Installation and Operation Manual
X-DPT-PROFIBUS-4800-eng
Part Number: 541B135AAG
February, 2010

Supplemental Manual for Brooks® 4800 Series PROFIBUS® MFCs/MFMs

BROOKS® INSTRUMENT

Essential Instructions

Read this page before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using and maintaining Brooks Products.

- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.
- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation and maintenance of the product.
- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument.
- Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

ESD (Electrostatic Discharge)

⚠ CAUTION

This instrument contains electronic components that are susceptible to damage by electricity. Proper handling procedures must be observed during the removal, installation, or other handling of internal circuit boards or devices.

Handling Procedure:

1. Power to the unit must be removed.

2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.

3. Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.

Comments:

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

Dear Customer,

We appreciate this opportunity to service your flow measurement and control requirements with a Brooks Instrument device. Every day, flow customers all over the world turn to Brooks Instrument for solutions to their gas and liquid low-flow applications. Brooks provides an array of flow measurement and control products for various industries from biopharmaceuticals, oil and gas, fuel cell research and chemicals, to medical devices, analytical instrumentation, semiconductor manufacturing, and more.

The Brooks product you have just received is of the highest quality available, offering superior performance, reliability and value to the user. It is designed with the ever changing process conditions, accuracy requirements and hostile process environments in mind to provide you with a lifetime of dependable service.

We recommend that you read this manual in its entirety. Should you require any additional information concerning Brooks products and services, please contact your local Brooks Sales and Service Office listed on the back cover of this manual or visit www.BrooksInstrument.com

Yours sincerely,
Brooks Instrument

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1. Introduction

Many applications of Flow Controllers/Meters are moving to increasing use of automation. Automation comes in many forms: PLC's (Programmable Logic Controllers such as the Siemens S7 300/4000), DCS's (Distributed Control Systems, such as Emerson's Digital V), 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.

1.1. How to Use This Manual

This instruction manual along with the 4800 Series product manual (X-TMF-4800-MFC-eng) is intended to provide the user with all the information necessary to install, operate and maintain the Brooks 4800 Series PROFIBUS digital interface module.

This manual is organized into the following sections:

Section 1 – Introduction
Section 2 – Receipt & Storage of Equipment
Section 3 – Background & Numbering
Section 4 – Installation
Section 5 – Slave Configuration
Section 6 – DPV0 Cyclic Exchange
Section 7 – DPV1 Acyclic Communication
Section 8 – Appendices

1.2. Description

Many applications of Flow Controllers/Meters are moving to increasing use of automation. Automation comes in many forms: PLC's (Programmable Logic Controllers such as the Siemens S7 300/4000), DCS's (Distributed Control Systems, such as Emerson's Digital V), 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

1.3. Specifications

Electrical Connections

One (1) 15-pin D-sub connector for connection to the 4800 Series device.

One (1) 9-Pin D-sub connector for remote connection.

Pin	Signal
1	Shield
2	Not connected
3	RXD / TXD - B - red wire
4	Not connected
5	Ground
6	+5 Vdc
7	Not connected
8	RXD / TXD - A - green wire
9	Not connected

One (1) M5 connector for power.

Pin	Signal
1	+24 Vdc
2	Not connected
3	Ground
4	Not used

Materials of Construction
Enclosure: ABS plastic with CU-Ni plating.

Operating Limits:
Temperature: 0 - 50°C
Operating Humidity: 5 to 95% R.H. (ambient)

Refer to the 4800 Series product manual X-TMF-4800-MFC-eng for all other specifications.

1.4. Definition of Terms

Table 1-1 Definition of terms

Abbreviation	Description
MFC/MFM	Mass Flow Controller/Meter device
MSB	Most Significant Bit
LSB	Least Significant Bit

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2. Receipt & Storage

2.1. General

This section contains the procedures for the receipt and installation of the instrument. See Section 1 of this manual and the 4800 Series product manual (X-TMF-4800-MFC-eng) for dimensional and connection requirements. Do not attempt to start the system until the instrument has been permanently installed. It is important that the start-up procedures be followed in the exact sequence presented.

2.2. Receipt of Equipment

When the instrument is received, the outside packing case should be checked for damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding his liability. A report should be submitted to your nearest Product Service Department.

Brooks Instrument
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Hatfield, PA 19440 USA
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Tel (215) 362 3700
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Tokyo, 136-0073 Japan
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Fax +81 (0) 3 5633 7101
Email: BrooksAs@BrooksInstrument.com

Remove the envelope containing the packing list. Carefully remove the instrument from the packing case. Make sure spare parts are not discarded with the packing materials. Inspect for damaged or missing parts.

2.3. Recommended Storage Practice

If intermediate or long-term storage of equipment is required, it is recommended that the equipment be stored in accordance with the following conditions:

a. Within the original shipping container.
b. Stored in a sheltered area, preferably a warm, dry, heated warehouse.
c. Ambient temperature 21°C (70°F) nominal, 32°C (90°F) maximum, 7°C (45°F) minimum.
d. Relative humidity 45% nominal, 60% maximum, 25% minimum.

2.4. Return of Equipment

Prior to returning any instrument to the factory, contact your nearest Brooks location for a Return Materials Authorization Number (RMA#). This can be obtained from one of the following locations:

Brooks Instrument
407 W. Vine Street
P.O. Box 903
Hatfield, PA 19440 USA
Toll Free (888) 554 FLOW (3569)
Tel (215) 362 3700
Fax (215) 362 3745
E-mail: BrooksAm@BrooksInstrument.com
www.BrooksInstrument.com

Brooks Instrument
Neonstraat 3
6718 WX Ede, Netherlands
P.O. Box 428
6710 BK Ede, Netherlands
Tel +31 (0) 318 549 300
Fax +31 (0) 318 549 309
E-mail: BrooksEu@BrooksInstrument.com

Brooks Instrument
1-4-4 Kitasuna Koto-Ku
Tokyo, 136-0073 Japan
Tel +81 (0) 3 5633 7100
Fax +81 (0) 3 5633 7101
Email: BrooksAs@BrooksInstrument.com

Instrument must have been purged in accordance with the following:

⚠WARNING

Before returning the device purge thoroughly with a dry inert gas such as Nitrogen before disconnecting gas connections. Failure to correctly purge the instrument could result in fire, explosion or death. Corrosion or contamination may occur upon exposure to air.

All flow instruments returned to Brooks requires completion of Form RPR003-1, Brooks Instrument Decontamination Statement, along with a Material Safety Data Sheet (MSDS) for the fluid(s) used in the instrument. Failure to provide this information will delay processing by Brooks personnel. Copies of these forms can be downloaded from the Brooks website www.BrooksInstrument.com or are available from any Brooks Instrument location listed above.

2.5. Transit Precautions

To safeguard the instrument against transportation damage, it is recommended to keep the instrument in its factory container until ready for installation.

2.6. Removal from Storage

Upon removal of the instrument from storage, a visual inspection should be conducted to verify its "as-received" condition. If the instrument has been subject to storage conditions in excess of those recommended (See Section 2-3), it should be subjected to a pneumatic pressure test in accordance with applicable vessel codes.

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3. Background & Numbering

3.1. Background & Assumptions

This manual is a supplement to the Brooks 4800 Series installation and operation manual. It is assumed that the owner of this 48xx 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).

3.2. 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, like 1001b. All other numbers not annotated this way will be assumed decimal (base 10).

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4. Installation

This section assumes the owner of the Digital Series device has a fully operational and trouble-free communications network with appropriate power supplies (15-24V depending on the 48xx device type). 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 48xx PROFIBUS device.

4.1. 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.

4.2. 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. Each rotary switch supports 16 positions but only a couple of them are implemented, see picture below. The MSB (Most Significant Bit) is used to specify 10, 20, 30..120, the LSB (Least Significant Bit) 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 can not be used and the address will be retrieved from the rotary switch positions.

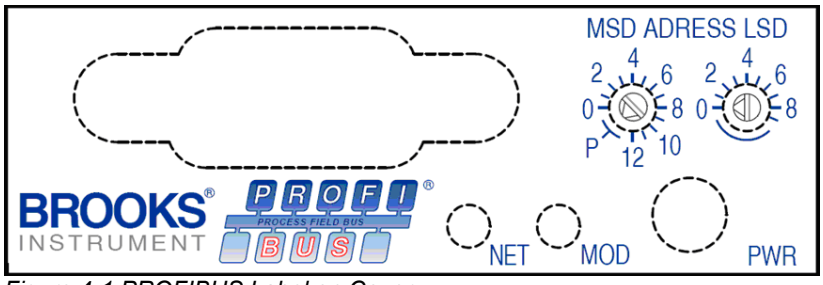

Figure 4-1 PROFIBUS Label on Cover

4.3. Bus and Device LEDs

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

Table 4-1 Bus Led Specification

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 Device LED will indicate the following:

Table 4-2 Device Led Specification

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

4.4. Profibus Bus signals

Below you'll find the pin layout of the 9 pins Profibus D-sub connector.

⚠CAUTION

Do not touch pins or unit may become inoperable.

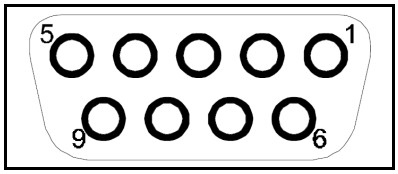

Figure 4-2 Profibus 9 pin D-sub connector

Table 4-3 Profibus 9 pin D-sub layout

Pin	Signal
1	Shield
2	Not connected
3	RxD/Txd - B - red wire
4	Not connected
5	Ground
6	+5Vdc
7	Not connected
8	RxD/Txd - A - green wire
9	Not connected

4.5. Power Supply

Power needs to be supplied via the separate M5 power connector. See tables below for the supplier part numbers and signal connections of the mating M5 cable.

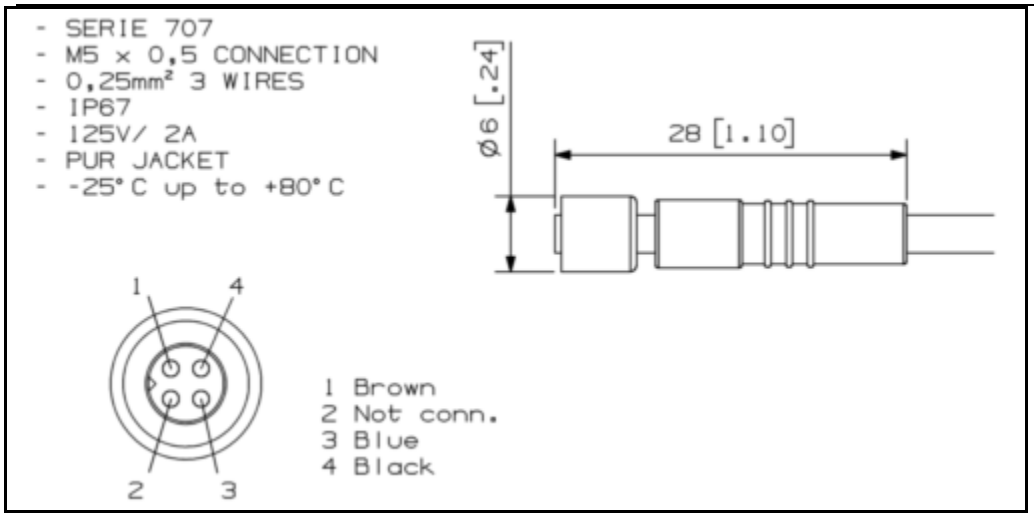

Figure 4-3 M5 Mating Connector and Cable Specifications

Table 4-4 M5 Mating Connector Supplier Part Numbers

Supplier	Part Number	Description
Brooks Instrument	124x035ZZZ	Female M5 connector with 2m cable
	124x036ZZZ	Female M5 connector with 5m cable

Table 4-5 Signal Definitions

Signal	Description
Brown	+V
Blue	GND
Black	Not used

5. Slave Configuration

5.1. 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. To download the GSD file for the Brooks Instrument 4800 Series go to www.Profibus.com and enter the Products section and select Product Guide. Enter “Brooks Instrument” into the “Full Text Search” box and hit enter or click the search arrow. Scroll down and click the view product icon(magnifying glass icon). The downloadable GSD file is at the bottom of the page (www.Profibus.com/nc/products/product-guide/product/display/digital-thermal-mass-flow-metercontroller/5/1/).

For the PROFIBUS network configuration of the 48xx Series PROFIBUS devices the following GSD file is provided:

- BIMF4800.GSD – 48xx Series Mass Flow Controller/Meter

5.2. Parameterization of the Slave (48xx Series MFC/MFM)

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

Table 5-1 Complete DP Parameterization

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8	Byte9	Byte10	Byte11	…	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	Bit field
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved						Selected Calibration Parameter Enable	DP parameter-ization enable
-						0 = disabled 1 = enabled	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	Attribute Name	Block	Description	Instance	Attrib ID	Size (bytes)	Default Value	
								Dec	Hex
1	11-12	Presssure Data Units	Device PB	Defines the engineering unit of temperature Refer to the Pressure Units Table 8-3	PB_1	4	2	1138	0x0472
2	13-14	Presssure Reference Units	Device PB	Defines the engineering unit of the pressure reference Refer to the Pressure Reference Units Table 8-4	PB_1	5	2	0	0x00
3	15-16	Data Units	Analog Sensor FB	Flow Data Units: Parameterizes the Data Units for the Analog Sensor FB. Refer to the 'Volumetric Flow Units Table' 8-2 for a list of valid values.	FB_1	3	2	1342	0x053e
4	17	Zero Cut-off	Analog Sensor FB	Parameterizes the Zero Cut-off attribute in the Analog Sensor FB for Flow.	FB_1	4	1	0	0x00
5	18	Selected Calibration	Sensor TB	Parameterizes the Selected Calibration attribute in the TMF Sensor TB. Refer to the block description for a list of valid values.	TB_1	5	1	1	0x01
6	19	Device Type	Device PB	Parameterizes the Device Type MFC or MFM Refer to the block description for a list of valid values.	PB_1	5	1	0	0x00

7	20-21	Temperature Data Units	Device PB	Defines the engineering unit of temperature Refer to the Temperature Units Table 8-5 Note that if this attribute is changed also attribute 8 needs to be updated to the new temperature unit.	PB_1	3	2	1001	0x03e9
8	22-25	Sel Calb Ref Temperature (/100)	Device PB	The selected calibration reference temperature for the active flow sensor calibration (multiplied by 100[1]), specified in the temperature data unit selected by user attribute 7, refer to TMF Sensor Transducer Block attribute 8, Section 7-5	PB_1	2	4	0	0x00
9	26	Safe State	Sensor TB	In case the device is commanded into the safe state the valve should be put into safe mode indicated by the Safe State attribute 7 of Actuator Function Block, Section 7-8	FB_3	8	4	0	0x01

5.3. Configuration of the Slave (48xx Series MFC)

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 table below lists the input and output modules which can be selected when the device type of the slave (see Section 5.2. Parameterization of the Slave (48xx Series MFC/MFM)) is configured in MFC mode.

[1] Value is multiplied by 100 to pass 2 decimal digits, e.g. for Kelvin 27315

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

Input Data						
Configuration Byte	Attribute Name	Block	Instance	Attrib. ID	Description	Size (bytes)
0x42, 0x83, 0x81, 0x00	Process Variable (PV)	Analog Sensor FB	FB_1	0	The amount of flow going through the device in engineering units.	4
0x42, 0x83, 0x83, 0x02	Drive Value	Actuator FB	FB_3	2	The value of the analog output signal used to drive the physical actuator.	4
0x42, 0x83, 0x43, 0x0b	Temperature	Sensor TB	TB_1	11	Temperature in the data unit selected by attribute 2 of the Device Physical Block	4

Output Data						
Configuration Byte	Attribute Name	Block	Instance	Attrib. ID	Description	Size (bytes)
0x82, 0x83, 0x82, 0x01	Setpoint	Controller FB	FB_2	1	The amount of flow the device will control to in engineering units.	4
0x82, 0x83, 0x83, 0x06	Override	Actuator FB	FB_3	6	Specifies a direct override of the physical actuator.	1
0x82, 0x80, 0x41, 0x02	Sensor Zero Adjust	Sensor TB	TB_1	2	Initiates a Zero Adjust.	1
0x82, 0x80, 0x41, 0x04	Selected Calibration	Sensor TB	TB_1	4	Selects the active flow sensor calibration by a number in the range of 1 through 10.	1

5.4. Configuration of the Slave (48xx Series MFM)

In case the slave is a Mass Flow Meter it doesn't have a valve and valve related modules can not be selected. The device type needs to be configured into MFM mode, see Section 5.2. Parameterization of the Slave (48xx Series MFC/MFM)).

Table 5-4 DPV0 Input/Output Modules for Device Type MFM

Input Data						
Configuration Byte	Attribute Name	Block	Instance	Attrib. ID	Description	Size (bytes)
0x42, 0x83, 0x81, 0x00	Process Variable (PV)	Analog Sensor FB	FB_1	0	The amount of flow going through the device in engineering units.	4
0x42, 0x83, 0x43, 0x0b	Temperature	Sensor TB	TB_1	11	Temperature in the data unit selected by attribute 2 of the Device Physical Block	4

Output Data						
Configuration Byte	Attribute Name	Block	Instance	Attrib. ID	Description	Size (bytes)
0x82, 0x80, 0x41, 0x02	Sensor Zero Adjust	Sensor TB	TB_1	2	Initiates a Zero Adjust.	1
0x82, 0x80, 0x41, 0x04	Selected Calibration	Sensor TB	TB_1	4	Selects the active flow sensor calibration by a number in the range of 1 through 10.	1

5.5. Device Diagnostics

The device supports one diagnostic byte, below the layout of this byte is shown.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Reserved	Reserved	Reserved	Reserved	Power Failure Indication	Invalid Gas selection	Invalid Valve Override Command	Zero Failed

Figure 5-1 Device Diagnostic Byte

In case of a Mass Flow Meter (MFM) the Invalid Valve Override Command alarm is disabled. If the ‘Selected Calibration’ module is used in DPV0 cyclic communication, make sure that it’s set to a valid value (1..10), otherwise the ‘Invalid Gas Selection’ diagnostic indication will be raised.

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6. 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 5.3. Configuration of the Slave (48xx Series MFC) and 5.4. Configuration of the Slave (48xx Series MFM). 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.

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7. DPV1 Acyclic Data Communication

7.1. 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 attributes that defines the configuration and represents the state of a logical function. An attribute 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 Brooks 48xx Series device.

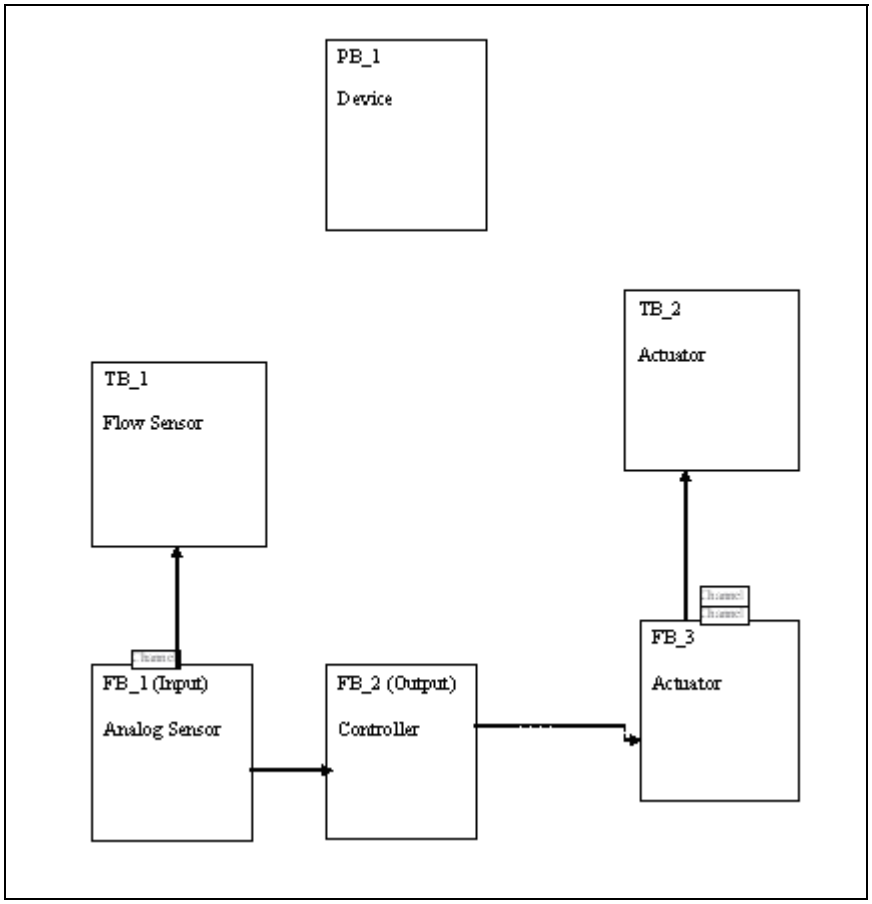

Figure 7-1 Device Block Model

7.2. 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).

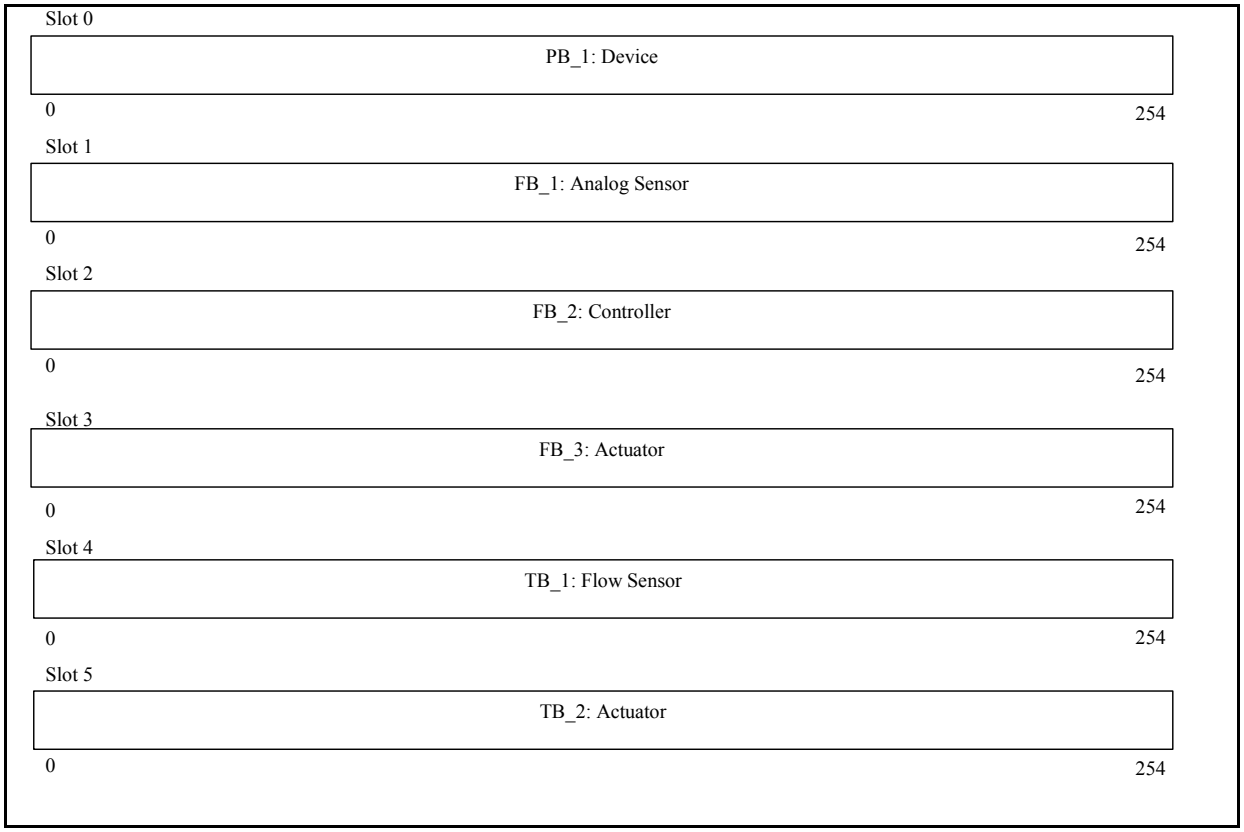

Figure 7-2 Slot and Index definition

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

Table 7-1 Table Legend

	Description
Attribute ID	Identification of the attribute within the block
Attribute Name	Name of the attribute
Description	Description of the attribute
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: **N**on-volatile, **D**ynamic (i.e. volatile) or **C**on**st**ant (no Static parameters are supported).
Number of Bytes	Data length in bytes
Access	**r**eadable and/or **w**ritable
DP Data Exchange	Defines if the attribute is accessible as an **I**nput or **O**utput 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.

7.3. Identification & Maintenance Function (I&M0)

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

Table 7-2 I&M0 table

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 = 0x0A = Brooks Instrument)	Simple	Unsigned16	N	2	r	-	-
2	Order ID	Manufacturers order number (48xx)	Simple	Visible String	N	20	r	-	-
3	Serial Number	Serial number of the device assigned by the manufacturer. (RS232 command READ_SERIAL_MFC, with trailing spaces	Simple	Visible String	N	16	r	-	-
4	Hardware Revision	Revision level of the hardware in the device. (RS232 command not supported)	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 F600h)	Simple	Unsigned16	N	2	r	-	-
8	Profile Specific Type	In case a module follows a	Simple	Unsigned16	N	2	r	-	-

		special profile this parameter offers information about the usage of its channels and/or sub devices (00h) (PA specific)							
9	IM Version	This parameter indicates the implemented version of the I&M functions (11h)	Simple	Unsigned8	N	2	r	-	-
10	IM Supported	This parameter indicates the availability of I&M records (00h)	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.

7.4. TMF Device Physical Block (Slot 0; PB_1)

The TMF (Thermal Mass Flow) Device Physical Block provides access to general device parameters which are not included in I&M0

Table 7-3 TMF Device Physical Block (Slot 0; PB_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	Software Revision Digital Interface (AA)	Revision level of the firmware in the digital interface	Simple	Visible String	N	6	r	-	-
1	Hardware Revision Digital Interface (A)	Revision level of the hardware in the digital interface.	Simple	Visible String	N	6	r	-	-
2	Temperature Data Units	Defines the engineering unit of temperature Refer to the Temperature Units Table	simple	Unsigned16	N	2	r/w	-	P
3	Presssure Data Units	Defines the engineering unit of Pressure Refer to the Pressure Units Table	simple	Unsigned16	N	2	r/w	-	P
4	Presssure Reference Units	Defines the engineering unit of the pressure reference Refer to the Pressure Reference Units Table	simple	Unsigned16	N	2	r/w	-	P
5	Device Type	Defines the device type which has been configured by the user (MFC or MFM)	simple	Unsigned8	N	1	r/w	-	P

7.4.1. Note: Attribute 5

The table below lists the values of the Device Type attribute

Table 7-4 Device Type attribute

Value	Description
0	Mass Flow Controller
1	Mass Flow Meter

Changing the Device Type from MFC to MFM will be prohibited if a module (cyclic communication) is selected which is not supported by the MFM.

7.5. TMF Sensor Transducer Block (Slot 4; TB_1)

The TMF (Thermal Mass Flow) Sensor TB provides access to device parameters for the purpose of configuring of a Thermal Mass Flow Sensor of the device.

Table 7-5 TMF Sensor Transducer Block (Slot 4; TB_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	Normalized Flow	The measured flow signal, normalized to a number from 0 to 100. Note: Attribute 0	simple	Floating-Point	D	4	r	-	-
1	Sensor Zero Value	Zero correction value that the device uses to remove an offset from the sensor signal. (determined by the device during a Zero Adjust).	simple	Floating-Point	N	4	r	-	-
2	Sensor Zero Adjust	Initiates a Zero Adjust. Note: Attribute 2	simple	Unsigned8	D	1	r/w	-	P
3	Sensor Zero Status	Indicates the status of a Zero Adjust action. Note Attribute 3	simple	Unsigned8	D	1	r	-	-
4	Selected Calibration	Selects the active flow sensor calibration by a number in the range of 1 through 10.	simple	Unsigned8	N	1	r/w	-	P
5	Selected Calibration Data Units	Defines the engineering unit of the full scale attributes of the active flow sensor calibration. Refer to the Volumetric Flow Units Table	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	-	-
7	Selected Calibration Reference Pressure	The absolute pressure reference condition for the active flow sensor calilbration, specified in the data unit selected by attributes 4 of the Device Physical Block	simple	Floating-Point	N	4	r/w	-	-
8	Selected Calibration Reference Temperature	The temperature reference condition for the active flow sensor calilbration, specified in the data unit selected by attribute 2 of the Device Physical Block	simple	Floating-Point	N	4	r/w	-	-
9	Selected Calibration	Name of the process	simple	Visible-	N	15	r	-	-

	Gas Name	gas of the active flow sensor calibration.		String					
10	Selected Calibration Gas Density	Gas density [gm/m3]	Simple	Floating-Point	N	4	r		
11	Temperature	Temperature specified in the data unit selected by attribute 2 of the Device Physical Block	Simple	Floating-Point	N	4	r	I	

7.5.1. 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 Custom Full Scale'.

7.5.2. Note: Attribute 2

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

Table 7-6 Sensor Zero Adjust attribute

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.

7.5.3. Note: Attribute 3

Attribute 'Sensor Zero Status' will report the status of a zero adjustment, see table.

Table 7-7 Sensor Zero Status attribute

Value	Zero Adjust Command Code	Description
0	Idle	The device is not performing a zero adjust cycle.
1	Executing	The device is zeroing the sensor and has not yet finished the zero adjustment.

7.5.4. Note: Attribute 9

The table below lists the corresponding Gas Name.

Table 7-8 List of Gas Names

Gas Symbol	Gas Name
He	Helium
Ar	Argon
H2	Hydrogen
Air	Air
CO	Carbon Monoxide
N2	Nitrogen
O2	Oxygen
CO2	Carbon Dioxide
N2O	Nitrous Oxide
CH4	Methane
C3H6	Propene
C3H8	Propane

7.6. Analog Sensor Function Block (Slot 1; FB_1)

Table 7-9 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	Data Units	Defines the Engineering Units context of attributes 'Process Variable'. Refer to the Volumetric Flow Units Table	Simple	Unsigned16	N	2	r/w	-	P
3	Zero Cut-off	Defines a threshold near zero such that if the flow measurement goes below this threshold, the 'Process Variable' will report	Simple	Boolean	N	1	r/w	-	P

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

		zero. Supported values: True = 1% False = 0%							

7.7. Controller Function Block (Slot 2; FB_2) (Not supported by MFM)

Table 7-10 Controller Function Block (Slot 2; FB_2)

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	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]	O	-
2	Data Units	Defines the Engineering Units context of attributes 'Setpoint', 'Setpoint Internal' and 'Process Value'. This attribute is read only and the 'Data Units' attribute of the linked Analog Sensor FB configures the value. Refer to the Volumetric Flow Units Table	Simple	Unsigned16	N	2	r	-	-
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 Settings	Configuration of the PID controller. Note: Attribute 4	Array [3]	Floating-Point	N	12	r/w	-	-

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

7.7.1. 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.

Table 7-11 Target Mode attribute

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	Attributes 'Setpoint' is independent of the cyclic data exchange and can only be written through acyclic data exchange.

7.7.2. Note: Attribute 4

The device utilizes a PID compensator in the control loop as a means of optimizing and tuning control. Attribute 'Controller Settings PID' is an array of three numeric scalar values, Proportional Gain (P), Integral Gain (I), and Derivative Gain (D), used as multipliers in the control compensation calculation.

7.8. Actuator Function Block (Slot 3; FB_3) (Not supported by MFM)

Table 7-12 Actuator Function Block (Slot3; FB_3)

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[4]	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. Device only supports normally closed valve type	Simple	Floating-Point	D	4	r	I	-
3	Data Units	Defines the engineering unit for attribute 'Drive'. Note: the engineering	Simple	Unsigned16	C	2	r	-	-

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

		unit [Percent] (1342) and can not be altered.							
4	Control Value	The normalized input value to the actuator (unit-less). (See Control Value of the Controller)	Simple	Floating-Point	D	4	r	-	-
5	Override Channel[5]	Reference to the 'Override' attribute in the Actuator Transducer Block. Fixed to 0x0501	Simple	Unsigned16	C	2	r	-	-
6	Override	Specifies a direct override of the physical actuator. Note: Attribute 6	Simple	Unsigned8	D	1	r(/w)[6]	O	-
7	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 Note: Attribute 7	Simple	Unsigned8	D	1	r/w	-	-

7.8.1. 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.

Table 7-13 Target Mode attribute

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	Attributes 'Override' is independent of the cyclic data exchange and can only be written through acyclic data exchange.

7.8.2. Note: Attribute 6

The following table outlines valid values for this attribute.

Table 7-14 Override Mode attribute

Code	Override Mode	Description
0	Normal Control	Actuator is under normal operational control
1	Closed	Actuator is driven fully closed
2	Open	Actuator is driven fully open

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

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

7.8.3. Note: Attribute 7

The following table outlines valid values for this attribute

Table 7-15 Safe State attribute

Code	Safe State	Description
0	Normal Control	Actuator is under normal operational control
1	Closed	Actuator is driven fully closed
2	Open	Actuator is driven fully open
4	Off (unpowered)	Same as Closed for 4800 only has normally closed valve
5	On (Fully powered)	Same as Opened for 4800 only has normally closed valve
6	Hold Last position	Do not touch the valve configuration when going into safe state

7.9. Actuator Transducer Block (Slot 5; TB_2) (Not supported by MFM)

Table 7-16 Actuator Transducer Block (Slot 5; TB_2)

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.	Simple	Floating-Point	D	4	r	-	-
1	Override	Specifies a direct override of the physical actuator. Note: Attribute 1	Simple	Unsigned8	-	1	r	-	-

7.9.1. Note: Attribute 1

The following table outlines valid values for this attribute.

Table 7-17 Override attribute

Code	Override Mode	Description
0	Normal Control	Actuator is under normal operational control
1	Closed	Actuator is driven fully closed
2	Open	Actuator is driven fully open

8. Appendices

8.1. 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	0 to 4294967296	unsigned int
Floating-Point	4	An IEEE-754 single precision floating point number	-3.8E38 to 3.8E38	float

8.2. Appendix B Data Units

Table 8-2 Volumetric Flow Units Table (See Section 5.2 of Process Control Profile)

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
1324	0x052c	Kilogram per hour	kg/h
1320	0x0528	Gram per hour	g/h
1332	0x0534	Pound per hour	lb/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
1130	0x046a	Pascal	Pa
1133	0x046d	Kilopascal	kPa
1139	0x0473	Torr	torr
1140	0x0474	Atmosphere	atm

Table 8-4 Pressure Reference Table (Vendor Specific)

Value	Description
0	Absolute pressure
1	Effective pressure[7]

[7] Effective pressure + 1013.25 mBar = Absolute pressure

Table 8-5 Temperature Units Table (See Section 5.2 of Process Control Profile)

Value		Description	Symbol
Dec	**Hex**		
1000	0x03e8	Kelvin	K
1001	0x03e9	Degrees Celsius	^{o}C
1002	0x03ea	Degrees Fahrenheit	^{o}F

Brooks 4800 PROFIBUS MFCs/MFMs

LIMITED WARRANTY

Seller warrants that the Goods manufactured by Seller will be free from defects in materials or workmanship under normal use and service and that the Software will execute the programming instructions provided by Seller until the expiration of the earlier of twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller. Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer.

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