EtherCat® Supplemental Manual

GP200 Series
Mass Flow Controllers

BROOKS® INSTRUMENT

Beyond Measure

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.

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Section 2 Quick Start

Section 3 Slave Configuration

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Introduction

EtherCAT is an Ethernet based communication system and is known for its high cycle time and cost-efficient cabling and master application solutions. Brooks Instrument now introduces the EtherCAT® interface on its GP200 Series platform.

This manual is a supplement to the Brooks GP200 Series Installation and Operation Manual. It is assumed that the owner of this EtherCAT mass flow controller is thoroughly familiar with the theory and operation of this device. If not, it is recommended that the owner read the installation and operation manual first before continuing with this supplement.

This manual assumes basic knowledge and understanding of EtherCAT (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 EtherCAT specifications. It is recommended but not required for the purposes of this manual, that the user obtains a copy of the EtherCAT specifications (www.ethercat.org).

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 FAQs are available at the Brooks Instrument web site (www.BrooksInstrument.com).

Definition of Terms

Table 1-1 – Definition of Terms

Abbreviation	Description
CDP	Common Device Profile
CoE	CAN Application Protocol over EtherCAT
ESC	EtherCAT Slave Controller
ESI	EtherCAT Slave Information (EtherCAT Device Description)
ETG	EtherCAT Technology Group
MFC/MFM	Mass Flow Controller/Mass Flow Meter
OD	Object Dictionary
PDO	Process Data Object
PreOp	Pre-Operational
RO	Read Only
RW	Readable and Writable
RXPDO	Receive PDO
SDP	Specific Device Profile
SI	Sub-Index
TXPDO	Transmit PDO
WO	Write Only

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 that are not annotated this way will be assumed decimal (base 10).

Quick Start

This section assumes the owner of the device has a fully operational and trouble-free communications network with appropriate power supplies. This section also assumes that an EtherCAT master application is connected to the network capable of PDO and mailbox data communication. Both types of data communication modes are supported by the Brooks GP200 EtherCAT device.

Brooks® GP200 Series Mass Flow Controllers conform to the ETG.5003 Semiconductor Device Profile specification. This specification consists of two parts:

Part 1: Common Device Profile

The Common Device Profile (CDP) specifies requirements applicable to all devices described in the Specific Device Profiles. Furthermore, it describes features and functionalities which shall be further defined in the Specific Device Profiles.

Part 2xxx: Specific Device Profiles

The Specific Device Profile (SDP) is based on Part 1 (CDP) and defines the data structure of the specific devices. The Brooks GP200 Series implementation of the Semi EtherCAT SDP conforms to ETG.5003.202x.

For a complete specification of a device used in the semiconductor manufacturing industry a SDP shall be read complementary with the CDP. Users may obtain a copy of the EtherCAT specifications at (www.ethercat.org).

Master Hardware

Various companies provide EtherCAT master applications, e.g. TwinCAT from Beckhoff, or offer EtherCAT master stacks to develop a master application, e.g. Acontis. A PC can be used to run most EtherCAT master applications but needs dedicated Ethernet hardware to support the high cycle times and kernel mode operation of the master application, see (www.beckhoff.com).

Physical Interfaces

The available physical interfaces on the EtherCAT device are listed below. Refer to the GP200 Series Installation and Operation Manual for more details.

- Integrated LCD display
- Display push button - cycle through information and rotate display
- Zero push button - easily re-zero the device
- Micro-USB Diagnostic Port
- Twin RJ45 external top mounted communication connections
- 5-pin M8 threaded male connector for power located on upper inlet side

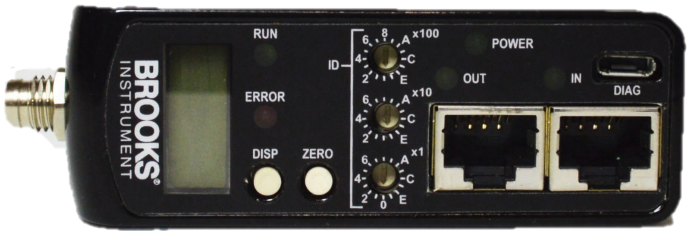

Figure 2-1 – Top View of GP200 EtherCAT Device

Power Supply

Power needs to be supplied via the standard male M8 5-pin connector. The M8 connector is located on the upper inlet side of the device. Refer to Figures 2-2 and 2-3 below.

Figure 2-2 – M8 Power Connector Location

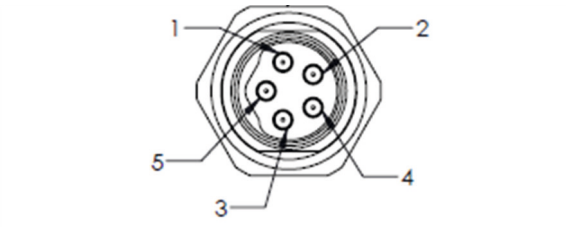

Figure 2-3 – M8 Power Connector Drawing

Pin 1: +24V
Pin 3: Power Common

LEDs

The POWER LED indicates that the device is supplied sufficiently with power.

The IN and OUT port LEDs indicate whether the respective removable port is connected.

The RUN indicator shows the status of the EtherCAT State Machine. Refer to Table 2-1 below for indicator states and descriptions.

Table 2-1 – RUN Indicator States

Indicator States	Slave State	Description
Off	INITIALIZATION	The device is in state INIT
Blinking	PRE-OPERATIONAL	The device is in state PRE-OPERATIONAL
Single Flash	SAFE-OPERATIONAL	The device is in state SAFE-OPERATIONAL
On	OPERATIONAL	The device is in state OPERATIONAL
Flickering	BOOTSTRAP	The device is in state BOOTSTRAP. Firmware download operation in progress

The ERROR indicator shows errors such as watchdog timeouts and unsolicited state changes due to local errors (ex. input error). If, at a given time several errors are present, the error that occurred first shall be indicated. Refer to Table 2-2 below for error states and descriptions.

Table 2-2 – ERROR Indicator States

ERR State	Error Name	Description	Example
On	Application controller failure	A critical communication or application controller error has occurred	Application controller is not responding any more (PDI Watchdog Timeout detected by ESC)
Double Flash	Process Data Watchdog Timeout/ EtherCAT Watchdog Timeout	An application watchdog timeout has occurred.	Sync Manager Watchdog timeout
Single Flash	Local Error	Slave device application has changed the EtherCAT state autonomously, due to local error (see ETG.1000 part 6 EtherCAT State Machine). Error Indicator bit is set to 1 in AL Status register.	Device changes its EtherCAT state from Op to SafeOpError due to a synchronization error.
Blinking	Invalid Configuration	General Configuration Error	State change commanded by master is impossible due to register or object settings, or invalid hardware configuration (pin sharing violation detected by ESC)
Flickering	Booting Error	Booting Error was detected. INIT state reached, but Error Indicator bit is set to 1 in AL Status register	Checksum error in Application controller flash memory.
Off	No error	The EtherCAT communication of the device is in working condition	

Exceptions Display Codes and Reporting

Whenever there is an active Error or Warning reported via the EtherCAT interface, that condition is also indicated on the display with the severity and the Display Code as defined in Table 2-3. When more than one condition exists, then the most severe condition will be displayed. The display will show the following information in the specified sequence:

1. Normal selected information for 3 seconds,

2. Severity (“FAIL”, “ERR”, or “ALrT”) for 1 second,

3. Display Code for 1 second.

The display of any Error or Warning can be disabled individually via EtherCAT object 0x400B and via the diagnostic port. See Table 2-3.

For more detailed information on individual conditions, see Section 4 on Exceptions Implementation.

Table 2-3 – Display Code Summary

Display Code	Condition Detected	Reported As	Severity	Exception Type
1	Non-Volatile Memory Failure	0x00000040	Failure	Manufacturer Error
2	Non-Volatile Corrupt	0x00000080	Failure	Manufacturer Error
4	Network Interface Failure	0x00000008	Failure	Manufacturer Error
5	Selected Calibration Invalid	0x00200000	Failure	Manufacturer Error
6	Identity Information Mismatch	0x00000400	Failure	Manufacturer Error
11	Sensor Failure	0x00010000	Failure	Manufacturer Error
12	Sensor Failure	0x00000020	Failure	Manufacturer Error
13	Flow Sensor Failure	0x00000001	Failure	Manufacturer Error
14	Pressure Sensor Failure	0x00000002	Failure	Manufacturer Error
15	Temperature Sensor Failure	0x00000004	Failure	Manufacturer Error
20	Factory Configuration Failure	0x00400000	Failure	Manufacturer Error
21	Factory Configuration Failure	0x00002000	Failure	Manufacturer Error
103	Non-Volatile Memory Error	0x00000100	Error	Manufacturer Error
105	Gas Page Invalid	0x08000000	Error	Manufacturer Error
109	Flow Sensor Error	0x00008000	Error	Manufacturer Error
110	Flow Sensor Error	0x00004000	Error	Manufacturer Error
113	Page Create Error	0x01000000	Error	Manufacturer Error
115	Flow Alarm High	0x00100000	Alarm	Manufacturer Alarm
116	Flow Alarm Low	0x00200000	Alarm	Manufacturer Alarm
140	Pressure Zero Process Error	0x00100000	Error	Manufacturer Error
141	Flow Zero Process Error	0x04000000	Error	Manufacturer Error
145	Control Deviation Alarm	0x00800000	Alarm	Manufacturer Alarm
155	Actuator Alarm High	0x01000000	Alarm	Manufacturer Alarm
156	Actuator Alarm Low	0x02000000	Alarm	Manufacturer Alarm
165	Zero Alarm High	0x08000000	Alarm	Manufacturer Alarm

166	Zero Alarm Low	0x10000000	Alarm	Manufacturer Alarm
215	Flow Warning High	0x00000100	Alert	Manufacturer Warning
216	Flow Warning Low	0x00000200	Alert	Manufacturer Warning
225	Pressure Warning High	0x00000400	Alert	Manufacturer Warning
226	Pressure Warning Low	0x00000800	Alert	Manufacturer Warning
235	Temperature Warning High	0x00001000	Alert	Manufacturer Warning
236	Temperature Warning Low	0x00002000	Alert	Manufacturer Warning
245	Control Deviation Warning	0x00010000	Alert	Manufacturer Warning
255	Actuator Warning High	0x00004000	Alert	Manufacturer Warning
256	Actuator Warning Low	0x00008000	Alert	Manufacturer Warning
260	Input Voltage Out of Range	0x00000008	Alert	Manufacturer Warning
265	Zero Warning High	0x00080000	Alert	Manufacturer Warning
266	Zero Warning Low	0x00100000	Alert	Manufacturer Warning
270	Totalizer Overflow	0x00020000	Alert	Manufacturer Warning
272	Page Index Invalid	0x00000001	Alert	Manufacturer Warning
273	Page Not Active	0x00040000	Alert	Manufacturer Warning
274	Range Table Error	0x00000002	Alert	Manufacturer Warning
299	Warm Up	0x00000010	Alert	Manufacturer Warning
None	Device ID Switch Changed	0x00000004	Alert	Manufacturer Warning

Introduction

Based on the information provided by the EtherCAT Slave Information file (ESI, device description in XML format) and/or the EEPROM, master applications can configure the EtherCAT network. For the EtherCAT network configuration of the GP200 Series devices, ESI files are provided on the Brooks website or contact Brooks Technical Support for more info.

The following table outlines the structure of the object dictionary and is divided into index areas as defined by ETG.5003. Not all index areas have objects defined within them, as demonstrated in the sections to follow.

Table 3-1 – Object Dictionary Structure

Index	Object
0x0000…0x0FFF	**Data Type Area**
0x1000…0x1FFF	**Communication Specific Data**
0x2000…0x5FFF	**Manufacturer Specific Data including Customer Requested Data**
0x2000 – 0x200B	Manufacturer Specific Inputs
0x200C – 0x200F	Customer Requested Inputs
0x3000 – 0x300B	Manufacturer Specific Outputs
0x300C – 0x300F	Customer Requested Outputs
0x4000 – 0x400B	Manufacturer Specific Configuration Data
0x400C – 0x400F	Customer Requested Configuration Data
0x5000 – 0x500B	Manufacturer Specific Information Data
0x500C – 0x500F	Customer Requested Information Data
0x6000…0xAFFF	**(SDP) Device Type Specific Data**
0x600x	Input Data of the Modules
0x700x	Output Data of the Modules
0x800x	Configuration Data of the Modules
0x900x	Information Data Modules
0xA00x	Diagnosis Data of the Modules
0xF0xx	**Semiconductor Device Profile Area**
0xF300	**Value Range Setting**
0xF38x…0xF3Ax	Exception Handling Data
0xF5xx	**Manufacturer Specific Device Data including Customer Requested Data**
0xF6xx	**SDP and CDP Device Specific Inputs**
0xF7xx	**SDP and CDP Device Specific Outputs**
0xF8xx	**SDP and CDP Device Specific Configuration Data**
0xF9xx	**SDP and CDP Device Specific Information Data**
0xFAxx	**SDP and CDP Device Specific Diagnosis Data**
0xFBxx	**SDP and CDP Command Objects**

Process Data Object (PDO) Mapping

Process Data Object Mapping defines the data that is exchanged between the Master and the device using high speed data exchange. RxPDO Mapping defines the data that is sent from the Master to the device and TxPDO Mapping defines the data that is sent from the device to the Master. Note that the Master normally refers to RxPDO as Outputs and the TxPDO as Inputs.

During network configuration, the user must configure the data to be exchanged. The Brooks GP200 Series devices provide a default and a flexible PDO Mapping object for each of the RxPDO and the TxPDO. The user may select either the default or the flexible PDO Mapping, or both by using the PDO Assignment objects 0x1C12 and 0x1C13.

Each flexible PDO Mapping may be configured with up to 10 objects. Objects assigned to a PDO Mapping must have the appropriate PDO access permission (see the Access column in the object definition tables). Mapping an object requires the user to specify the object's index, sub index, and size in bits in the PDO Mapping object. Objects with a data type that is not a multiple of 8 bits may require that a "pad" object be included so that the next object starts on an 8-bit boundary. An example of a data type that is not a multiple of 8 bits is the bool data type (1 bit). A pad object has an object number of 0x0000:00 with a non-zero-bit size. The pad object counts as one of the 10 objects that can be configured. It is best practice to group objects that are not a multiple of 8 bits so that only 1 pad is required.

PDO mappings are sent from the Master to the device while the device is in PREOP state. If the PDO mappings are not properly configured, the device will return an error when requested to transition to the SAFEOP state. The Error LED will flash RED and the resulting device state will be ERRPREOP.

RxPDO Mapping

The Brooks GP200 Series device supports one preconfigured, default RxPDO at 0x1600 and one user configurable RxPDO at 0x1601.

The default RxPDO for each device profile are defined in the tables below:

Table 3-2 – Default RxPDO (EMFC Profile)

PDO Index	PDO Sub Index	PDO Entry Index	PDO Entry Sub Index	Bit Length	Name
0x1600	0x01	0x7003	0x01	32	Flow SP [REAL]
	0x02	0x7009	0x01	8	Actuator Control
	0x03	0x7009	0x02	32	Actuator Position SP [REAL] See Note below.
	0x04	0x7008	0x01	32	Ramp Time

Note: The Actuator Position SP functionality is not supported in GP200 Series devices. However, the space must be included in this RxPDO to maintain compatibility with the ETG.5003.202x profile definition. Any value placed in this position is ignored. If the user wishes to eliminate this space, the Flexible RxPDO can be used.

The following limitations apply to the flexible RxPDO (0x1601):

- Any PDO entry from the dynamic or the default PDO may only exist once. Setpoint (which can either be real or integer) can only be declared once. If an entry is declared more than once, or any other PDO definition fault exists (bad gap, invalid entry, etc.), the device will not exit pre-op.
- All objects assigned to active RxPDO will be Read-Only when accessed via COE Mailbox.

TxPDO Mapping

The Brooks GP200 Series device supports one preconfigured, default TxPDO at 0x1A00 and one user configurable TxPDO at 0x1A01.

The default TxPDO for each device profile are defined in the tables below:

Table 3-3 – Default TxPDO (EMFC Profile)

PDO Index	PDO Sub Index	PDO Entry Index	PDO Entry Sub Index	Bit Length	Name
0x1Ann	0x01	0xF380	0x00	8	Active Exception Status
	0x02	0x6000	0x01	32	Flow Reading [REAL]
	0x03	0x6001	0x01	32	Pressure Reading [REAL]
	0x04	0x6002	0x01	32	Temperature Reading [REAL]
	0x05	0x6009	0x02	32	Position Read back [REAL] See Note below.
	0x06	0x6009	0x01	32	Position Set point [REAL]

Note: Position Read back [REAL] functionality is not supported in GP200 Series devices. However, the space must be included in this TxPDO to maintain compatibility with the ETG.5003.202x profile definition. The value of this object always returns 0.0. If the user wishes to eliminate this space, the Flexible TxPDO can be used.

Communication Specific Data

Table 3-4 – Communication Specific Data

Index	Sub Index	Data Type	Access	Name	Description
0x1000		UDINT	RO	Device Type	5003. Sub-profile number is defined in 0xF010
0x1001		USINT	RO	Error Register	Bit 0: generic error Bit 1: current error Bit 2: voltage error Bit 3: temperature error Bit 4: communication error Bit 5: device profile specific error Bit 6: reserved Bit 7: manufacturer specific error
0x1008		STRING(n)	RO	Manufacturer Device Name	Name of the device as non-zero terminated string (see ETG.1000)
0x1009		STRING(n)	RO	Manufacturer Hardware Version	Manufacturer Hardware Version
0x100A		STRING(n)	RO	Manufacturer Software Version	Manufacturer Firmware Version
0x100B		STRING(n)	RO	Manufacturer Bootloader Version	Manufacturer Bootloader Version
0x1018		IDENTITY	RO	Identity Object	
	0x01	UDINT	RO	Vendor ID	1538
	0x02	UDINT	RO	Product Code	777
	0x03	UDINT	RO	Revision Number	ESI Revision
	0x04	UDINT	RO	Serial Number	Numerical portion of the device serial number. For complete serial number see F9F0.

0x10F8		ULINT	RO	Timestamp Object	Local Timestamp of the device in ns. See ETG.1020
0x1600			RO	Default RxPDO Map	See Section 3.2
0x1601			RW	Flexible RxPDO Map	See Section 3.2
0x1A00			RO	Default TxPDO Map	See Section 3.2
0x1A01			RW	Flexible TxPDO Map	See Section 3.2
0x1C00		USINT	RO	Communication Type Sync Manager	
	0x01		RO	Communication Type Sync Manager 1	0: unused 1: mailbox receive 2: mailbox send 3: process data output 4: process data input
	0x02		RO	Communication Type Sync Manager 2	0: unused 1: mailbox receive 2: mailbox send 3: process data output 4: process data input
	0x03		RO	Communication Type Sync Manager 3	0: unused 1: mailbox receive 2: mailbox send 3: process data output 4: process data input
	0x04		RO	Communication Type Sync Manager 4	0: unused 1: mailbox receive 2: mailbox send 3: process data output 4: process data input
0x1C12			RW	RxPDO Assignment	See Section 3.2
0x1C13			RW	TxPDO Assignment	See Section 3.2
0x1C32		SCNC_PAR	RO	Output SyncManager Parameter	
	0x01		RO	Synchronization Type	0x00: Free Run
	0x04		RO	Synchronization Types supported	Bit 0: Free Run supported
0x1C33		SCNC_PAR	RO	Input SyncManager Parameter	
	0x01		RO	Synchronization Type	0x00: Free Run
	0x04		RO	Synchronization Types supported	Bit 0: Free Run supported

Manufacturer Specific Data

Manufacturer Specific Inputs

Table 3-5 – Manufacturer Specific Inputs

Index	Sub Index	Data Type	Access	Name	Description
0x2000		USINT	RO	Sensor: Flow Totalizer	
	0x01	ULINT	RW TxPDO	Flow Total	

Manufacturer Specific Configuration Data

Table 3-6 – Manufacturer Specific Configuration Data

Index	Sub Index	Data Type	Access	Name	Description
0x4000			RO	Sensor Flow	
	0x01	Real	RW	Alarm Threshold High	Specified in Flow Units (0x8000:01)
	0x02	Real	RW	Alarm Threshold Low	Specified in Flow Units (0x8000:01)
	0x03	Real	RW	Alarm Settling Time	milliseconds
	0x04	Real	RW	Warning Threshold High	Specified in Flow Units (0x8000:01)
	0x05	Real	RW	Warning Threshold Low	Specified in Flow Units (0x8000:01)
	0x06	Real	RW	Warning Settling Time	milliseconds
0x4001			RO	Sensor Pressure	
	0x01	Real	RW	Alarm Threshold High	Specified in Pressure Units (0x8001:01)
	0x02	Real	RW	Alarm Threshold Low	Specified in Pressure Units (0x8001:01)
	0x03	Real	RW	Alarm Settling Time	milliseconds
	0x04	Real	RW	Warning Threshold High	
	0x05	Real	RW	Warning Threshold Low	
	0x06	Real	RW	Warning Settling Time	

0x4002			RO	Sensor: Temperature Alarm	
	0x01	Real	RW	Alarm Threshold High	Specified in Temp. Units (0x8002:01)
	0x02	Real	RW	Alarm Threshold Low	Specified in Temp. Units (0x8002:01)
	0x03	Real	RW	Alarm Settling Time	milliseconds
	0x04	Real	RW	Warning Threshold High	Specified in Temp. Units (0x8002:01)
	0x05	Real	RW	Warning Threshold Low	Specified in Temp. Units (0x8002:01)
	0x06	Real	RW	Warning Settling Time	milliseconds
0x4003			RO	Sensor Zero Alarm	
	0x01	Real	RW	Alarm Threshold High	Specified in Flow Units (0x8000:01)
	0x02	Real	RW	Alarm Threshold Low	Specified in Flow Units (0x8000:01)
	0x03	Real	RW	Alarm Settling Time	milliseconds
	0x04	Real	RW	Warning Threshold High	Specified in Flow Units (0x8000:01)
	0x05	Real	RW	Warning Threshold Low	Specified in Flow Units (0x8000:01)
	0x06	Real	RW	Warning Settling Time	milliseconds
0x4008			RO	Controller Deviation Alarm	
	0x01	Real	RW	Alarm Deviation Error Band	Specified in Flow Units (0x8000:01)
	0x02	Real	RW	Alarm Settling Time	milliseconds
	0x03	Real	RW	Warning Deviation Error Band	Specified in Flow Units (0x8000:01)
	0x04	Real	RW	Warning Settling Time	milliseconds
0x4009			RO	Actuator Alarm	
	0x01	Real	RW	Alarm Threshold High	Specified in Flow Units (0x8000:01)
	0x02	Real	RW	Alarm Threshold Low	Specified in Flow Units (0x8000:01)
	0x03	Real	RW	Warning Threshold High	Specified in Flow Units (0x8000:01)
	0x04	Real	RW	Warning Threshold Low	Specified in Flow Units (0x8000:01)
0x400B			RO	Display Masks	
	0x01	UDINT	RW	Display Mask, Device Errors	A Bitmask to Enable/Disable the reporting of Device Errors on the display per Table 2-3.
	0x02	UDINT	RW	Display Mask, Device Warnings	A Bitmask to Enable/Disable the reporting of Device Warnings on the display per Table 2-3.
	0x03	UDINT	RW	Display Mask, Manufacturer Errors	A Bitmask to Enable/Disable the reporting of Manufacturer Errors on the display per Table 2-3.
	0x04	UDINT	RW	Display Mask, Manufacturer Warnings	A Bitmask to Enable/Disable the reporting of Manufacturer Warnings on the display per Table 2-3.

Customer Requested Information Data

Table 3-7 Customer Requested Information Data

Index	Sub Index	Data Type	Access	Name	Description
0x500A-500E			RO	Extended Gas Parameter Instance 1 - 5	
	0x01	REAL	RO	Nominal Inlet Pressure	Average of configured minimum and maximum inlet pressure (PSIA)
	0x02	REAL	RO	Nominal Outlet Pressure	Average of configured minimum and maximum outlet pressure (PSIA)

SDP Device Type Specific Data

Input Data

Table 3-8 – Input Data

Index	Sub Index	Data Type	Access	Name	Description
0x6000			RO	Sensor: Flow (floating)	
	0x01	REAL	RO TxPDO	Flow Reading	Current Flow Reading Units: Per Flow Data Unit
0x6001			RO	Sensor: Pressure (floating)	
	0x01	REAL	RO TxPDO	Pressure Reading	Current Pressure Reading Units: Per Pressure Data Unit
0x6002			RO	Sensor: Temperature (floating)	
	0x01	REAL	RO TxPDO	Temperature Reading	Current Temperature Reading Units: Per Temperature Data Unit
0x6004			RO	Sensor: Flow (integer)	
	0x01	INT	RO TxPDO	Flow Reading	Current Flow Reading Units: COUNTS(-32768 to +32767, 24576=100%FS)
0x6005			RO	Sensor: Pressure (integer)	
	0x01	INT	RO TxPDO	Pressure Reading	Current Pressure Reading Units: COUNTS(-32768 to +32767, 24576=100%FS)
0x6006			RO	Sensor: Temperature (integer)	
	0x01	INT	RO TxPDO	Temperature Reading	Current Temperature Reading Units: COUNTS(-32768 to +32767, 24576=100%FS)
0x6009			RO	Actuator	
	0x01	REAL	RO TxPDO	Position Set point	This is the read back of the Set point sent to the actuator. (e.g. valve voltage)
0x600F			RO	Status	
	0x01	BOOL	RO TxPDO	Service in Progress	True if any command service has been started and currently active

	0x02	BOOL	RO TxPDO	Invalid Data Input	True if invalid input in RxPDO
	0x03	BOOL	RO TxPDO	Ramp Active	True if ramp has started and currently active
	0x04	BOOL	RO TxPDO	Valve Control Mode (fully-open)	True if device mode is set to fully-open
	0x05	BOOL	RO TxPDO	Valve Control Mode (fully-closed)	True if device mode is set to fully-closed

Output Data

Table 3-9 – Output Data

Index	Sub Index	Data Type	Access	Name	Description
0x7003			RO	Controller: Flow SP (floating)	
	0x01	REAL	WRITE_OP RxPDO	Flow SP	Sets MFC Flow Set point. Note: If this parameter is mapped in PDO, the "Flow SP [INT]" is excluded from PDO mapping. Units: Per Flow Data Unit
0x7007			RO	Controller: Flow SP (integer)	
	0x01	INT	WRITE_OP RxPDO	Flow SP	Sets MFC Flow Set point Note: If this parameter is mapped in PDO, the "Flow SP [REAL]" shall be excluded from PDO mapping. Units: COUNTS(-32768 to +32767, 24576=100%FS)
0x7008			RO	Controller: Ramp Time	
	0x01	UDINT	WRITE_OP RxPDO	Ramp Time	See Appendix A for a description of the Ramp Feature. Min ramp time=100ms Units: milliseconds
0x7009			RO	Actuator	
	0x01	USINT	WRITE_OP RxPDO	Actuator Control	0: Feedback (default) 1: Reserved 2: Fully Open 3: Fully Close 4: Freeze Position

Configuration Data

Table 3-10 – Configuration Data

Index	Sub Index	Data Type	Access	Name	Description
0x8000			RO	Sensor: Flow (floating)	
	0x01	UDINT	RW	Flow Data Unit	Data Unit for Flow Reading (Ref. ETG.1004) SCCM= 0x00A00000 SLM= 0x03A00000 This value is non-volatile
0x8001			RO	Sensor: Pressure (floating)	
	0x01	UDINT	RW	Pressure Data Unit	Data Unit for Pressure Reading (Ref. ETG.1004) kPa(A)= 0x03220000 psi(A)= 0x00A30000 torr= 0x00A10000 atm= 0x00A20000 BAR= 0x004E0000 mBAR= 0xFD4E0000 Pa= 0x00220000 This value is non-volatile
0x8002			RO	Sensor: Temperature (floating)	
	0x01	UDINT	RW	Temperature Data Unit	Data Unit for Temperature Reading (Ref. ETG.1004) C= 002D0000 K= 00050000 This value is non-volatile
0x8008			RO	Controller: Ramp Time	
	0x01	UDINT	RW	Max Ramp Time	Maximum Ramp Time per User Setting Units: millisecond This value is non-volatile
0x8009			RO	Actuator	
	0x01	USINT	RW	Safe State	Specifies the behavior of the physical actuator while in safe state. MFC is in safe state while in INIT, BOOT, PREOP, or SAFEOP. 0: Valve unactuated (default) 1: Valve fully actuated 2: Hold last set point (flow or position) This value is non-volatile
0x800A			RO	Active Gas Calibration Index	
	0x01	USINT	RW	Index	Specifies current active gas calibration, 1-5 == 0x900A-0x900E This value is non-volatile

Information Data

Table 3-11 – Information Data

Index	SI	Data Type	Access	Name	Description
0x9000			RO	Sensor: Flow (floating)	
	0x01	REAL	RO	Flow Reading Zero Offset	Stores Result of last Zero Offset service command executed. Units %FS
0x9001			RO	Sensor: Pressure (floating)	
	0x01	REAL	RO	P0 Pressure Sensor Full Scale	Units: Per Pressure Data Unit Index.
	0x02	REAL	RO	P0 Pressure Reading Zero Offset	Units: %FS
	0x03	REAL	RO	MFC P0 Pressure High Threshold Alarm Limit	Units: %FS
	0x04	REAL	RO	MFC P0 Pressure Low Threshold Alarm Limit	Units: %FS
0x9002			RO	Sensor: Temperature (floating)	
	0x01	REAL	RO	Temperature Sensor Full Scale	Units: Per Temperature Data Unit Index.
	0x02	REAL	RO	MFC Temp High Threshold Alarm	Units: %FS
	0x03	REAL	RO	MFC Temp Low Threshold Alarm	Units: %FS
0x9008			RO	Controller: Ramp Time	
	0x01	UDINT	RO	Min Ramp Time	Minimum Ramp Time device is capable of. Manufacturer Defined Units: milliseconds
0x900A-0x900E				Gas Parameter Instance 1 to 5	Gas Calibration Page 1 to 5
	0x01	USINT	RO	Gas Calibration Index	1 to 5 = gas calibration instance is active

	0x02	UINT	RO	Gas Number	SEMI Number
	0x03	STRING (128)	RO	Gas Symbol	Text Symbol
	0x04	STRING (128)	RO	Gas Name	Gas Name Text
	0x05	REAL	RO	Minimum Full Scale	Minimum nominal value for this BIN and gas type in sub index 02 Units: SCCM
	0x06	REAL	RO	Nominal Full Scale	Maximum nominal value for this BIN and gas type in sub index 02 Units: SCCM
	0x07	REAL	RO	Configured Full Scale Range	Configured full scale range for the specified gas type in sub index 02 Units: SCCM
	0x08	REAL	RO	Minimum Flow SP	Manufacturer Defined, for this Gas and Bin with Configured Full-Scale Range Units: %FS
	0x09	REAL	RO	Maximum Flow SP	Manufacturer Defined, for this Gas and Bin with Configured Full-Scale Range Units: %FS
	0x0A	UINT	RO	Device Bin Number	Manufacturer defined
	0x0B	UINT	RO	Gas Calibration file revision number	Latest gas library revision stored in memory
	0x0C	UINT	RO	Revision of supported gas table	Revision number and description of update
	0x0D	STRING (10)	RO	Date of Factory Calibration	[DD/MM/YYYY]

Semi Device Profile Area

Table 3-12 – Semi Device Profile

Index	Sub Index	Data Type	Access	Name	Description
0xF000			RO	Semiconductor Device Profile	
	0x01	UINT	RO	Index Distance	Index offset between PDO entries of two consecutive modules (for ETG.5003 = 0x10), e.g. 0x7000, 0x7010
	0x02	UNIT	RO	Maximum Number of Modules	Up to 255 modules are possible. A device can support less than this. This entry described the supported number of modules
0xF010	0x01	UDINT	RO	Module Profile List	Each sub-index lists the profile-number of the corresponding module (hexadecimal representation, i.e. SDP 2000 is 0x07D0) Bit 15…0: SDP Number Bit 31...16: 0x0000

Value Range Setting

Exception Handling Data

See Section 4 for more information on Exceptions Implementation.

Table 3-13 – Value Range Setting

Index	Sub Index	Data Type	Access	Name	Description
0xF380		USINT	RO TxPDO	Active Exception Status	A condensed summary byte describing the collection of active device exceptions after corresponding masks (0xF3Ax) were applied. Bit 0: Device Warning Bit 1: Manufacturer Warning Bit 2: Device Error Bit 3: Manufacturer Error Bit 4...7: Reserved
0xF381	0x01	UDINT	RO TxPDO	Active Device Warning Details	Expanded details of the SDP specific device warning exceptions Bit 0-3: Reserved
0xF382	0x01	UDINT	RO TxPDO	Active Manufacturer Warning Details	Expanded details of the manufacturer warning exceptions specified by the manufacturer
0xF383	0x01	UDINT	RO TxPDO	Active Device Error Details	Expanded details of the SDP specific device error exceptions Bit 0 - Temperature High - Alarm Bit 1 - Temperature Low – Alarm Bit 2 - Pressure High - Alarm Bit 3 - Pressure Low – Alarm Bit 4 - Valve (malfunction) Bit 5 - Ramp Data – Invalid data input Bit 6 - Ramp Error – Cannot complete ramp Bit 7-31 - Reserved
0xF384	0x01	UDINT	RO TxPDO	Active Manufacturer Error Details	Expanded details of the manufacturer error exceptions specified by the manufacturer

0xF390		USINT	RO TxPDO	Latched Exception Status	A condensed summary byte describing the collection of device exceptions after corresponding masks (0xF3Ax) were applied. Bit 0: Device Warning Bit 1: Manufacturer Warning Bit 2: Device Error Bit 3: Manufacturer Error Bit 4...7: Reserved
0xF391	0x01	UDINT	RO TxPDO	Latched Device Warning Details	Expanded details of the SDP specific device warning exceptions Bit 0-31: Reserved
0xF392	0x01	UDINT	RO TxPDO	Latched Manufacturer Warning Details	Expanded details of the manufacturer warning exceptions specified by the manufacturer Mandatory if 0xF382 supported
0xF393	0x01	UDINT	RO TxPDO	Latched Device Error Details	Expanded details of the SDP specific device error exceptions Bit 0 - Temperature High - Alarm Bit 1 - Temperature Low – Alarm Bit 2 - Pressure High - Alarm Bit 3 - Pressure Low – Alarm Bit 4 - Valve (malfunction) Bit 5 - Ramp Data – Invalid data input Bit 6 - Ramp Error – Cannot complete ramp Bit 7-31 – Reserved
0xF394	0x01	UDINT	RO TxPDO	Latched Manufacturer Error Details	Expanded details of the manufacturer error exceptions specified by the manufacturer.
0xF3A1	0x01	UDINT	RW	Device Warning Mask	Bitmask to include the corresponding device warning exception bits (as defined in the device warning details) in the active and latched exception status objects (0xF380 bit 0 and 0xF390 bit 0), if the corresponding bit is TRUE. Default of all bits TRUE (no masking).
0xF3A2	0x01	UDINT	RW	Manufacturer Warning Mask	Bitmask to include the corresponding manufacturer warning exception bits (as defined in the manufacturer warning details) in the active and latched exception status objects (0xF380 bit 1 and 0xF390 bit 1), if the corresponding bit is TRUE. Default of all bits TRUE (no masking).
0xF3A3	0x01	UDINT	RW	Device Error Mask	Bitmask to include the corresponding device error exception bits (as defined in the device error details) in the active and latched exception status objects (0xF380 bit 2 and 0xF390 bit 2), if the corresponding bit is TRUE. Default of all bits TRUE (no masking).
0xF3A4	0x01	UDINT	RW	Manufacturer Error Mask	Bitmask to include the corresponding manufacturer error exception bits (as defined in the manufacturer error details) in the active and latched exception status objects (0xF380 bit 3 and 0xF390 bit 3), if the corresponding bit is TRUE. Default of all bits TRUE (no masking).

Manufacturer Specific Device Data

Table 3-14 – Manufacturer Specific Device Data

Index	Sub Index	Data Type	Access	Name	Description
0xF500		STRING(n)	RO	Manufacturer Model Number	
0xF501		STRING(n)	RO	Product Device Configuration	
0xF502			RO	Zero History	
	0x01	USINT	RO	History Length	Number of days
	0x02	USINT	RW	History Index to Read	Day Number: Writing requested day number will update subindex 0x03 and 0x04
	0x03	UDINT	RO	Time in Seconds	Cumulative time device powered when zero in subindex 0x04 was stored
	0x04	REAL	RO	Daily Zero	Average of all zeros stored on the day requested in subindex 0x02
0xF514			RW	Create Extended Gas Page Service	
	0x01		RW	Command	Offset 0:1 -> Gas ID (uint16) Offset 2 -> Page number (uint8) Offset 3:6 -> Configured Range (float) Offset 7:10 -> Inlet Pressure (float) Offset 11:14 -> Outlet Pressure (float)
	0x02		RO	Status	
	0x03		RO	Response	

SDP and CDP Device Specific Inputs

Table 3-15 – SDP and CDP Device Specific Inputs

Index	Sub Index	Data Type	Access	Name	Description
0xF6F0	0x01	UDINT	RO TxPDO	Input Latch Local Timestamp	Local controller time corresponding to the input latch time in microseconds. It starts at zero on device power-up. If device has physical inputs: time of latching those inputs. If device has no physical inputs: time immediately prior to writing to input SyncManager

SDP and CDP Device Specific Information Data

Table 3-16 – SDP and CDP Device Specific Information Data

Index	Sub Index	Data Type	Access	Name	Description
0xF9F0		STRING(n)	RO	Manufacturer Serial Number	A string representing the manufacturer's serial number for the device. Note: This may have the same value as 0x1018:04.
0xF9F1	0x01	UDINT	RO	CDP Functional Generation Number	Common device profile functional generation number which this device supports.
0xF9F2	0x01	UDINT	RO	SDP Functional Generation Number	SDP functional generation number which this module supports. It shall be specified by each SDP.
0xF9F3		STRING(n)	RO	Vendor Name	String identifying the vendor text.
0xF9F4	0x01	STRING(n)	RO	Semiconductor SDP Device Name	String identifying the device type of this device, as defined by the SDP.
0xF9F5	0x01	USINT	RW RxPDO TxPDO	Output Identifier	The host (e.g. PLC application) increments this value each output change to verify the device has received the output(s). The slave shall not change the received value. Value shall be copied to the TxPDO if 0xF9F5 is mapped.
0xF9F6		UDINT	RO	Time since power on	Time since device has been powered on in seconds.
0xF9F7		UDINT	RO	Total time powered	Total time device has received power in seconds. It persists through power cycle.
0xF9F8		UDINT	RO	Firmware Update Functional Generation Number	FW Update Functional Generation Number supported by the device/module. Value shall be specified by the Firmware Update Profile (ETG.5003-2)

SDP and CDP Command Objects

Table 3-17 – SDP and CDP Command Objects

Index	Sub Index	Data Type	Access	Name	Description
0xFB10				Zero Adjust for Flow Sensor	Service causes the device to modify flow reading offset [0x9nn0.01] such that flow reading [0x6nn0.01 and 0x6nn4.01] value equals the target value sent with the request. Note: “Real” values are rounded to nearest “Int” value, when converting the offset from Real to Integer data type
	0x01	ARRAY [0..3] OF BYTE	WRITE_ OP	Command	Send target reading [REAL]
	0x02	USINT	RO	Status	Supported values: 0: last command completed, no errors, no reply 1: Reserved 2: last command completed, error, no reply 3: Reserved 100-200: indicates how much of the command has been executed (in %, 100 = 0 %, 200 = 100 %) 255: command is executing (if the percentage display is not supported)
	0x03	ARRAY [0..1] OF BYTE	RO	Response	Byte 0: see Sub Index 2 Byte 1: unused (shall be 0)
0xFB11		COMMA ND_PAR		Zero Adjust for Pressure Sensor	Service causes the device to modify pressure reading offset [0x9nn1.02] such that pressure reading [0x6nn1.01 and 0x6nn5.01] value equals the target value sent with the request. Note: “Real” values are rounded to nearest “Int” value, when converting the offset from Real to Integer data type. The value sent should be in the active pressure data units in 0x8001:01
	0x01	ARRAY [0..3] OF BYTE	WRITE_ OP	Command	Send target reading [REAL]
	0x02	USINT	RO	Status	Supported values: 0: last command completed, no errors, no reply 1: Reserved 2: last command completed, error, no reply 3: Reserved 100-200: indicates how much of the command has been executed (in %, 100 = 0 %, 200 = 100 %) 255: command is executing (if the percentage display is not supported)

Index	Sub Index	Data Type	Access	Name	Description
	0x03	ARRAY [0..1] OF BYTE	RO	Response	Byte 0: see Sub Index 2 Byte 1: unused (shall be 0)
0xFB12		COMMAND_PAR		Set Temperature Sensor	Service causes the device to modify temperature reading [0x6nn2.01 and 0x6nn6.01] value equals the target value sent with the request. Note: “Real” values are rounded to nearest “Int” value, when converting the offset from Real to Integer data type
	0x01	ARRAY [0..3] OF BYTE	WRITE_OP	Command	Send adjusted reading [REAL]
	0x02	USINT	RO	Status	Supported values: 0: last command completed, no errors, no reply 1: Reserved 2: last command completed, error, no reply 3: Reserved 100-200: indicates how much of the command has been executed (in %, 100 = 0 %, 200 = 100 %) 255: command is executing (if the percentage display is not supported)
	0x03	ARRAY [0..1] OF BYTE	RO	Response	Byte 0: see Sub Index 2 Byte 1: unused (shall be 0)
0xFB13			RW	Cardinal Point Calibration	
	0x01		RW	Command	
	0x02		RO	Status	
	0x03		RO	Response	
0xFB14			RW	Create Gas Page Service	Offset 0:1 -> Gas ID (uint16) Offset 2 -> Page number (uint8) Offset 3:6 -> Configured Range (Float)
	0x01		RW	Command	
	0x02		RO	Status	
	0x03		RO	Response	
0xFBF0		COMMAND_PAR		Device Reset Command	Execution of this command causes the device to emulate a complete power cycle. This includes an ESC reset. Some devices may require this reset to maintain a specific state not matching power cycle behavior for proper operation, per the SDP. Note: As a consequence of an ESC reset all following devices are disconnected from the network. There are two versions of this command: Standard Reset: as described above Factory Reset: as described above, but additionally, all parameters are restored to as-shipped defaults

Index	Sub Index	Data Type	Access	Name	Description
	0x01	STRING (6)	RW	Command	A device reset is initiated when the following byte sequence is sent. Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72 Byte 5: Standard Reset = 0x00 Factory Reset = 0x66
	0x02	USINT	RO	Status	Supported values: 0: Reserved 1: Reserved 2: last command completed, error, no response 3: Reserved 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
	0x03	STRING (1)	RO	Response	Byte 0: see Sub index 2
0xFBF1		COMMAND_PAR		Exception Reset Command	Execution of this command clears the latched exceptions
	0x01	STRING (5)	RW	Command	A Latched Exception Reset is initiated when the following byte sequence is sent. Byte 0: 0x74 Byte 1: 0x65 Byte 2: 0x73 Byte 3: 0x65 Byte 4: 0x72
	0x02	USINT	RO	Status	Supported values: 0: last command completed, no error, no response 1: Reserved 2: last command completed, error, no response 3: Reserved 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
	0x03	STRING (1)	RO	Response	Byte 0: See Sub index 2

Index	Sub Index	Data Type	Access	Name	Description
0xFBF2		COMMAND_PAR		Store Parameters Command	Execution of this command will store all parameters to non-volatile memory. If a device automatically saves all non-volatile parameters at the time they are written, this command will not take any action.
	0x01	STRING (4)	RW	Command	Read: Bit 1 = 1: slave saves the non-volatile parameters automatically when they are written Bit 2-31: reserved, shall be 0 Write: No action since slave saves the non-volatile parameters automatically
	0x02	USINT	RO	Status	Supported values: 0: last command completed, no error, no response 1: Reserved 2: last command completed, error, no response 3-99: Reserved; shall be 0 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
	0x03	STRING (1)	RO	Response	Byte 0: See Sub index 2
0xFBF3			RO	Calculate Checksum Command	Execution of this command calculates a checksum for all writable, non-volatile parameters as currently stored in non-volatile memory.
	0x01	ARRAY [0…3] OF BYTE	RW	Command	Read: Returns information about the supported checksum type Bit 0= 1 Non-volatile parameters supported Bit 4-6 Reserved, shall be 0 Bit 7= 1 Manufacturer specific algorithm Bit 8…31: Reserved Write: Bit 0=1 Use default checksum algorithm of the slave
	0x02	USINT	RO	Status	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Last command completed, no error, reply ready 3-99: Reserved 100-200: Indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)

Index	Sub Index	Data Type	Access	Name	Description
	0x03	ARRAY [0..n] OF BYTE	RO	Response	Byte 0: See sub index 2 Byte 1: Shall be zero Byte 2-n: Checksum return value. Max length is 64 bytes
0xFBF4			RO	Load Parameters Command	Execution of this command will load all parameters from non-volatile memory. If a device automatically saves all non-volatile parameters at the time they are written, this command will not take any action.
	0x01	ARRAY [0..3] OF BYTE	RW	Command	Read: Bit 1=1 Slave saves the non-volatile parameters automatically when they are written Write: No action since slave saves the non-volatile parameters automatically
	0x02	USINT	RO	Status	Supported values: 0: last command completed, no error, no response 1: reserved 2: last command completed, error, no response 3-99: reserved 100-200: Indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved; shall be 0 255: command is executing (if the percentage display is not supported)
	0x03	ARRAY [0..1] OF BYTE	RO	Response	Byte 0: See sub index 2

Exceptions Implementation

The GP200 EtherCAT MFC detects exception conditions and reports these exceptions via EtherCAT objects and on the display. Each exception is assigned to a category for EtherCAT reporting. Each exception is also assigned a severity classification. The severity classification defines how the exception is displayed and the action the device may take when the exception occurs.

The GP200 MFC supports 3 severity classifications: failure, error and alert

Failure
An exception is assigned to the Failure classification if the exception is likely the result of a component failure or a configuration issue. Either of these results in the device being grossly inaccurate or otherwise unable to control flow. When an exception of this classification is detected, the device will be placed into safe state.

Error
An exception is assigned to the Error classification when the cause of the exception may require action by the user. Exceptions of this type are typically process related and may affect flow accuracy.

Alert
Exceptions assigned to the Alert classification are informational and/or notifications to the user.

The ETG.5003 Semiconductor Common Device Profile defines 4 categories for reporting of exceptions:

- Device Errors
- Device Warnings
- Manufacturer Errors
- Manufacturer Warnings

The assignment of exceptions to Device Errors and Device Warnings is specified by the Mass Flow Controller Specific Device Profile (SDP), ETG.5003.202x. The assignment of exceptions to Manufacturer Errors and Manufacturer Warnings is specified by the manufacturer for each device type.

EtherCAT defines objects to report Exception information and objects to control the reporting of exceptions as shown in Table 4-1. In addition, the Brooks MFC defines 1 additional object to control the display of active errors and warnings.

Each error and warning condition can be enabled/disabled using the Mask objects 0xF3A1, 0xF3A2, 0xF3A3, and 0xF3A4. A set bit in the mask enables the error or warning. See Table 4-2, Table 4-3, and Table 4-4 for the appropriate mask object and bit for each error or warning condition.

Table 4-1 – Objects for reporting and controlling exceptions

Index	Sub Index	Data Type	Access	Name	Description
0xF380		USINT	RO	Active Exception Status	A condensed summary byte summarizing all active device and manufacturer defined exceptions: Bit 0 = Device Defined Warning Bit 1 = Manufacturer Defined Warning Bit 2 = Device Defined Error Bit 3 = Manufacturer Defined Error
0xF381	0x01	UDINT	RO	Active Device Warning Details	Bit mapped reporting of all Device defined Warnings. Note: There are no exceptions of this type defined by the Device Profile.
0xF382	0x01	UDINT	RO	Active Manufacturer Warning Details	Bit mapped reporting of all Manufacturer defined Warnings per Table 4-4
0xF383	0x01	UDINT	RO	Active Device Error Details	Bit mapped reporting of all Device defined Errors as described in Error! Reference source not found..
0xF384	0x01	UDINT	RO	Active Manufacturer Error Details	Bit mapped reporting of all Manufacturer defined Warnings as described in Error! Reference source not found..
0xF390		USINT	RO	Latched Exception Status	A latched version of the Active Exception Status, 0xF380. To clear latched bits see object 0xFBF1, Exception Reset Command.
0xF391	0x01	UDINT	RO	Latched Device Warning Details	A latched version of the Active Device Warning Details, 0xF381. To clear latched bits see object 0xFBF1, Exception Reset Command.
0xF392	0x01	UDINT	RO	Latched Manufacturer Warning Details	A latched version of the Active Manufacturer Warning Details, 0xF382. To clear latched bits see object 0xFBF1, Exception Reset Command.
0xF393	0x01	UDINT	RO	Latched Device Error Details	A latched version of the Active Device Error Details, 0xF383. To clear latched bits, see object 0xFBF1, Exception Reset Command.
0xF394	0x01	UDINT	RO	Latched Manufacturer Error Details	A latched version of the Active Manufacturer Error Details, 0xF384. To clear latched bits, see object 0xFBF1, Exception Reset Command.
0xF3A1	0x01	UDINT	RW	Device Warning Mask	A Bitmask to Enable/Disable the reporting of Device Warnings. Note: There are no exceptions of this type defined by the Device Profile.

Index	Sub Index	Data Type	Access	Name	Description
0xF3A2	0x01	UDINT	RW	Manufacturer Warning Mask	A Bitmask to Enable/Disable the reporting of Manufacturer Warnings per Table 4-4. A bit defined as a 1 enables the corresponding exception.
0xF3A3	0x01	UDINT	RW	Device Error Mask	A Bitmask to Enable/Disable the reporting of Manufacturer Warnings per Error! Reference source not found. A bit defined as a 1 enables the corresponding exception.
0xF3A4	0x01	UDINT	RW	Manufacturer Error Mask	A Bitmask to Enable/Disable the reporting of Manufacturer Warnings per A bit defined as a 1 enables the corresponding exception.
0x400B*	0x01	UDINT	RW	Display Mask, Device Errors	A Bitmask to Enable/Disable the reporting of Device Errors on the display per Table 2-3.
0x400B*	0x02	UDINT	RW	Display Mask, Device Warnings	A Bitmask to Enable/Disable the reporting of Device Warnings on the display per Table 2-3.
0x400B*	0x03	UDINT	RW	Display Mask, Manufacturer Errors	A Bitmask to Enable/Disable the reporting of Manufacturer Errors on the display per Table 2-3.
0x400B*	0x04	UDINT	RW	Display Mask, Manufacturer Warnings	A Bitmask to Enable/Disable the reporting of Manufacturer Warnings on the display per Table 2-3.

* Manufacturer defined

Table 4-2: Device Errors

Display Code	Condition Detected	Reported As	Bit Number	Severity	Exception Type
125	Process Pressure Out of Range High	0x00000004	2	Error	Device Error
126	Process Pressure Out of Range Low	0x00000008	3	Error	Device Error
135	Temperature Out of Range High	0x00000001	0	Error	Device Error
136	Temperature Out of Range Low	0x00000002	1	Error	Device Error
None	Ramp Abort	0x00000010	4	Alert	Device Error
None	Ramp Data	0x00000020	5	Alert	Device Error

Table 4-3: Manufacturer Errors

Display Code	Condition Detected	Reported As	Bit Number	Severity	Exception Type
1	Non-Volatile Memory Failure	0x00000001	0	Failure	Manufacturer Error
2	Non-Volatile Corrupt	0x00000002	1	Failure	Manufacturer Error
4	Network Interface Failure	0x00000004	2	Failure	Manufacturer Error
5	Selected Calibration Invalid	0x00000008	3	Failure	Manufacturer Error
6	Identity Information Mismatch	0x00000010	4	Failure	Manufacturer Error
11	Sensor Failure	0x00000040	6	Failure	Manufacturer Error
12	Sensor Failure	0x00000040	6	Failure	Manufacturer Error
13	Flow Sensor Failure	0x00000100	8	Failure	Manufacturer Error
14	Pressure Sensor Failure	0x00000200	9	Failure	Manufacturer Error
15	Temperature Sensor Failure	0x00000400	10	Failure	Manufacturer Error
20	Factory Configuration Failure	0x00000020	5	Failure	Manufacturer Error
21	Factory Configuration Failure	0x00000020	5	Failure	Manufacturer Error
103	Non-Volatile Memory Error	0x00010000	16	Alarm	Manufacturer Error
105	Gas Page Invalid	0x00020000	17	Alarm	Manufacturer Error
109	Flow Sensor Error	0x00040000	18	Alarm	Manufacturer Error
110	Flow Sensor Error	0x00080000	19	Alarm	Manufacturer Error
113	Page Create Error	0x00020000	17	Alarm	Manufacturer Error
115	Flow Alarm High	0x00200000	21	Alarm	Manufacturer Error
116	Flow Alarm Low	0x00400000	22	Alarm	Manufacturer Error
140	Pressure Zero Process Error	0x00100000	20	Alarm	Manufacturer Error
141	Flow Zero Process Error	0x04000000	26	Alarm	Manufacturer Error
145	Control Deviation Alarm	0x00800000	23	Alarm	Manufacturer Error
155	Actuator Alarm High	0x01000000	24	Alarm	Manufacturer Error
156	Actuator Alarm Low	0x02000000	25	Alarm	Manufacturer Error
165	Zero Alarm High	0x08000000	27	Alarm	Manufacturer Error
166	Zero Alarm Low	0x10000000	28	Alarm	Manufacturer Error

Table 4-4: Manufacturer Warnings

Display Code	Condition Detected	Reported As	Bit Number	Severity	Exception Type
215	Flow Warning High	0x00000100	8	Alert	Manufacturer Warning
216	Flow Warning Low	0x00000200	9	Alert	Manufacturer Warning
225	Pressure Warning High	0x00000400	10	Alert	Manufacturer Warning
226	Pressure Warning Low	0x00000800	11	Alert	Manufacturer Warning
235	Temperature Warning High	0x00001000	12	Alert	Manufacturer Warning
236	Temperature Warning Low	0x00002000	13	Alert	Manufacturer Warning
245	Control Deviation Warning	0x00010000	16	Alert	Manufacturer Warning
255	Actuator Warning High	0x00004000	14	Alert	Manufacturer Warning
256	Actuator Warning Low	0x00008000	15	Alert	Manufacturer Warning
260	Input Voltage Out of Range	0x00000008	3	Alert	Manufacturer Warning
265	Zero Warning High	0x00080000	19	Alert	Manufacturer Warning
266	Zero Warning Low	0x00100000	20	Alert	Manufacturer Warning
270	Totalizer Overflow	0x00020000	17	Alert	Manufacturer Warning
272	Gas Page Index Invalid	0x00000001	0	Alert	Manufacturer Warning
273	Page Not Active	0x00040000	18	Alert	Manufacturer Warning
274	Gas Page Range Table Error	0x00000002	1	Alert	Manufacturer Warning
299	Warm Up	0x00000010	4	Alert	Manufacturer Warning
None	Device ID Switch Changed	0x00000004	2	Alert	Manufacturer Warning

Error and Warning Condition Descriptions

Non-Volatile Memory Failures (Display Codes 1, 2, 103, 105)

This condition is reported when a non-volatile memory failure is detected. If any non-volatile memory failure occurs, the device must be serviced to guarantee that is performing properly.

Network Interface Failure (Display Code 4)

This condition is reported when the device detects that a critical component in the primary communications network has failed. Note that not all component failures can be detected.

Selected Calibration Invalid (Display Code 5)

This condition is reported when the device detects the calibration linearization table stored in the selected gas page is not valid. This would never have occurred if this table was created by Brooks Instrument supplied calibration tool.

Identity Information Mismatch (Display Code 6)

This condition is reported when the product and revision code do not match the firmware SII.

Flow Sensor Failure (Display Code 11,12, 13, 109, 110)

This condition is reported when the device detects failures of the flow sensor and/or related electronics, connector, or cable. Note that this condition is reported as both Sensor Failure and Flow Sensor Error.

Pressure Sensor Failure (Display Code 14)

This condition is reported when the device detects failures of the pressure sensor.

Temperature Sensor Failure (Display Code 15)

This condition is reported when the device detects a failure of the temperature sensor and/or related electronics.

Gas Database Failure and Error (Display Codes 20, 21)

This condition is reported when the device detects a factory configuration failure.

Page Create Error, Page Index Invalid, Page Not Active, Range Table Error (Display Codes 113, 272, 273, 274)

This condition is reported when there is an error with the gas page creation process.

Process Flow Out of Range (Display Codes 115, 116, 215, 216)

This condition is reported when the measured flow (0x6000:01) is out of the user specified limits for the specified time. The user specified limits are set using object 0x4000. Flow limits must be specified in the Flow Units as defined by 0x8000:01 and the time is set in milliseconds.

Table 4-5 – User Specified Flow Limits

Index	Sub Index	Data Type	Access	Name	Description	Default Value
0x4000				Sensor Flow		
	0x01	Real	RW	Alarm Threshold High	Specified in Flow Units (0x8000:01)	110% FS
	0x02	Real	RW	Alarm Threshold Low	Specified in Flow Units (0x8000:01)	-10% FS
	0x03	Real	RW	Alarm Settling Time	milliseconds	0 ms
	0x04	Real	RW	Warning Threshold High		
	0x05	Real	RW	Warning Threshold Low		
	0x06	Real	RW	Warning Settling Time		

Process Pressure Out of Range (Display Codes 125, 126, 225, 226)

This condition is reported when the measured pressure (0x6001:01) is outside of the user specified limits for the specified time. The user specified limits are set using object 0x4001. Pressure limits must be specified in the Pressure Units as defined by 0x8001:01 and the time is set in milliseconds.

NOTE: Pressure limits are also readable using the Sensor Pressure Information at 0x9001 in percent of full scale as defined by the Mass Flow Controller Specific Device Profile (SDP), ETG.5003.202x.

Table 4-6 – User Specified Pressure Limits

Index	Sub Index	Data Type	Access	Name	Description	Default Value
0x4001				Sensor Pressure		
	0x01	Real	RW	Alarm Threshold High	Specified in Pressure Units (0x8001:01)	100 psia
	0x02	Real	RW	Alarm Threshold Low	Specified in Pressure Units (0x8001:01)	0 psia
	0x03	Real	RW	Alarm Settling Time	milliseconds	0 ms
	0x04	Real	RW	Warning Threshold High		
	0x05	Real	RW	Warning Threshold Low		
	0x06	Real	RW	Warning Settling Time		

Temperature Out of Range (Display Codes 135, 136, 235, 236)

This condition is reported when the measured temperature (0x6002:01) is out of the device allowable limits. The device allowable limits are defined by the manufacturer and cannot be adjusted (5°C to 70°C).

Note: The temperature limits are readable using the Sensor Temperature Information at 0x9002 in percent of full scale as defined by the Mass Flow Controller Specific Device Profile (SDP), ETG.5003.202x. Note that full scale is defined as 500 degrees C.

Zero Process Error (Display Codes 140 and 141)

This condition is reported when there is an error with the zero-process detected.

Control Deviation Out of Limits (Display Code 145, 245)

This condition is reported when the difference between measured flow (0x6000:01) and setpoint (0x7003:01) is out of the user specified band for the specified time. The user specified band is set using object 0x4008. The band must be specified in the Flow Units as defined by 0x8000:01 and the time is set in milliseconds.

Table 4-7 – Control Deviation Out of Limits

Index	Sub Index	Data Type	Access	Name	Description	Default Value
0x4008				Sensor Flow		
	0x01	Real	RW	Alarm Deviation Error Band	Specified in Flow Units (0x8000:01)	1000 sccm
	0x02	Real	RW	Alarm Settling Time	milliseconds	1000 ms
	0x03	Real	RW	Warning Deviation Error Band		
	0x04	Real	RW	Warning Settling Time		

Actuator Alarm Out of Limits (Display Codes 155, 156, 255, 256)

This condition is reported when the actuator alarm is out of limits.

Voltage Input Out of Limits (Display Code 260)

This condition is reported when the voltage on the device power input is outside of the following limits:

- ± 25% of the nominal 24 Volts for 0.2 seconds
- ± 20% of the nominal 24 Volts for 1 second.

Totalizer Overflow Alert (Display Code 270)

This condition is reported when the flow totalizer reaches its maximum value. The flow totalizer is a 64-bit unsigned integer which reports total flow in sccm. When the totalizer value reaches its maximum value of 0xFFFFFFFFFFFFFFFF (greater than 18 * 1018) sccm, the totalizer will stop, and the Totalizer Overflow Alert will occur. The flow totalizer value can be reset to zero by writing a zero to object 0x2000:01.

Gas Page Index Invalid (Display Code 272)

This condition is reported when the requested process gas page number is invalid.

Gas Page Not Active (Display Code 273)

This condition is reported when there is an attempt to directly write the nominal flow range of a process gas page that is not currently the active gas page.

Gas Page Range Table Error (Display Code 274)

This condition is reported when the requested process gas page flow range and pressure parameters are not appropriate for the gas and application.

Warm-up (Display Code 299)

This condition is reported when the device has been powered for less than the time specified as the device warm-up time, typically 60 min. During this period, the device has not reached equilibrium temperature and may not be accurate to specification.

Device ID Switch Changed Alert (No Display Code)

This condition is reported when the device EtherCAT address rotary switches have been changed and do not represent the address last reported to the Master. Note: If the master is using station alias address register to access the device address (known as legacy addressing), then the device cannot detect when the master has read the switch setting, and this condition will be reported until the MFC has power cycled or otherwise reset.

Ramping Feature

Setting the Ramp Time (0x7008) to a valid non-zero value activates the Ramping Feature.

A valid Ramp Time is a time that is within the limits specified by 0x9008:01, Min Ramp Time and 0x8008:01, Max Ramp Time.

When starting a ramp from a setpoint of 0, the controller immediately sets the internal setpoint to the Minimum Setpoint as defined in 0x900x:08, and then ramps to the specified setpoint for the time specified in Ramp Time, 0x7008. See Figure 5-1 below.

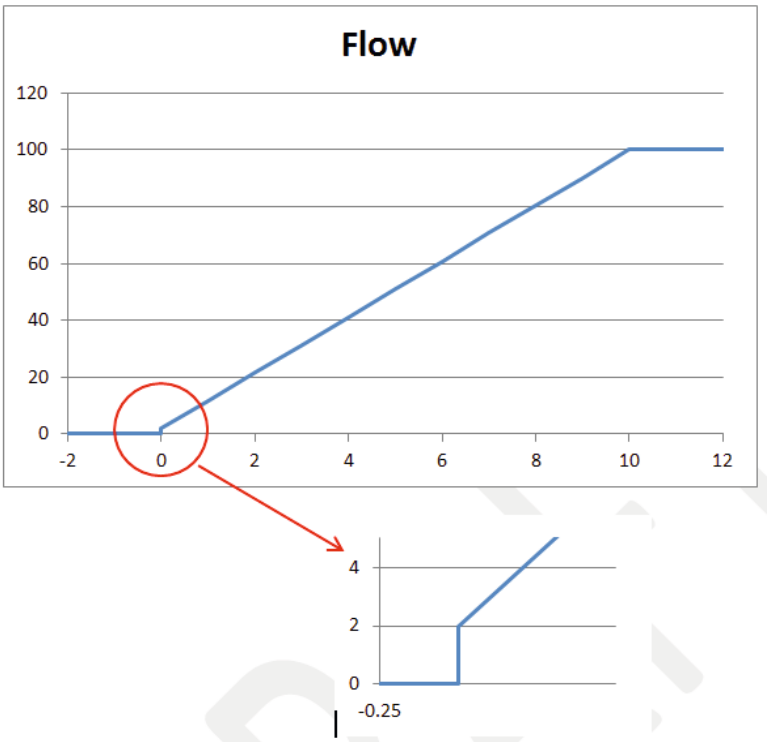

Figure 5-1 – Ramping Feature

If the Ramp Time is changed to a valid non-zero value while a ramp is in progress, the change does not affect the current ramp. A setpoint change is required for the new Ramp Time to take effect.

If the Ramp Time is changed to zero while a ramp is in progress, the ramp is aborted, and the controller immediately attempts to control at the currently specified setpoint. The Ramp Error bit is set in the Active Device Error Details (0xF383).

If the setpoint is changed while a ramp is active, the device will terminate the current ramp and begin a new ramp from the current control flow rate to the new setpoint over the time-period specified by the Ramp Time. This is not considered a ramp abort and no error is indicated.

If a setpoint of zero is received, the device will immediately act on the zero setpoint and stop flow without ramping. Note: Ramping to zero can be enabled by special order. Contact Brooks Technical Support for more information.

The Ramp feature can be monitored using the following:

0x600F:03 – Ramp Active is set when the device is ramping from one setpoint to another. The bit is cleared when the ramp is complete.

0xF383 bit 5 – Active Device Error Details, Ramp Data is set when an invalid Ramp Time is received. The bit is cleared when a valid ramp time is received.

0xF383 bit 6 – Active Device Error Details, Ramp Error is set when a Ramp Time of zero is received by the device when a ramp is active.

LIMITED WARRANTY

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Brooks Instrument can provide start-up service prior to operation when required.
For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

SEMINARS AND TRAINING

Brooks Instrument can provide seminars and dedicated training to engineers, end users and maintenance persons.

Please contact your nearest sales representative for more details.

Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

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