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EtherCAT Module and Object Dictionary Supplement

HIGH ACCURACY MASS FLOW VERIFIER (HAMFV)

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1 HA-MFV EtherCAT Communication

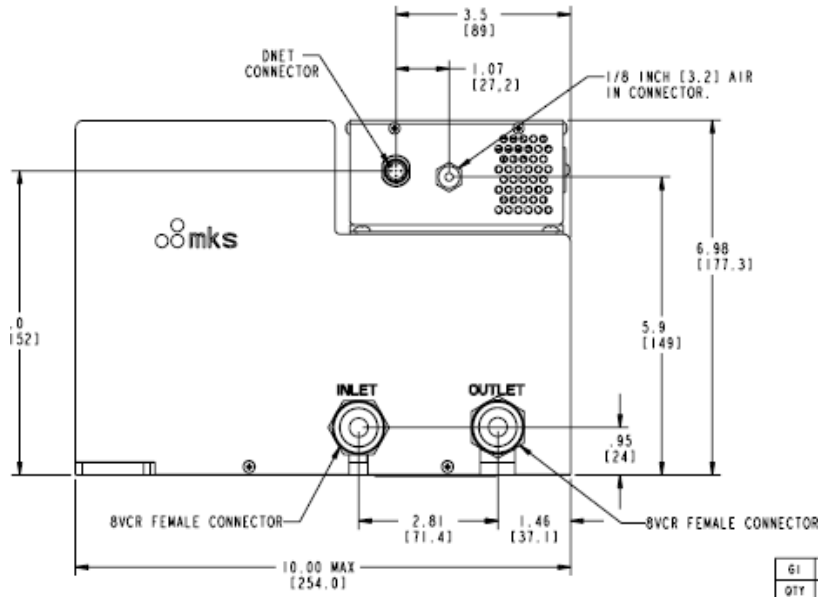

Figure 1: HA-MFV EtherCAT

EthercCAT is a high performance Ethernet based fieldbus network protocol that takes advantage of the efficient way messages between the master and slave devices propagate through the network. Messages or instructions from the master are —passed through‖ each slave device (node), and corresponding data from the slave device is added to the output message that is going to the next node in the network. This process continues throughout the network and, when the message arrives back at the master, every slave has received new input data from the master and returned new output data to the master.

EtherCAT requires an ESI file that provides the master with an appropriate configuration file specific to a HA-MFV Model.

1.1.1 HA-MFV Ethercat Features

Two Ethernet ports marked <IN> and <OUT> are used to propagate messages from the master (IN), adding any data to the string and then allowing message to pass to the next slave or node (OUT).

There are three LEDs for Power (PWR), Network communication (RUN), and network issues (ERR).

LED status indicators function as follows:

- When power has been established, the PWR LED will turn solid green.

- The RUN LED will remain dark until a network connection between the master and slave has been established and the device has been put in an operational mode by the master. At this time, the slave device will respond to messages from the master and the LED is solid green.
- The ERR LED stays dark as long as there are no issues between the master and the slave. If an issue is detected, the LED will flash red.

ECAT ID consists of three rotary switches that provide an option of manually setting the node address (function is normally automatic from the master). A maximum of 4095 distinct addresses can be set by these rotary switches and it is important to note that these switches are in HEX (max setting FFF = 4095 decimal).

- Ethernet port on the side of the electronics enclosure that provides access to the embedded Web Browser (see HA-MFV Manual).

1.1.2 Power Connections

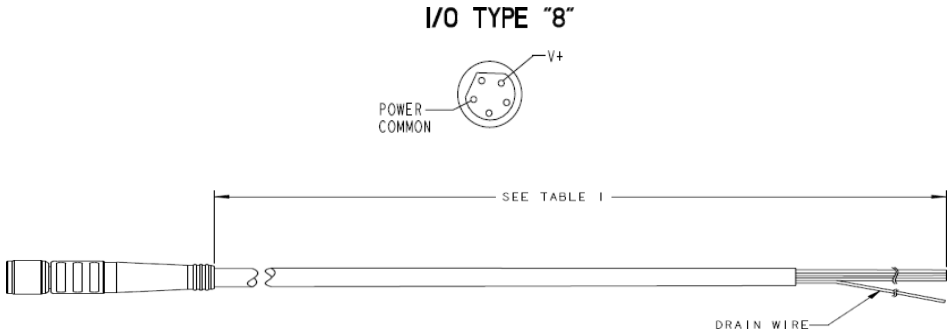

Figure 2: Power Connection

1.2 Profinet Cables

TABLE I		
PART NO.	SUPPLIER PT. NO.	CABLE LENGTH (MM)
1056693-001	120086-5564	2000
1056693-002	120086-5566	5000

Figure 3: Profinet Cables

This cable is for power only. Pin 1 (Brown) supplies +24V and Pin 3 (Blue) is power common. Cable is manufactured for MKS by Molex.

1.3 HAMFV Functional Diagram

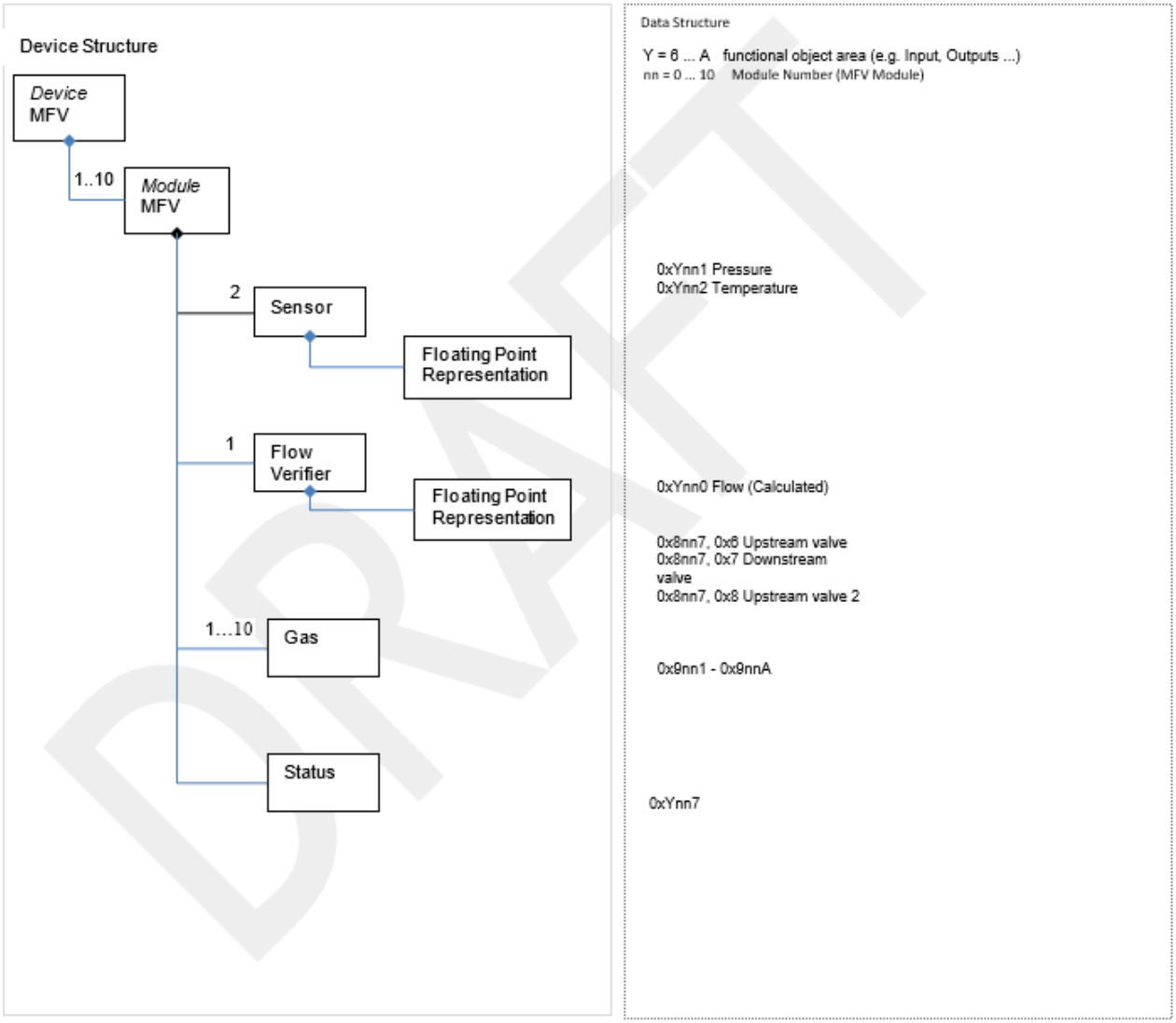

Figure 4: Device Structure MFV

2 EtherCAT Communication Module Description and Object Dictionary

The following table which describes the supported Ethercat attributes of HAMFV is a combination of the Semiconductor EtherCAT Technology Group (ETG) Common Device Profile **(ETG.5003-1 S (R) V1.1.0)** and Specific Device Profile **(ETGXXXX_20xx_MFV_OD_MKS_(008))** compatible with **HAMFV FW 1.0.0.1**

//0x1xxx		**Communication Area**										
Index	**ObjectCode**	**SI**	**DataType**	**M/O/C**	**B/S**	**Access**	**rx/tx**	**Default**	**Min**	**Max**	**Name**	**Description**
//0x10F3	RECORD										Diagnosis History	see definition in clause Object Dictionary for detailed SDP usage definition
//0x16nn, 0x1Ann		**Mapping Area**										
// 0x16nn	RECORD											See clause "Process Data" for process Data definition
// 0x1Ann	RECORD											See clause "Process Data" for process Data definition
//0x6nnx		**Input Data of the Modules**										
0x6nn0	**RECORD**										**Calculated Flow (floating)**	
		0x01	REAL	M		RO	Tx				Flow Reading [REAL]	Calculated Flow Reading Units: Per Flow Data Unit Index
0x6nn1	**RECORD**										**Sensor: Pressure (floating)**	
		0x01	REAL	M		RO	Tx				Pressure Reading [REAL]	Current Pressure Reading Units: Per Pressure Data Unit Index
0x6nn2	**RECORD**										**Sensor: Temperature (floating)**	
		0x01	REAL	M		RO	Tx				Temperature Reading [REAL]	Current Temperature Reading data type REAL Units:Deg C
0x6nnF	**RECORD**										**Status**	
		0x01	USINT	M		RO	Tx				Service in Progress	True if any command service has been started and currently active
		0x02	pad_03								Reserved	
		0x03...0x04									Reserved	
//0X8nnx		**Configuration Data of the Modules**										
0x8nn0	**RECORD**										**Sensor: Flow (floating)**	
		0x01	ENGUNITS	M	B	RO,WR_PREOP					Flow Data Unit	Data Unit for Flow Reading (Ref. ETG.1004) sccm, slm This value shall be non-volatile
0x8nn1	**RECORD**										**Sensor: Pressure (floating)**	
		0x01	ENGUNITS	M	B	RO,WR_PREOP					Pressure Data Unit	Data Unit for Pressure Reading (Ref. ETG.1004) torr,psia This value shall be non-volatile

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0x8nn7	**RECORD**										**Flow Verifier**	
		0x01	USINT	M	B	RO,WR_PREOP					Safe State	0=Valves Open, 1= Valves Closed [Default], This value shall be non-volatile
		0x02	REAL	M	B	RO,WR_PREOP					High Pressure Service constant.	For use with Leak Check, Flow Verify Services. High Pressure Max value. Default: 98Torr
		0x03	REAL	M	B	RO,WR_PREOP					Service Time Constant	This value shall be non-volatile. This attribute stores the duration in seconds that the upstream and downstream valves will remain open for the flow through Manifold Purge service request. This attribute stores the duration in seconds over which the pressure is measured during either the Device Leak Check service request or the System Leak Check Service request.
		0x04	REAL	M	B	RO,WR_PREOP					Low Pressure Service Limit	Used with Flow Verify. The minimum device pressure required to perform a valid flow verification measurement
		0x05	UINT	M	B	RW					Purge Cycles	Number of times to purge. Default = 5.0 This value shall be non-volatile
		0x06	USINT	M		RW	**Tx**				Upstream Valve Position (small orifice)	0 = closed state, 1 = open state, Default =0
		0x07	USINT	M		RW	**Tx**				Downstream Valve Position	0 = closed state, 1 = open state, Default =0
		0x08	USINT	M		RW	**Tx**				Upstream-2 Valve Position (large orifice)	0 = closed state, 1 = open state, Default =0
		0x09	REAL	M	B	RO,WR_PREOP					Pressure Fault Limit	Max Pressure Limit Default: 100Torr, This value shall be non-volatile
		0x0A	UDINT	M	B	RW					Stabilization Time	Stabilization period prior to Flow Verify Service. Default 10 seconds. Stabilization period starts after service request received and MFV inlet/outlet valves open. This value shall be non-volatile
		0X0B	REAL	M		RO					Device Leak Rate	Units in Torr/second
		0X0C	REAL	M		RO					System Leak Rate	Units in Torr/second
0x8nn9	**RECORD**										**Pressure: Full Scale**	
		0x01	See Data Type	M	B	RO					Full Scale	The value of attribute Value corresponding to the Full Scale calibrated measurement of the sensor. This value shall be non-volatile
0x8nnA	**RECORD**										**Pressure: Auto Zero Status**	
		0x01	BOOL	M	B	RO_PREOP					Auto Zero Status	0 = Device is not in process of nulling. 1= Device in process of nulling.

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
//0x9nnx		**Information Data of the Modules**										
0x9nn1	**RECORD**										**Gases - Supported**	
		0x01	USINT	M		RO					Size	Array elements
		0x02	ARRAY [0..71] OF UINT	M		RO					Semi Gas #	Semi standard gas number
		0x03	ARRAY [0..71] OF USINT	M		RO					Gas Revision Level	Revision level from vendor file.
0x9nn2	**RECORD**										**Device Volume**	
		0x01	REAL								Volume	Device Volume in Liters
//0xF380…0xF3FF		**Exception Handling**										
//0xF380											Active Exception Status	see ETG.5003-1
0xF381	ARRAY	0xnn+1	UDINT	M		RO	TX				Active Device Warning Details	Expanded details of the device warning exceptions. Bit 0-31 Reserved
//0xF382											Active Manufacturer Warning Details	see ETG.5003-1
0xF383	ARRAY	0xnn+1	UDINT	M		RO	TX				Active Device Error Details	Expanded details of the device error exceptions. Bit 0 - Pressure High - Alarm Bit 1 - Pressure Low – Alarm/Warning Bit 2 - Pressure Limit – (Alarm only) Bit 3 - Service Arguments Invalid - (Warning Only) Bit 4 - Add Gas Configuration Error -(Alarm Only) Bit 5 - 31 Reserved –
//0xF384											Active Manufacturer Error Details	see ETG.5003-1
//0xF390											Latched Exception Status	see ETG.5003-1
0xF391	ARRAY	0xnn+1	UDINT	M		RO	TX				Latched Device Warning Details	Expanded details of the device warning exceptions. Bit 0-31 Reserved
//0xF392											Latched Manufacturer Warning Details	see ETG.5003-1
0xF393	ARRAY	0xnn+1	UDINT	M		RO	TX				Latched Device Error Details	Expanded details of the device error exceptions specified by the SDP. Bit 0 - Pressure High - Alarm Bit 1 - Pressure Low – Alarm/Warning Bit 2 - Pressure Limit – (Alarm only) Bit 3 - Service Arguments Invalid - (Warning Only) Bit 4 - Add Gas Configuration Error -(Alarm Only) Bit 5 - 31 Reserved –

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
//0xF394											Latched Manufacturer Error Details	see ETG.5003-1
0xF3A1	ARRAY	0xnn+1	UDINT	M	B	RW		0xFFFFFFFF	0x00000000	0xFFFFFFFF	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 bit0 and 0xF390 bit 0), if the corresponding bit is TRUE. Default of all bits TRUE (no masking). This value shall be non-volatile
//0xF3A2											Manufacturer Warning Mask	see ETG.5003-1
0xF3A3	ARRAY	0xnn+1	UDINT	M	B	RW		0xFFFFFFFF	0x00000000	0xFFFFFFFF	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 (0xF382 bit0 and 0xF390 bit 2), if the corresponding bit is TRUE. Default of all bits TRUE (no masking). This value shall be non-volatile
//0xF3A4											Manufacturer Error Mask	see ETG.5003-1
//0xFB10…0xFB16		**SDP Device Specific Commands**										
0xFB10	**RECORD**										**Flow Verify Request**	
		0x01	USINT	M		RO,WR_OP					Command	Supported values: Read 0: Write 1
		0x02	USINT	M		RO,WR_OP					MFC Position	1 – 4095
		0x03	UINT	M		RO,WR_OP					Semi Gas #	Semi standard gas number
		0x04	REAL	M		RO,WR_OP					Flow	Flow = Flow Rate to verify, Use specific parameters based on Flow Parameter. Units = sccm."
		0x05	USINT	M		RO					Status	0: No Error 2: Invalid Gas Standard Number.This would result from a gas standard number that is not in the supported gas list. 3: Invalid Stability Time. The stabilization Time is too high(0x8007:0A) 4: High Pressure. Starting pressure greater than HIgh Pressure Service Constant 0x8007:02 5: Invalid State. If for some reason, State is not in OP 6: Invalid Configuration. This is an error related to an internal MKS error where parameters are not set correctly to allow starting of the Flow Verify Service 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	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0xFB11	**RECORD**										**Manifold Purge**	
		0x01	USINT	M	B	RO,WR_OP					Command	Parameter equals the number of Purge cycles to execute.
		0x02	USINT	M		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)
0xFB12	**RECORD**										**Device Leak Check**	
		0x01	UINT	M	B	RO,WR_OP					Command	Supported values: Read 0: Write 1 MFV will be in "Active" state while service executing. Service time constant defines the duration of this leak check. The Hi pressure service constant serves as a second limit to time.
		0x02	USINT	M		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)
0xFB13	**RECORD**										**System Leak Check**	
		0x01	UINT	M	B	RO,WR_OP					Command	Read 0: Write 1 Service time constant defines the duration of this leak check. The Hi pressure service constant serves as a second limit to time. MFV will be in "Active" state while service executing.
		0x02	USINT	M		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	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0xFB14	**RECORD**										**Flow Verify Reset Service**	
		0x01	USINT	M	B	RO,WR_OP					Command	Read 0: Write 1 MFV will transition to inactive after receiving reset service. In all cases this service will stop service under way. Calibration or return values from service is then invalid. Interruption of a service in progress will result in the up stream and down stream valve states reverting back to state prior to service start.
		0x02	USINT	M		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)
0xFB15	**RECORD**										**Add Gas Service**	
		0x01		M		RO,WR_PREOP					Command	Read 0: Write 1
		0x02	UINT	M		RO,WR_PREOP					SEMI Gas Number	SEMI Gas Number
		0x03	UINT	M		RO,WR_PREOP					Data size	Size of data to be sent from vendor Cfg file.
		0x04	USINT	M		RO,WR_PREOP					Gas Revision Level	From Vendor Cfg file
		0x05	USINT	M		RO,WR_PREOP					The array index	Index to be updated
		0x06	DUINT	M		RO,WR_PREOP					Data CRC	Vendor CRC for data from vendor
		0x07	ARRAY [0..150] OF BYTE	M		RO,WR_PREOP					Data	Array of chars containing configuration data
		0x08	USINT	M		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	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0xFB15		0x02	USINT	M		RO					Status	Supported values: 0: Default value if the command has not been initiated. Not a supported value otherwise. 1: Reserved 2: last command completed, error, no response 3: Reserved 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
		0x03	USINT	M		RW					Response	
0xFBF1	**RECORD**			M		RO					**Exception Reset Command**	Execution of this command clears the latched exceptions. Execution of this command may also optionally acknowledge device or SDP-specific exceptions (if specified) that would otherwise require a separate acknowledgement action to resume normal operation. If this is required, it shall be noted in the SDP or device documentation.
		0x01	ARRAY [0..4] OF BYTE	M		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	M		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, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
		0x03	ARRAY [0..1] OF BYTE	M		RO					Response	Byte 0: see Subindex 2 Byte 1: Unused- Shall be zero

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0xFBF2	**RECORD**			M		RO					**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. In the event that this command may interfere with the safe or expected functional operation of a device, it may be optionally restricted to functioning only in certain functional conditions while in OPERATIONAL state. If the command cannot be performed due to this operating condition, the Abort Code "0x08 00 00 21" shall be returned. In this case, documentation shall be supplied detailing the proper condition to execute this command. All devices shall be able to execute this command in PREOP without restriction.
		0x01	ARRAY [0..3] OF BYTE	M		RW					Command	Read: Bit 0 = 1: slave saves the non-volatile parameters when writing 0xFBF2:01 with 0x65766173 Bit 1 = 1: slave saves the non-volatile parameters automatically when they are written Bit 2-31: reserved, shall be 0 Write: All writable, non-volatile values will be stored in non-volatile memory when the following is sent: Byte 0: 0x73 Byte 1: 0x61 Byte 2: 0x76 Byte 3: 0x65 If other values are written the Abort Code "0x06040043 General parameter incompatibility reason" shall be returned.
		0x02	USINT	M		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, 255: command is executing (if the percentage display is not supported)
		0x03	ARRAY [0..1] OF BYTE	M		RO					Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0xFBF2		0x02	USINT	M		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 there 2: last command completed, error, no response 3: Reserved 3-99: Reserved, 100-200: indicates how much of the command has been executed (in %, 100 = 0%, 200 = 100%) 201-254: Reserved, 255: command is executing (if the percentage display is not supported)
		0x03	USINT	M		RW					Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero Byte 2-n: Checksum return value. Size varies depending on checksum type used. The maximum length shall be 64 bytes.
0xFBF4	**RECORD**		**COMMAND_PAR**	**M**		**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. In the event that this command may interfere with the safe or expected functional operation of a device, it may be optionally restricted to functioning only in certain functional conditions while in OPERATIONAL state. If the command cannot be performed due to this operating condition, the Abort Code "0x08 00 00 21" shall be returned. In this case, documentation shall be supplied detailing the proper condition to execute this command. All devices shall be able to execute this command in PREOP without restriction.

Index	ObjectCode	SI	DataType	M/O/C	B/S	Access	rx/tx	Default	Min	Max	Name	Description
0xFBF4		0x01	USNIT	M		RW					Command	Read: Bit 0 = 1: slave loads the non-volatile parameters when writing 0xFBF4:01 with 0x64616F6C Bit 1 = 1: slave saves the non-volatile parameters automatically when they are written Bit 2-31: reserved, shall be 0 Write: All writable, non-volatile parameters will loaded from non-volatile memory when the following is sent: Byte 0: 0x6C Byte 1: 0x6F Byte 2: 0x61 Byte 3: 0x64 If other values are written the Abort Code "0x06040043 General parameter incompatibility reason" shall be returned.
		0x02	USINT	M		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, 255: command is executing (if the percentage display is not supported)
		0x03	USINT	M		RW					Response	Byte 0: see Subindex 2 Byte 1: Unused - Shall be zero