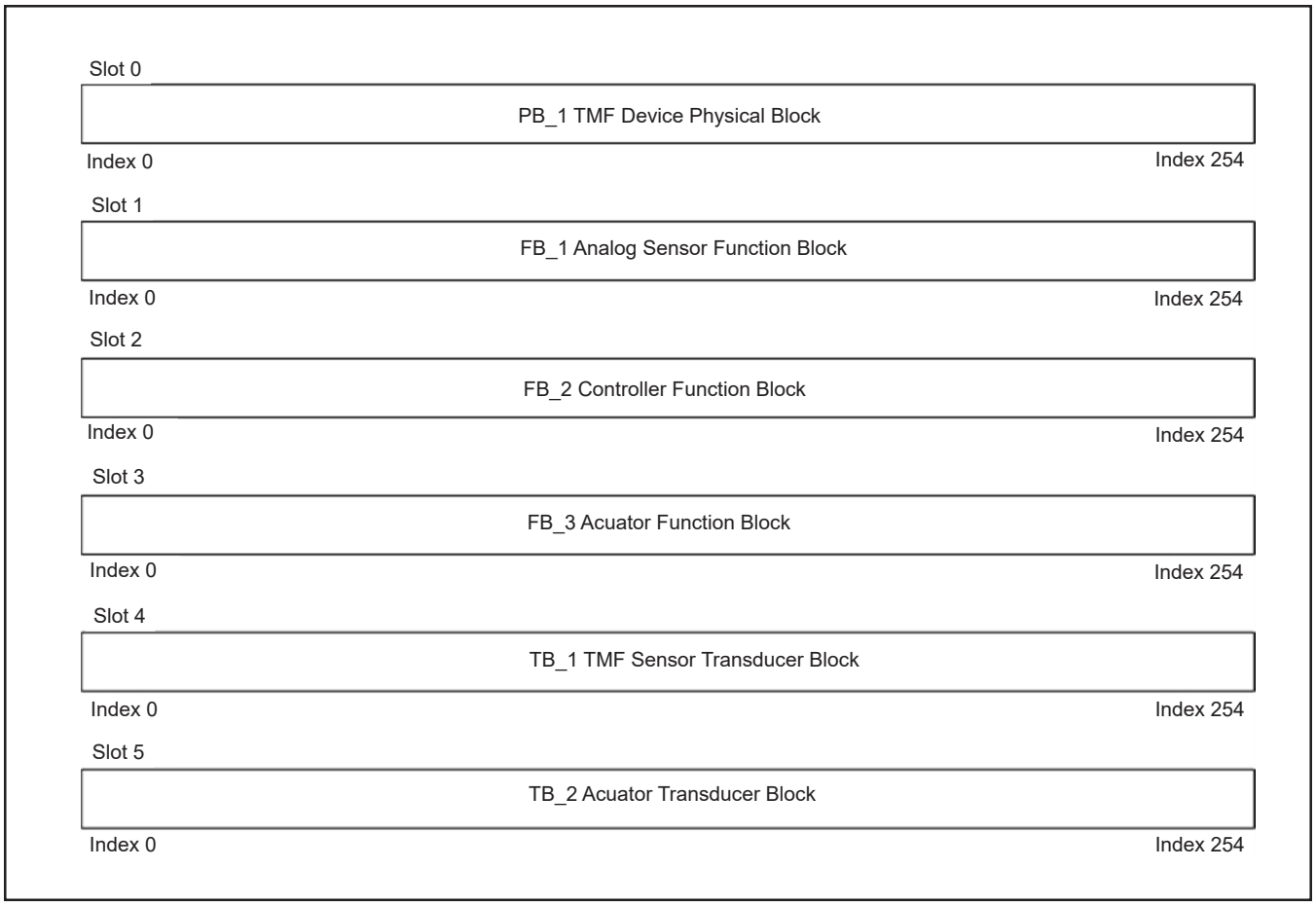

Figure 7-2 Slot and Index Mapping

A definition of blocks and attributes is given in the tables shown in the following paragraphs.

Table 7-1 Table Legend

Table Column Heading	Description
Attribute ID	Identification of the index within the block
Attribute Name	Name of the index
Description	Description of the index
Object Type	Simple data type, Record (i.e. struct), or Array of simple data types
Data Type	Data format as defined in document ‘Profibus DP Extensions to EN 50170, paragraph 10.5’.
Storage	Storage definition: Non-volatile, Dynamic (i.e. volatile) or Constant (no Static parameters are supported).
Number of Bytes	Data length in bytes
Access	Readable and/or writable
DP Data Exchange	Defines if the attribute is accessible as an Input or Output parameter though cyclic data exchange (DP)
DP Param	Defines if the attribute can (P) or cannot (-) be set through the DP parameterization service

When the user requests an attribute from a block which is not supported by the configured device type (MFC/MFM) an invalid parameter response will be returned.

Identification and Maintenance Function (I&MO)

The I&M0 table is required as per DPV1 Profibus specification and contains data needed for identification and maintenance of the device

Block existence: MFC, MFM									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Header	Manufacturer Specific	Simple	Octet String (bitwise)	N	10	r	-	-
1	Manufacturers ID	Manufacturers identification number (10 = 0x000A = Brooks Instrument)	Simple	Unsigned16	N	2	r	-	-
2	Order ID	Manufacturers order number (GFxx)	Simple	Visible String	N	20	r	-	-
3	Serial Number	Serial number of the device assigned by the manufacturer.	Simple	Visible String	N	16	r	-	-
4	Hardware Revision	Revision level of the hardware in the device.	Simple	Visible String	N	2	r	-	-
5	Software Revision	Revision level of the firmware in the device.	Simple	Visible String	N	4	r	-	-
6	Revision Counter	A changed value of the REV_COUNTER parameter of a given module marks a change of hardware or of its parameters	Simple	Unsigned16	N	2	r	-	-
7	Profile ID	A module following a special profile may offer extended information (PROFILE_ SPECIFIC_TYPE) about its function and/or sub devices, e.g. HART (fixed to 0xF600)	Simple	Unsigned16	N	2	r	-	-
8	Profile Specific Type	In case a module follows a special profile this parameter offers information about the usage of its channels and/or sub devices (0x0000) (PA specific)	Simple	Unsigned16	N	2	r	-	-
9	IM Version	This parameter indicates the implemented version V1.1 of the I&M functions (0x01 and 0x01)	Simple	Unsigned8	N	2	r	-	-
10	IM Supported	This parameter indicates the availability of I&M records (0x0000)	Simple	Unsigned16	N	2	r	-	-

Reading the I&M0 table can be done by using the DPV1 write and read functionality sequentially. First you should perform a write to Slot 0 and Index 255, length is 4 bytes, of the following data 08, 00, FD, E8 in hex. This will set the subindex of the I&M0 record (i.e. 65000) and each sequential read to Slot 0 and Index 255 will return the I&M0 table. After a DPV1 abort and initiate the DPV1 write cycle needs to be performed again before retrieving the I&M0 table.

TMF (Thermal Mass Flow) Device Physical Block (Slot0; PB_1)

The TMF Device Physical Block provides access to general device parameters which are not included in I&M0.

Block existence: MFC, MFM									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Software Revision Digital Interface	Revision level of the firmware in the digital interface.	Simple	Visible String	N	8	r	-	-
1	Hardware Revision Digital Interface	Revision level of the hardware in the digital interface.	Simple	Unsigned16	N	2	r	-	-
2	Temperature Data Units	Defines the engineering unit of temperature. Refer to Table 8-5 Temperature Units Table.	Simple	Unsigned16	N	2	r/w	-	P
5	Device Type	Defines the device type should always return MFC.	Simple	Unsigned8	N	1	r	-	-
6	Auxiliary Analog Selection	The selection of the auxiliary analog as a coded integer: 0 = 5 volts. 1 = 10 volts. Note that the auxiliary analog input currently is not supported.	Simple	Unsigned8	N	1	r/w[1]	-	-

[1] If the flow control mode is set to analog mode, then the auxillary analog selection can not be written.

TMF (Thermal Mass Flow) Sensor Transducer Block (Slot 4; TB_1)

The TMF Sensor Transducer Block provides access to device parameters for the purpose of configuring of a Thermal Mass Flow Sensor of the device.

Block existence: MFC, MFM									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Normalized Flow	The measured flow signal, normalized to a number from 0 to 100. Refer to “7.5.1 Note: Attribute 0” on p. 7-7.	Simple	Floating-Point	D	4	r	-	-
2	Sensor Zero Adjust	Initiates a Zero Adjust. Refer to “7.5.2 Note: Attribute 2” on p. 7-7.	Simple	Unsigned 8	D	1	r/w	IO	P
3	Sensor Zero Status	Indicates the status of a Zero Adjust action. Refer to “7.5.3 Note: Attribute 3” on p. 7-7.	Simple	Unsigned 8	D	1	r	I	
4	Selected Calibration	Selects the active flow sensor calibration. Refer to Table 8-7 Calibration Instance Table	Simple	Unsigned16	N	2	r/w	IO	P
5	Selected Calibration Data Units	Defines the engineering unit of the full scale attributes of the active flow sensor calibration. Refer to Table 8-4 Selected Calibration Data Units.	Simple	Unsigned16	N	2	r	-	-
6	Selected Calibration Full-scale	This full-scale value applies to the factory calibration polynomial of the active flow sensor calibration.	Simple	Floating-Point	N	4	r/w	-	-
7	Selected Calibration Reference Pressure	The absolute pressure reference condition for the active flow sensor calibration, specified in kPa.	Simple	Floating-Point	N	4	r	-	-
8	Selected Calibration Reference Temperature	The temperature reference condition for the active flow sensor calibration.	Simple	Floating-Point	N	4	r	-	-
9	Selected Calibration Gas Name	Name of the process gas of the active flow sensor calibration.	Simple	Visible-String	N	64	r	-	-

TMF (Thermal Mass Flow) Sensor Transducer Block (Slot 4; TB_1) (Continued)

Block existence: MFC, MFM									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
11	Temperature	Temperature specified in the data unit selected by attribute 2 of the Device Physical Block. Refer to “7.4 TMF” Device Physical Block” on p. 7-4.	Simple	Floating-Point	N	4	r	I	-
12	Flow Meter Alarm Enable	Configuration of the flow meter alarm enable. 0 = Disabled. 1 = Enabled.	Simple	Unsigned	N	1	r/w	-	P
13	Flow Meter Alarm Trip Point High	Allows the flow meter alarm trip point high to be configured in whole numbers from 0 to 32767 (equal to 0..133.33%; 24575=100%)	Simple	Unsigned 16	N	2	r/w	-	P
14	Flow Meter Alarm Trip Point Low	Allows the flow meter alarm trip point low to be configured in whole numbers from 0 to 32767. (equal to 0..133.33%; 24575=100%)	Simple	Unsigned 16	N	2	r/w	-	P
15	Flow Totalizer	The amount of volume through the device as a long integer in engineering units referred to in Table 8-6 by the Flow Totalizer Data Units.	Simple	Unsigned 32	D	4	r/w	I	-
16	Flow Totalizer Data Units	The flow totalizer data units as a coded integer. Refer to Table 8-6 Flow Totalizer Data Units	Simple	Unsigned 16	D	2	r/w	-	P
17	Flow Analog Selection	The selection of the flow analog as a coded integer: 0 = 5 volts. 2 = 4 to 20 mA. 3 = 0 to 20 mA.	Simple	Unsigned 8	N	1	r/w[1]	-	-

[1] If the flow controller is set to analog mode, then the flow analog selection cannot be written.

Note: Attribute 0

The normalized flow is a measure for the amount of gas flowing through the device, where 0 means no flow, and 100 means a flow of 100% of the full scale as identified by attribute 'Selected Calibration Full Scale'.

Note: Attribute 2

Using the 'Sensor Zero Adjust' attribute, a flow sensor zero action can be initiated by setting the value to 1, as shown below.

Value	Zero Adjust Command Code	Description
0	Normal Operation	The device will continue normal operation and will not perform a zero adjust cycle.
1	Zero	Initiates a zero adjust cycle.

Use attribute 'Sensor Zero Status' to observe the status of a zero adjustment. Note that the storage for this attribute defined as dynamic. The device will reset the value to 0 after the user sets it.

Note Attribute 3

Attribute 'Sensor Zero Status' will report the status of a zero adjustment, as shown below.

Value	Zero Adjust Command Code	Description
0	Idle	The device will continue normal operation and will not perform a zero adjust cycle.
1	Executing	Initiates a zero adjust cycle.

Analog Sensor Function Block (Slot 1; FB_1)

Block existence: MFC, MFM									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Process Variable (PV)	The amount of flow through the device. This value is corrected, converted and calibrated to report the actual value of flow in the engineering units configured by attribute 'Data Units'.	Simple	Floating-Point	D	4	r	I	-
1	PV Channel[2]	Reference to the Sensor Transducer Block that provides the measurement value to this function block. Fixed to 0x0400.	Simple	Unsigned16	N	2	r	-	-
2	Flow Data Units	Defines the Engineering Units context of attributes 'Process Variable'. Refer to Table 8-2 for Volumetric Flow Units	Simple	Unsigned16	N	2	r/w	-	P

[2] Reference is a slot (MSB) and attribute (LSB) combination.

Controller Function Block (Slot 2; FB_2) (Not Supported by MFM)

Block existence: MFC									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Target Mode	Mode of operation of this Function Block Note: Attribute 0	Simple	Unsigned8	D	1	r/w	-	-
1	Setpoint[5]	The amount of flow the device will control to. This value is represented in the engineering units defined by attribute 'Data Units'.	Simple	Floating-Point	D	4	r(/w)[3]	IO	-
2	Setpoint Data Units	Flow control setpoint data units. Refer to Table 8-2 for Volumetric Flow Units.	Simple	Unsigned16	N	2	r/w	-	-
3	Control Value	The normalized output value (0..100) of the controller (unit-less)	Simple	Floating-Point	D	4	r	I	-
4	Selected Controller PID Proportional Gain	Configuration of the PID controller proportional gain[4]	Simple	Floating-Point	N	4	r/w	-	-
5	Selected Controller PID Integral Gain	Configuration of the PID controller integral gain[4]	Simple	Floating-Point	N	4	r/w	-	-
6	Selected Controller PID Derivative Gain 1	Configuration of the PID controller derivative gain 1[4]	Simple	Floating-Point	N	4	r/w	-	-
7	Selected Controller PID Derivative Gain 2	Configuration of the PID controller derivative gain 2[4]	Simple	Floating-Point	N	4	r/w	-	-
8	Flow Control Mode	Mode of operation for flow control. Refer to Table 8-11 Flow Control Mode Table for more details.	Simple	Unsigned8	D	1	r/w	-	P
9	Flow Control Alarm Enable	Configuration of the flow controller alarm enable. 0 = Disabled. 1 = Enabled.	Simple	Unsigned8	N	1	r/w	-	P
10	Flow Controller Alarm Error Band	Allows the flow controller alarm error band to be configured in whole numbers from 0 to 32767. (equal to 0..133.33%; 24575=100%)	Simple	Unsigned16	N	2	r/w	-	P
11	Setpoint Analog Selection[5]	The selection of the setpoint analog as a coded integer: 0 = 5 volts. 2 = 4 to 20 mA 3 = 0 to 20 mA	Simple	Unsigned8	N	1	r/w	-	-

[3] Setpoint is only writable through acyclic data transfer when the Target Mode is set to manual.

[4] Be aware that changing PID Gain settings might affect operation of the device.

[5] If the flow control mode is set to analog mode, then the setpoint and setpoint analog selection cannot be written.

Note: Attribute 0

The target mode indicates the mode of operation of the Controller Function Block. The supported modes are described in the following table.

Code	Target Mode	Description
8 (0x08)	Automatic (Default)	Attribute 'Setpoint' can only be written through cyclic data exchange. No write access is allowed through acyclic data exchange.
16 (0x10)	Manual	Attribute 'Setpoint' is independent of the cyclic data exchange and can only be written through acyclic data exchange.

Acuator Function Block (Slot 3; FB_3) (Not Supported by MFM)

Block existence: MFC									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Target Mode	Mode of operation of this Function Block Note: Attribute 0	Simple	Unsigned8	D	1	r/w	-	-
1	Drive Channel[6]	Reference to the 'Drive' attribute in the Actuator Transducer Block. Fixed to 0x0500	Simple	Unsigned16	C	2	r	-	-
2	Drive Value	The value of the analog output signal used to drive the physical actuator. In case of normally closed valve type same as Control Value, in case of normally opened valve type inverted to Control Value.	Simple	Floating-Point	D	4	r	I	-
3	Drive Valve Data Units	Defines the engineering unit for attribute 'Drive'. Note: the engineering unit [Percent] (1342) and can not be altered.	Simple	Unsigned16	C	2	r	-	-
4	Control Value	The normalized input value to the actuator (unit-less). (See Control Value of the Controller)	Simple	Floating-Point	D	4	r	-	-

[6] Reference is a slot (MSB) and attribute (LSB) combination.

Acuator Function Block (Slot 3; FB_3) (Not Supported by MFM) (Continued)

Block existence: MFC									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
5	Override Channel[6]	Reference to the 'Override' attribute in the Actuator Transducer Block. Fixed to 0x0501	Simple	Unsigned16	C	2	r	-	-
6	Override[8]	Specifies a direct override of the physical actuator, see Table 8-9 Valve Override Table	Simple	Unsigned8	D	1	r(/w)[7]	IO	-
7	Drive Valve Safe State	In case the device is commanded into the safe state the valve should be put into safe mode indicated by the Safe State, see Table 8-8 Valve Drive Safe State Table.	Simple	Unsigned8	D	1	r/w	-	P
8	Drive Valve Alarm Enable	Configuration of the drive valve alarm enable. 0 = Disabled. 1 = Enabled.	Simple	Unsigned8	N	1	r/w	-	P
9	Drive Valve Alarm Trip Point High	Allows the drive valve alarm trip point high to be configured in whole numbers from 0 to 32767. (equal to 0..133.33%; 24575=100%)	Simple	Unsigned16	N	2	r/w	-	P
10	Drive Valve Alarm Trip Point Low	Allows the drive valve alarm trip point low to be configured in whole numbers from 0 to 32767. (equal to 0..133.33%; 24575=100%)	Simple	Unsigned16	N	2	r/w	-	P

[6] Reference is a slot (MSB) and attribute (LSB) combination.

[7] Attribute 'Override' is only writable through acyclic data transfer when the Target Mode is set to manual.

[8] If the flow control mode is set to analog mode, then the valve override cannot be written.

Note: Attribute 0

The target mode indicates the mode of operation of the Actuator Function Block. The supported modes are described in the following table.

Code	Target Mode	Description
8 (0x08)	Automatic (Default)	Attribute 'Override' can only be written through cyclic data exchange. No write access is allowed through acyclic data exchange.
16 (0x10)	Manual	Attribute 'Override' is independent of the cyclic data exchange and can only be written through acyclic data exchange.

Actuator Transducer Block (Slot 5; TB_2) (Not Supported by MFM)

Block existence: MFC									
Attribute ID	Attribute name	Description	Object type	Data type	Storage	Number of Bytes	Access	DP Data Exchange	DP Param
0	Drive	The value of the analog output signal used to drive the physical actuator in percent	Simple	Floating-Point	D	4	r	-	-
1	Override[1]	Specifies a direct override of the physical actuator. See Table 8-9 Valve Override Table.	Simple	Unsigned8	-	1	r/w	-	-

[1] If the flow control mode is set to analog mode, then the valve override cannot be written.

Appendix A: Data Type Definitions

The following table lists Profibus data types used throughout this manual. The column C/C++ Encoding is given as a comparative common example reference.

Table 8-1 Profibus Data Type Definitions

Data Type	Size (bytes)	Description	Range	C/C++ Keyword
Signed8	1	An 8-bit signed integer value	-128 to 127	char
Unsigned8	1	An 8-bit unsigned integer value	0 to 255	unsigned char
Signed16	2	A 16-bit signed integer value	-32768 to 32767	short int
Unsigned16	2	A 16-bit unsigned integer value	0 to 65535	unsigned short int
Signed32	4	A 32-bit signed integer value	-2147483648 to 2147483647	int
Unsigned32	4	A 32-bit unsigned integer value	0 to 4294967296	unsigned int
Floating-Point	4	An IEEE-754 single precision floating point number	-3.8E38 to 3.8E38	float

Appendix B: Data Units

Table 8-2 Volumetric Flow Units Table

Value		Description	Symbol
Dec	Hex		
1342	0x053e	Percent	%
1347	0x0543	Cubic meter per second	m^3/s
1348	0x0544	Cubic meter per minute	m^3/min
1349	0x0545	Cubic meter per hour	m^3/h
1351	0x0547	Liter per second	l/s
1352	0x0548	Liter per minute	l/min
1353	0x0549	Liter per hour	l/h
1357	0x054d	Cubic foot per minute	ft^3/min
1358	0x054e	Cubic foot per hour	ft^3/h
1511	0x05e7	Cubic centimeter per second	cm^3/s
1512	0x05e8	Cubic centimeter per minute	cm^3/min
1513	0x05e9	Cubic centimeter per hour	cm^3/h
1577	0x0629	Milliliter per second	ml/s
1563	0x061b	Milliliter per minute	ml/min
1578	0x062a	Milliliter per hour	ml/h

Table 8-3 Pressure Units Table (See Section 5.2 of Process Control Profile)

Value		Description	Symbol
Dec	Hex		
1141	0x0475	Pounds/square inch	psi
1137	0x0471	Bar	bar
1138	0x0472	Millibar	mbar
1145	0x0479	Kilograms/square centimeter	kgf/cm^2

Table 8-4 Selected Calibration Data Units

Value		Description	Symbol
Dec	Hex		
5120	0x1400	Standard cubic centimeters per minute	sccm
5121	0x1401	Standard liter per minute	slm

Table 8-5 Temperature Units Table

Value		Description	Symbol
Dec	Hex		
1000	0x03e8	Kelvin	K
1001	0x03e9	Degrees Celsius	^oC
1002	0x03ea	Degrees Fahrenheit	^oF

Table 8-6 Flow Totalizer Data Units Table

Value		Description	Symbol
Dec	Hex		
1034	0x040A	Cubic meters	m^3
1036	0x040C	Cubic centimeters	cm^3
1038	0x040E	Liters	L
1040	0x0410	Milliliters	ml
1043	0x0413	Cubic feet	ft^3

Table 8-7 Calibration Instance Table

Value		Description
Dec	Hex	
1	0x01	Calibration instance 1
2	0x02	Calibration instance 2
3	0x03	Calibration instance 3
4	0x04	Calibration instance 4
5	0x05	Calibration instance 5
6	0x06	Calibration instance 6

Table 8-8 Valve Drive Safe State Table

Value		Description
Dec	Hex	
0	0x00	Normal
1	0x01	Closed
2	0x02	Open
3	0x03	Hold

Table 8-9 Valve Override Table

Value		Description
Dec	Hex	
0	0x00	Normal
1	0x01	Off
2	0x02	Purge

Table 8-10 Flow Control Ramp Time Table

Value		Description
Dec	Hex	
0	0x0000	Fast
5000	0x1388	5 seconds
8000	0x1F40	8 seconds
12500	0x30D4	12.5 seconds
25000	0x61A8	25 seconds
50000	0xC350	50 seconds

Table 8-11 Flow Control Mode Table

Value		Description
Dec	Hex	
0	0x00	Digital
1	0x01	Off
2	0x02	Purge
128	0x80	Analog

Appendix C: Profibus Safe State

When the GF40/GF80 MFC loses Profibus communications, it can enter a safe state. This safe state can be configured through the “valve drive safe state” in the user parameters.

The safe state can be set to normal, hold, close, or open. The normal safe state action will not perform any action and can be used if the device is controlled using the analog setpoint source without Profibus communication. The hold safe state action will hold the setpoint at the current setting. The close safe state action will set the setpoint to zero. The open safe state action will set the setpoint to the configured high range.

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