Modicon X80

BMXETM0200H Expert Frequency Module
User Guide

Original instructions

09/2020

Schneider Electric

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Safety Information

Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a "Danger" or "Warning" safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

⚠ WARNING

UNGUARDED EQUIPMENT

- Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

NOTE: Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

START-UP AND TEST

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

⚠ WARNING
EQUIPMENT OPERATION HAZARD
● Verify that all installation and set up procedures have been completed. ● Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices. ● Remove tools, meters, and debris from equipment.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:
● Remove tools, meters, and debris from equipment.
● Close the equipment enclosure door.
● Remove all temporary grounds from incoming power lines.
● Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

About the Book

At a Glance

Document Scope

This documentation describes the hardware and software implementation of the Hardened X80 2-Channel Turbomachinery Expert Input Frequency module BMXETM0200H.

Validity Note

This documentation is valid for EcoStruxure™ Control Expert 15.0 or later.

Related Documents

Title of documentation	Reference number
Modicon M580, M340, and X80 I/O Platforms, Standards and Certifications	EIO0000002726 (English), EIO0000002727 (French), EIO0000002728 (German), EIO0000002730 (Italian), EIO0000002729 (Spanish), EIO0000002731 (Chinese)
Modicon X80 Racks and Power Supplies, Hardware, Reference Manual	EIO0000002626 (English), EIO0000002627 (French), EIO0000002628 (German), EIO0000002630 (Italian), EIO0000002629 (Spanish), EIO0000002631 (Chinese)
System Time Stamping, User Guide	EIO0000001217 (English), EIO0000001707 (French), EIO0000001708 (German), EIO0000001710 (Italian), EIO0000001709 (Spanish), EIO0000001711 (Chinese)

You can download these technical publications and other technical information from our website at *www.schneider-electric.com/en/download*.

Product Related Information

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter, and apply this product.
Follow all local and national safety codes and standards.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Part I
BMXETM0200H Module Description

Overview

This part gives an overview of the module BMXETM0200H and its technical specifications.

What Is in This Part?

This part contains the following chapters:

Chapter 1
Module Introduction

Overview

This chapter gives an overview of the module.

What Is in This Chapter?

This chapter contains the following topics:

General Information About the BMXETM0200H Module

Definition

The module BMXETM0200H is an expert module for speed and frequency control.

It provides two independent channels for fast speed measuring up to 500 kHz.

Each channel supports:
- One input to interface sensors such as:
  - Magnetic pickup (MPU) in variable reluctance technology
  - Active pickup (APU) including electronic for signal conditioning
  - Incremental encoders
- One reflex output controlled from an embedded compare function.

Platform Compatibility

This module is compatible with the following platforms:
- M340 PLCs
- M580 PLCs including Hot Standby configurations.
  In M580 Ethernet remote I/O configurations, the module can only be installed in a drop that includes an X80 or eX80 performance EIO adapter module (BM•CRA31210).

Typical Application

The module functionalities enable speed measuring for governor control of turbo-machinery such as hydro-power or gas turbine.

The speed value (also called frequency value) is published each 10 ms to the PLC task. This enables fast regulation loops.

Thanks to a pattern recognition feature, the module provides a fast and accurate measurement for asymmetrical machine rotation patterns, such as slow speed reciprocating engines.

Physical Description of the Module

Illustration

The figure below presents the module separated from the terminal block:
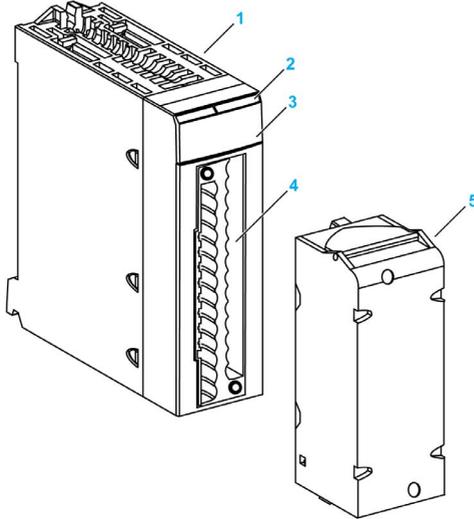
1 Module
2 Module reference label
3 Module and channel status LEDs
4 28-pin connector
5 28-pin removable terminal block

NOTE: The terminal block is supplied separately.

Required Accessories

The BMXETM0200H module requires the use of the following accessories:
● 28-pin removable terminal block BMXFTB2800/2820 *(see page 32)*.
● One BMXXSP••00 shielding connection kit *(see page 38)*.

Dimensions of X80 BMXETM0200(H) Expert Input Frequency Module

General Presentation of X80 BMXETM0200(H) Expert Input Frequency Module
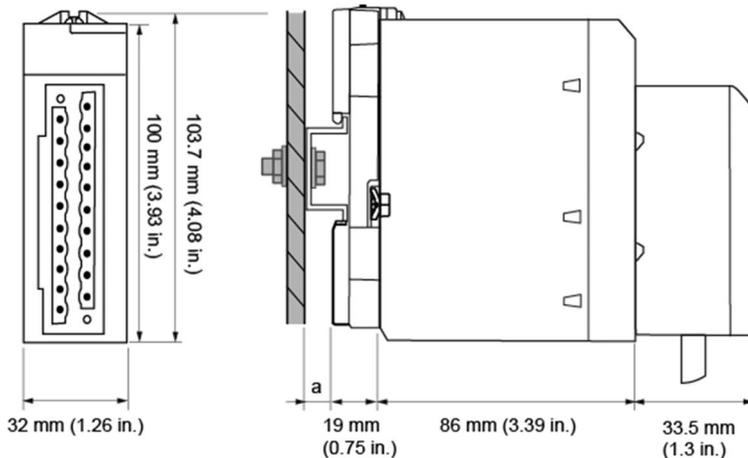
a DIN-rail depth: the value depends on the DIN-rail type used in your platform.

Dimensions of X80 BMXETM0200(H) Expert Input Frequency Module

Module reference	Module dimensions			Installation depth[1]
	Width	Height	Depth	
BMXETM0200(H)	32 mm (1.26 in.)	103.7 mm (4.08 in.)	86 mm (3.39 in.)	119.5 mm (4.69 in.)[1]
(1) DIN-rail depth (a) is not included.				

NOTE: Connectors that are delivered with BMXETM0200(H) modules (20-pin removable terminal blocks) and the corresponding pre-assembled cordsets (BMXFTW*01S) have the same dimensions.

NOTE: Consider clearance for cable installation and spacing around the racks.

Module Diagnostic LEDs

LED Panel Display

A LED display is located on the front panel of the module:
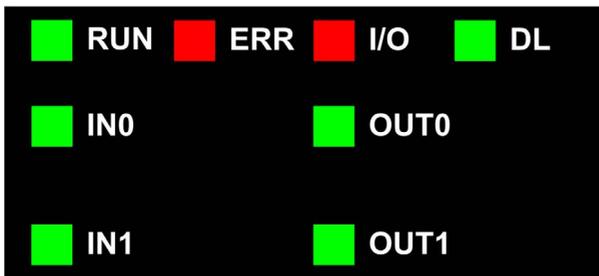
LED Diagnostics

Use the combined states of the LEDs to diagnose the channel and module status:

LED								Description
ERR	RUN	I/O	DL	IN0	OUT0	IN1	OUT1	
OFF								Module is faulty or switched off.
OFF	BLK	–	BLK	–				Firmware download in progress.
ON	OFF							Module error detected.
FLK	OFF	–						No channel configured.
BLK	ON	–						Module has lost communication.
OFF	ON	ON	OFF	–	BLK	–	BLK	Actuator supply fault.
				BLK	–	BLK	–	Sensor supply fault.
				–	FLK	–	FLK	Output over load or short circuit.
				FLK	–	FLK	–	Broken wired detected on MPU.
OFF	ON	OFF		–				Channels are operational.
				ON	–	–	–	Input 0 active state.
				–	–	ON	–	Input 1 active state.
				–	ON	–	–	Output 0 energized.
				–	–	–	ON	Output 1 energized.
ON LED is steady on **OFF** LED is off **FLK** Flickering: ON for 50 ms, OFF for 50 ms, repeat. **BLK** Blinking: ON for 200 ms, OFF for 200 ms, repeat. **–** This LED is not used in determining the channel or module status.								

Module Pin Assignments

Pin Assignments

The following table gives the pin assignment to connect sensors, actuators, and power supplies to the module via the 28-pin terminal block:

Symbol	Pin number		Symbol	Description
APU_OC1	2	1	APU_OC0	Inputs and supply for active pickup (APU) sensors
APU_ST1	4	3	APU_ST0	
+24VDCS	6	5	0VDCIN	
+24VDCS	8	7	0VDCIN	
+24VDCIN	10	9	0VDCIN	Supply sensor interface
MPU0-	12	11	MPU0-	Inputs for magnetic pickup (MPU) sensors
MPU0+	14	13	MPU0+	
MPU1-	16	15	MPU1-	
MPU1+	18	17	MPU1+	
Not used	20	19	Not used	–
Q1	22	21	Q0	Outputs
+24VDCOUT	24	23	0VDCOUT	Supply outputs interface
+24VDCOUT	26	25	0VDCOUT	
FG	28	27	FG	Functional earth, for shield continuation

NOTE: Only one wire per terminal is required to implement the recommended circuit.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block.
- Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.

Failure to follow these instructions will result in death or serious injury.

Chapter 2
Module Specifications

What Is in This Chapter?

This chapter contains the following topics:

Characteristics of the Module

Altitude Operating Conditions

The characteristics apply to the module for use at altitude up to 2000 m (6560 ft). When the module operates above 2000 m (6560 ft), apply additional derating.

For detailed information, refer to chapter *Operating and Storage Conditions (see Modicon M580, M340, and X80 I/O Platforms, Standards and Certifications)*.

Environment and Operating Temperature

The BMXETM0200H module is a ruggedized module, also called hardened (H).

It can be used at extended temperatures -25...70 ºC (-13...158 ºF) and in harsh chemical environments.

This conformal coating treatment increases the isolation capability of the circuit boards and their resistance to:
● Condensation
● Dusty atmospheres (conducting foreign particles)
● Chemical corrosion, in particular during use in sulphurous atmospheres (oil, refinery, purification plant, and so on) or atmospheres containing halogens (chlorine, and so on)

If this equipment is operated outside the -25...70 ºC (-13...158 ºF) temperature range, the equipment can operate abnormally.

⚠ CAUTION
UNINTENDED EQUIPMENT OPERATION
Do not operate this equipment outside of its specified temperature range.
Failure to follow these instructions can result in injury or equipment damage.

General Characteristics

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Do not exceed any of the rated values in the characteristic table.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following table presents the general characteristics of the module:

Characteristic		Value
Counter-channel number		2
Maximum input frequency		500 kHz
I/O Channels per counter	Number of digital inputs per channel	Two: ● One differential type *(see page 23)*. ● One sink type *(see page 23)*.
	Number of digital outputs per channel	One 24 Vdc 0.5 A *(see page 27)*.
Hot swapping supported		Yes
Encoder Compliance		Complies to incremental encoder
Power distribution to sensors or encoders		Voltage: 24 Vdc (from field power supply input) Current: Maximum 300 mA
Back plane power consumption	+3.3 Vdc	Typical: 150 mA Maximum: 200 mA
	+24 Vdc	Typical: 25 mA Maximum: 30 mA
Dielectric strength	Between field and bus or ground	1400 Vdc for 1 minute
	Between differential interfaces	1000 Vdc for 1 minute
	Between inputs and outputs	1000 Vdc for 1 minute
Insulation resistance		> 10 MΩ
Field power supplies	Voltage	19.2...30 Vdc (24 Vdc Typical)
	Current	It depends on the field sensors and the load of reflex output consumption. For module operating: 30 mA.
I/O Diagnostics	Power supplies	Input or output not supplied
	Input	Wrong connection with MPU sensor
	Output	Overload or short circuit

Standards and Certifications

Download

Click the link that corresponds to your preferred language to download standards and certifications (PDF format) that apply to the modules in this product line:

Title	Languages
Modicon M580, M340, and X80 I/O Platforms, Standards and Certifications	- English: *EIO0000002726* - French: *EIO0000002727* - German: *EIO0000002728* - Italian: *EIO0000002730* - Spanish: *EIO0000002729* - Chinese: *EIO0000002731*

Differential Input Characteristics
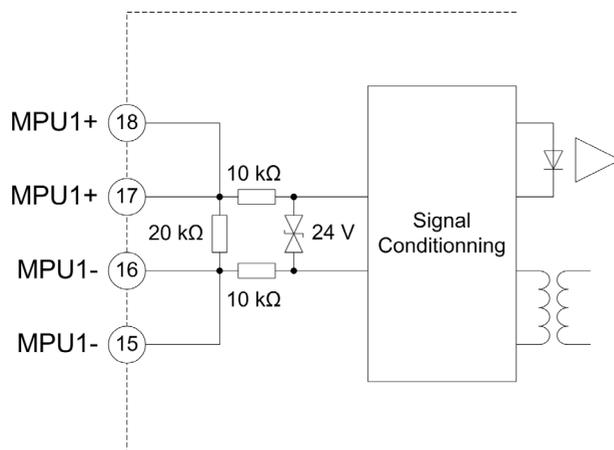
Internal Wiring Diagram

Input Characteristics

⚠ **WARNING**
UNINTENDED EQUIPMENT OPERATION
Do not exceed any of the rated values in the characteristic table.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

This following table presents the characteristics of the differential input:

Characteristic	Value
Number of inputs per channel	One differential input per channel. Fully insulated cell.
Signal handling	Differential: Sinus or square wave
Built in input impedance	Resistive: 20 KΩ +/- 5% up to +/- 5 V Resistive greater than 12 kΩ up to +/- 100 V
User input impedance	Two terminals for external resistor
Maximum input voltage from magnetic pickup (MPU) sensor	200 Vdc peak to peak simultaneously on both channels
(1) The pattern recognition system requires the input voltage to be greater than 4 V peak to peak in **Noisy** mode and 3 V peak to peak in **Sensitive** mode. **(2)** When the minimum input voltage and frequency levels are maintained, the threshold increases in line with the actual signal level.	

Characteristic	Value
Maximum input voltage from instrument potential transformer	150 Vac 50/60 Hz only for one channel 100 Vac 50/60 Hz simultaneous on both channels
Minimum input voltage[1] with sinus wave form (MPU sensor or PT)	Depending on parameter **MPU input Mode** configuration: ● In **Noisy** mode: 2.8 V peak to peak plus 0.08 V peak to peak per 10 kHz ● In **Sensitive** mode: 0.3 V peak to peak plus 0.01 V peak to peak per 10 kHz
Minimum input voltage with square wave form (Encoder)	Depending on parameter **MPU input Mode** configuration: ● In **Noisy** mode: 4.8 V peak to peak (compliant with RS422 line driver) ● In **Sensitive** mode: 1 V peak to peak

Threshold (Immunity)	Depending on parameter **MPU input Mode** configuration:
	● In **Noisy** mode: +1.2 V (no pulse is detected while the signal value is less than the threshold)
	● In **Sensitive** mode[2]: Also depending on the input signal:
	  ❍ +0.05 V for 0.3 V peak to peak
	  ❍ +1 V for 5 V peak to peak or above

Minimum pulse detected with MPU sensor	Time delay > 1.5 µs with U = +2.5 V (Negative pulse is mandatory between pulses)
Maximum frequency	Square wave in **Sensitive** mode: 500 kHz Square wave in **Noisy** mode: 250 kHz Sinus wave in **Sensitive** mode: 250 kHz Sinus wave in **Noisy** mode: 250 kHz
Minimum frequency with MPU sensor	Depending on parameter **MPU input Mode** configuration: ● In **Noisy** mode: 1 Hz ● In **Sensitive** mode: 12 Hz

(1) The pattern recognition system requires the input voltage to be greater than 4 V peak to peak in **Noisy** mode and 3 V peak to peak in **Sensitive** mode.
(2) When the minimum input voltage and frequency levels are maintained, the threshold increases in line with the actual signal level.

⚠ WARNING

UNEXPECTED VALUES

Ensure that the minimum signal frequency levels are maintained.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Sink Input Characteristics
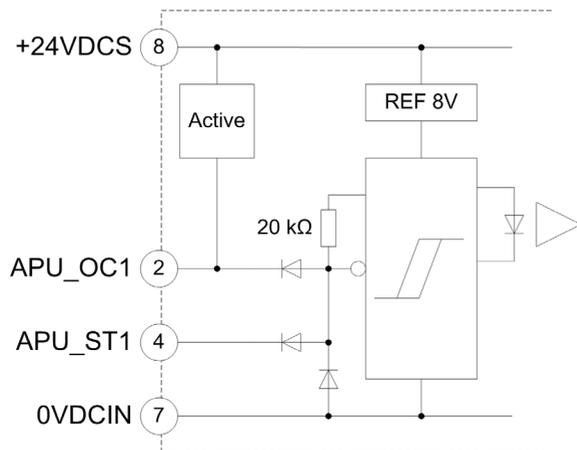
Internal Wiring Diagram

Input Characteristics

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Do not exceed any of the rated values in the characteristic table.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following table presents the sink input characteristics for 3 wire sensors:

Characteristic	Value
Number of inputs per channel	One input per channel 0 V is common between the two channels
Type	Input is sink current to 0 V with two dedicated terminals: ● APU_OC for open collector source ● APU_ST for supply tracking, TTL, or any signal conditioner 24 V
Voltage limits	-0.5...+30 Vdc
Active state voltage	APU_OC or APU_ST less than 2 V
Passive state voltage	APU_OC or APU_ST greater than 2.5 V
Built in line polarization	APU_ST terminal provides a 20 kΩ pull up to 8 V APU_OC terminal provides a 2 kΩ pull up resistor to 8 V then 10 kΩ up to 24 V APU_OC terminal provides a dynamic 10 Ω pull up to 8 V on rising edge detection. 35 kHz signal can be detected up to 300 m for sensor to module without external pull-up adaptation.
Minimum pulse detected	1 µs
Maximum frequency	500 kHz

Output Characteristics

Output Characteristics

⚠ **WARNING**
UNINTENDED EQUIPMENT OPERATION
Do not exceed any of the rated values in the characteristic table.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following table presents the digital output characteristics:

Characteristic		Value
Number of outputs per channel		One 24 Vdc source 0.5 A
Output voltage		19.2...30 Vdc
Minimum load current		None
Maximum load current	Each Point	0.5 A
	Per Module	1.0 A
Off state leakage/point		-0.1 mA maximum
On state output voltage drop		3.0 Vdc maximum
Short circuit output current		(each point) 1.5 A maximum
Surge current maximum		Self-limiting per channel
Maximum load capacitance		50 µF
Maximum load inductance L = load inductance (Henry) I = load current (A) F = switching frequency (Hz)		0.5 Henry at 4 Hz switching frequency $L = 0.5 / (I^2 \times F)$
Maximum frequency		10 kHz with load = 2 kΩ. **NOTE:** To be considered when the **OutputBlock** parameter is set to **Scaling Pulse**. For more detail, refer to the module functionality Reflex Output Block Function *(see page 73)*.
Output protection (internal)		Transient voltage suppression
Short circuit		Short circuit protection of the output with breakdown

Characteristic		Value
Polarity of output	By default	Logical 0 provides 0 V
	Configurable setting	Applied when the module is operating without any detected fault
Fallback policy	By default	Apply 0
	Configurable setting	Applied to the output when the module has lost the communication or PLC Stop or Halt. Apply 0, 1 or maintain the last value

Chapter 3
Module Installation

Overview

This chapter provides information to install the module.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Installing the Module	30
Connecting 28-pin Terminal Block	32
How to Avoid Electromagnetic Interference	38

Installing the Module

Installation Precautions

Power is supplied to the module by the bus at the bottom of the rack (3.3 Vdc and 24 Vdc).

⚠ ⚠ DANGER
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH
● Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block. ● Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.
Failure to follow these instructions will result in death or serious injury.

Backplane Slot Selection

In the main local rack, slot 00 (the first module slot after the power supply) is where the CPU is installed. In the main rack of a remote drop, slot 00 is where the (e)X80 EIO adapter module is installed. The remaining slots can be used by the module.

Before installing a module, take off the protective cap from the module connector located on the rack.

Installing the Module on the Rack

Mount the module in a single slot on the backplane:

Step	Action	Illustration
1	**NOTE:** Before positioning the pins, remove the protective cover. Position the locating pins situated at the rear of the module (on the bottom part) in the corresponding slots in the rack.	
2	Swivel the module towards the top of the rack so that the module sits flush with the back of the rack. It is now set in position.	
3	Tighten the retaining screw to hold the module in place on the rack. Tightening torque: 0.4...1.5 N•m (0.30...1.10 lbf-ft).	
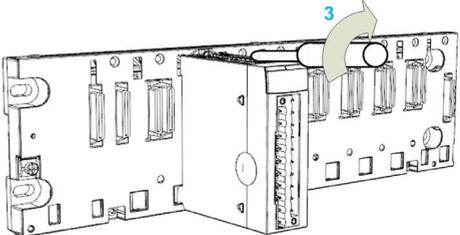
Connecting 28-pin Terminal Block

Overview

The module uses one of the 2 types of 28-pin removable terminal blocks:
● BMXFTB2800 caged clamp terminal block
● BMXFTB2820 spring terminal block

Cable Ends and Contacts

Each terminal block can accommodate:
● Solid core wire
● Flexible stranded wire
● Wire with DZ5-CE type cable ends

28-pin Terminal Blocks Description

The following table describes the characteristics of the terminal blocks:

-	BMXFTB2800 Caged Clamp Terminal Block	BMXFTB2820 Spring Terminal Block
Front view		
Number of wires supported	1	1
Wire gauge supported Minimum	AWG 24 (0.34 mm^2)	
Wire gauge supported Maximum	AWG 16 (1.5 mm^2)	
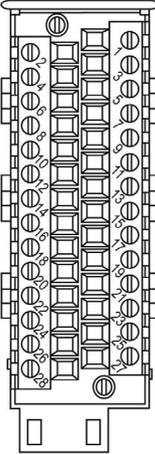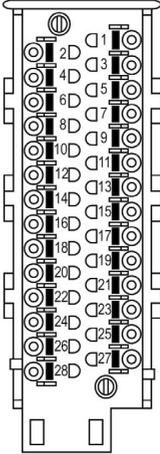
-	BMXFTB2800 Caged Clamp Terminal Block	BMXFTB2820 Spring Terminal Block
Wiring constraints	Caged clamp terminal blocks have captive screws. On the supplied blocks, these screws are not tightened. To tighten the screws, use flat-tipped screwdriver with a diameter of 3 mm.	To insert and remove wires from the connectors, use a 2.5 x 0.4 mm screwdriver to open the clamp by pushing the corresponding button.
Maximum screw tightening torque	0.5 N•m (0.37 lb-ft)	–

The connectors of the terminal blocks are designed for only one wire or one cable end.

⚡ ⚠ DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

Do not connect more than one wire per terminal block connector.

Failure to follow these instructions will result in death or serious injury.

Installing the 28-Pin Terminal Block

⚡ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block.
- Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.

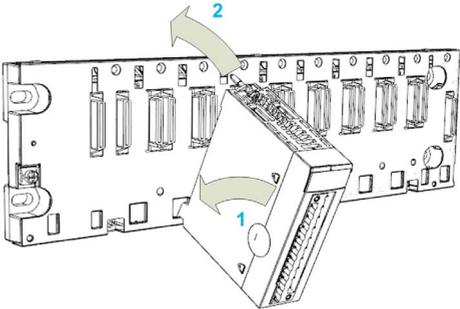**Failure to follow these instructions will result in death or serious injury.**

Plugging a terminal block into the incorrect electronic module can cause an electric shock or unintended operation of the application and/or damage the electronic module.

Coding the terminal block *(see page 35)* help to prevent the terminal block from being mounted on an incorrect module.

⚠ ⚠ **DANGER**
ELECTRIC SHOCK OR UNINTENDED EQUIPMENT OPERATION
Connect the terminal blocks to their designated location.
Failure to follow these instructions will result in death or serious injury.

⚠ **CAUTION**
TERMINAL BLOCK IMPROPERLY FIXED TO THE MODULE
● Follow the procedure instructions to fix the terminal block to the module. ● Verify that the screws are tightened.
Failure to follow these instructions can result in injury or equipment damage.

To fit the 28-pin terminal block onto the module, follow these steps:
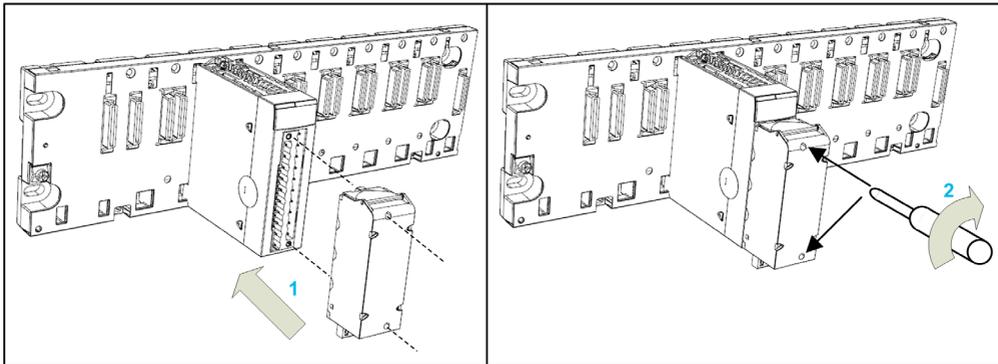
Step	Action
1	Insert the rear lower part of the terminal block into the front lower part of the module.
2	Tighten the two mounting screws located on the lower and upper parts of the terminal block. **NOTE:** Apply a tightening torque of 0.4 N•m (0.30 lb-ft).

The following figure shows the method for opening the 28-pin terminal block cover so that it can be wired.
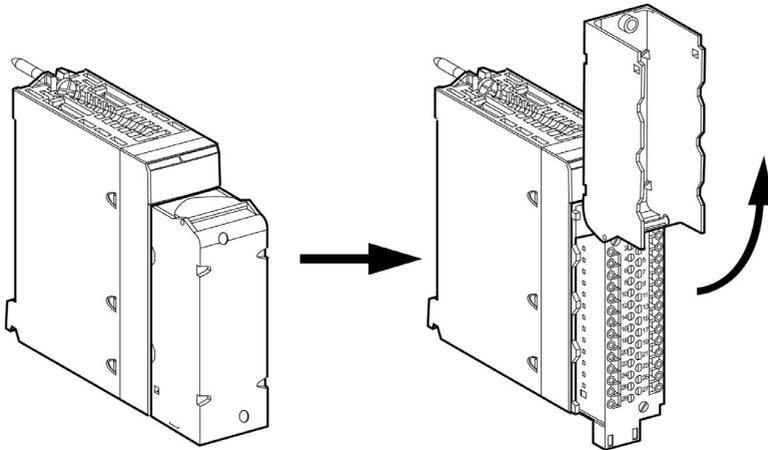
Labeling 28-Pin Terminal Block

The label for the 28-pin terminal block is supplied with the module.

Each label has two sides and can be slitted behind the front part of the cover:
- One side is visible from the outside when the cover is closed. This side features the commercial product references, an abbreviated description of the module, and a blank section for customer labeling.
- One side is visible from the inside when the cover is open. This side shows the terminal block connection diagram.

Coding the Terminal Block

When installing a terminal block on a module, you can code the terminal block so that it may be used only with a particular module. To do this, apply studs to both the terminal block and to the module in a pattern so that the 2 components fit each other, but do not fit other modules or terminal blocks. In this way, you can reduce the likelihood that a terminal block will be mounted on a module other than the intended module.

To perform coding, use the studs on the **STBXMP7800** guidance wheel. You can insert studs in the 6 guidance slots on the left side of the module, and in the corresponding 6 slots in the terminal block.

NOTE: The module connector has indicators that show the proper direction for inserting studs into a terminal block installation.

To fit the terminal block to the module:
- a module slot with a stud corresponds to an empty slot in the terminal block, and
- a terminal block slot with a stud corresponds to an empty slot in the module

The following diagram depicts a guidance wheel and the slots on the module used for coding the terminal block:

Guidance wheel

Detachable stud

Guidance slots

Module slots
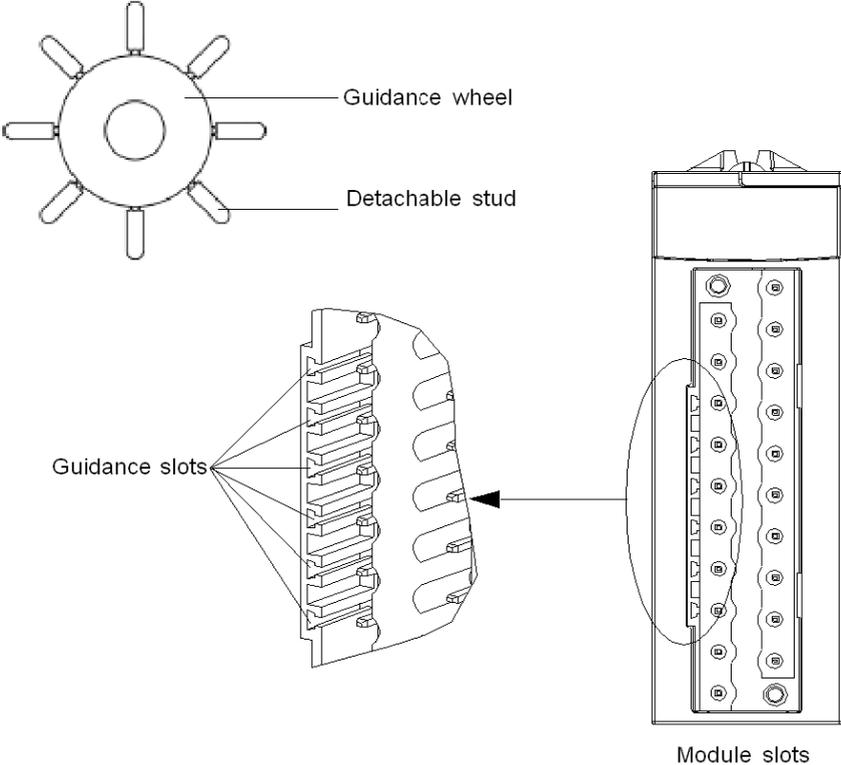
The following example depicts a coding configuration that allows a terminal block to fit together with a module:

Terminal block   Module

Empty slots

Slots filled with studs

Slots filled with studs

Empty slots
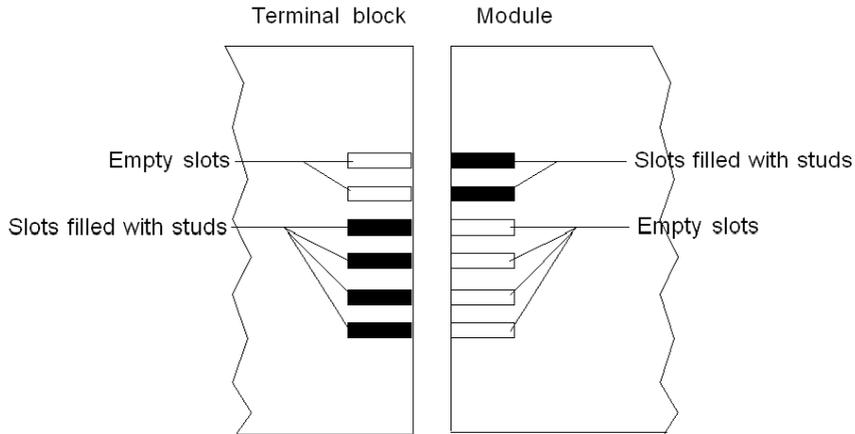
The following example depicts a coding configuration that obstructs the terminal block from fitting onto the module:

Terminal block   Module

Empty slot

Slots filled with studs

Slots filled with studs

Empty slots
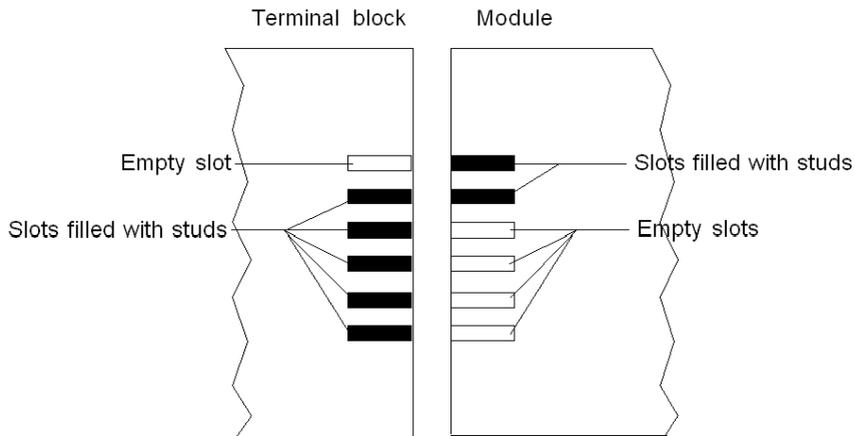
How to Avoid Electromagnetic Interference

Electromagnetic Protection

Electromagnetic perturbations may cause unintended equipment operation.

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
In a highly disturbed electromagnetic environment: ● Use the BMXXSP••00 shielding connection kit to connect the shielding of each cable. ● Use a stabilized and dedicated 24 Vdc power supply and a shielded cable for connecting the supply to the module. ● Use shielded cables for inputs and outputs if any of them are wired.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTE: For more detailed information about BMXXSP••00 shielding connection kit, refer to *Modicon X80 Racks and Power Supplies, Hardware, Reference Manual.*

The figure below shows the recommended circuit for a high-noise environment using the BMXXSP••00 shielding connection kit:
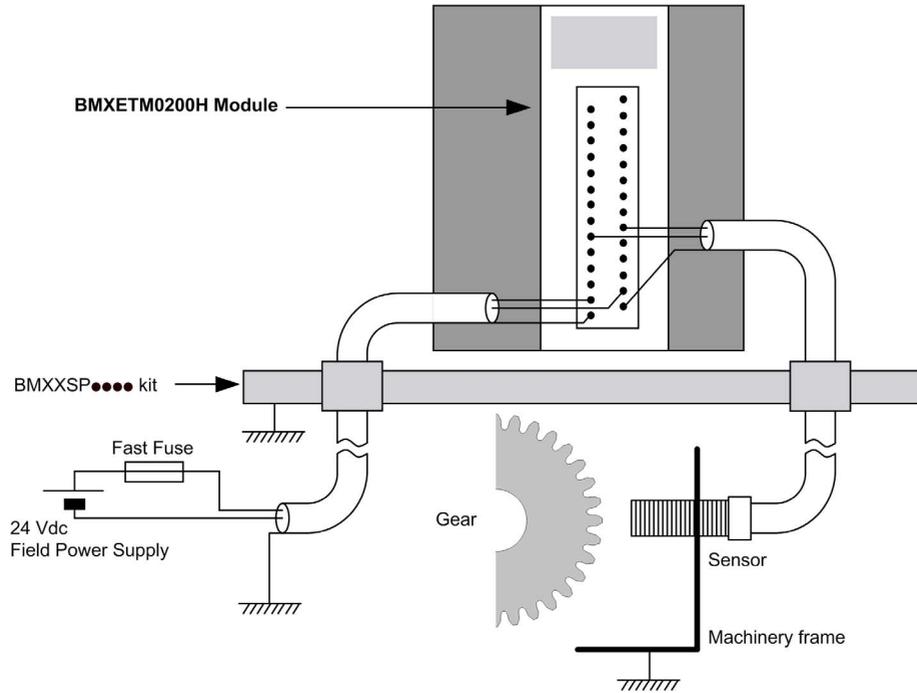
Improper fuse selection could result to damage to the module.

⚠ CAUTION
POTENTIAL MODULE DAMAGE - IMPROPER FUSE SELECTION
Use fast acting fuses to protect the electronic components of the module from overcurrent and reverse polarity of the input/output supplies.
Failure to follow these instructions can result in injury or equipment damage.

Chapter 4
Module Wiring

Overview

This chapter gives sensors wiring examples.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Magnetic Pickup Sensor Wiring	42
Active Pickup Sensors Wiring	45
Incremental Encoders Wiring	48
Power Supplies and Actuators Wiring	50

Magnetic Pickup Sensor Wiring

Introduction

Use the BMXFTB2800 or BMXFTB2820 28-pin terminal blocks to connect the magnetic pickup sensors to the module.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block.
- Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.

Failure to follow these instructions will result in death or serious injury.

Input Signal Restriction

MPU interface cannot handle variation in signal level greater than 50% from pulse to pulse when configured in **Sensitive** mode. Air gap variation from tooth to tooth may lead the couple MPU/Gear providing such signal level variation even at constant metal speed. The **Noisy** mode must be selected in this case to detect the whole pulses.

⚠ WARNING

UNEXPECTED APPLICATION BEHAVIOR - INCORRECT INTERPRETATION OF INPUT DATA

Set the parameter **MPU Input Mode** to **Noisy** when the level variation detected by the MPU sensor is greater than 50% from tooth to tooth.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Sensor (MPU) Wiring

Wiring example for an MPU sensor on channel 1:
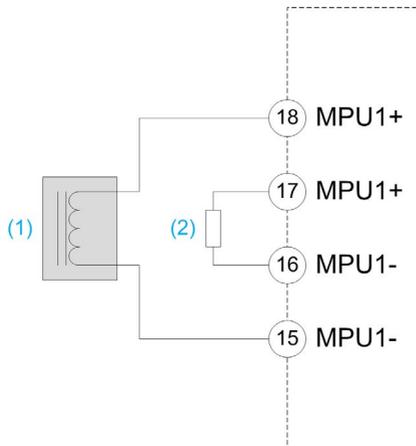
1 Variable reluctance sensor
2 Optional load

Optional Load

The differential input circuit is fully isolated and requires the outputs of the sensor to be free of potential.

When the built-in input impedance *(see page 23)* does not match with the characteristics of the MPU sensor, place an appropriate optional load as terminating impedance.

In case of inappropriate termination resistance, glitches or high voltage picks may appear in the frequency input signal.

⚠ **WARNING**
UNEXPECTED VALUE
● Check that the optional load value is conform to the supplier recommendations. ● Install the sensor in accordance to the supplier recommendation.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Precautions

Externally wire pin 13 (MPU0+) to pin 12 (MPU0-) and pin 17 (MPU1+) to pin 16 (MPU1-) if the application does not use magnetic pickup sensors:
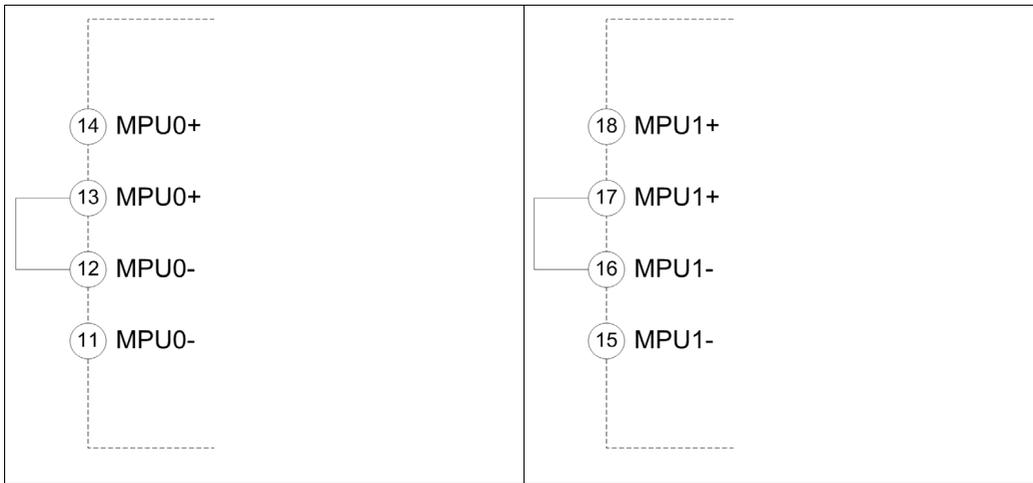
Active Pickup Sensors Wiring

Introduction

Use the BMXFTB2800 or BMXFTB2820 28-pin terminal blocks to connect the active pickup (APU) sensors to the module.

⚡ ⚠ DANGER
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH
● Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block. ● Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.
Failure to follow these instructions will result in death or serious injury.

⚠ WARNING
UNEXPECTED VALUES
Do not use incorrect APU sensor source output type to the specified input port.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following three wires sensors can be connected to the sink type digital input. They are classified by output signal types:
● Open collector sink
● Supply tracking
● TTL
● Open collector source

Precaution

To prevent from interference, you must short wire the MPU interface *(see page 44)* when using active pickup sensor (APU). Otherwise detected interference may cause unexpected measured values.

⚠ WARNING
UNEXPECTED VALUES
Be sure to short wire the MPU interface when using active pickup sensor (APU).
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Open Collector Sink Type Wiring

Wiring example for an APU sensor on channel 1:
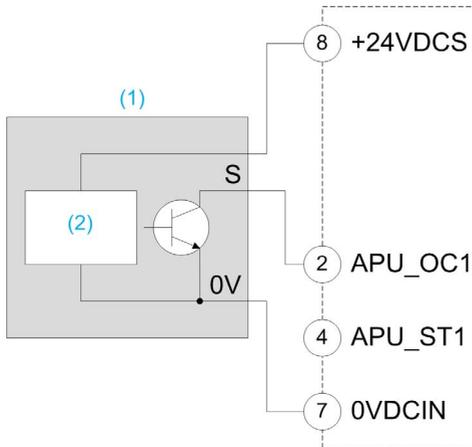
(1) Sensor with open collector sink output
(2) Magnetic hall effect

Supply Tracking Type Wiring

Wiring example for an APU sensor on channel 1:
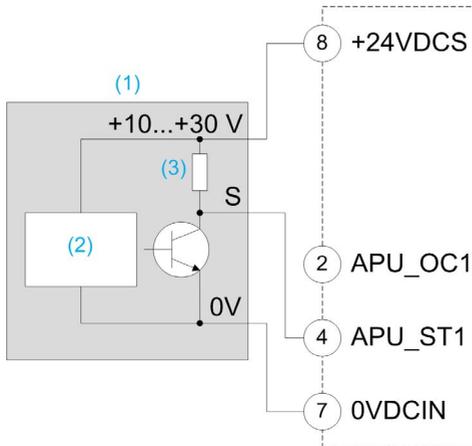
(1) Sensor with supply tracking output
(2) Magnetic hall effect
(3) Generally 2 kΩ

TTL Type Wiring

Wiring example for an APU sensor on channel 1:
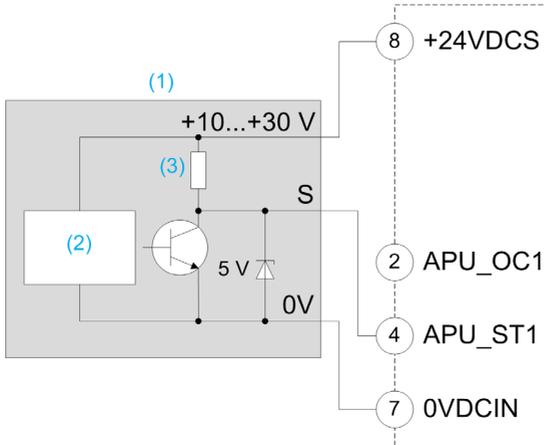
(1) Sensor with TTL output
(2) Magnetic hall effect
(3) Generally 2 kΩ

Open Collector Source Type Wiring

Wiring example for an APU sensor on channel 1:
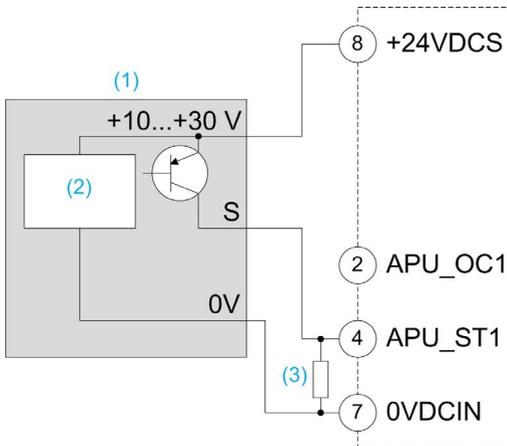
(1) Sensor with open collector source output
(2) Magnetic hall effect
(3) Maximum 2 kΩ

Incremental Encoders Wiring

Introduction

Use the BMXFTB2800 or BMXFTB2820 28-pin terminal block to connect incremental encoders to the module.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block.
- Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.

Failure to follow these instructions will result in death or serious injury.

The following types of incremental encoder can be connected to respectively:
- Differential input: RS422 type
- Sink input: Line driver type

RS422 Type Wiring
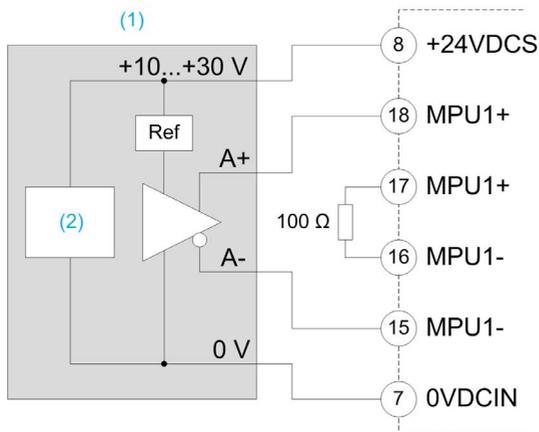
1 Incremental encoder RS422
2 Optical

Supply Tracking Line Driver Type Wiring

To prevent from interference, you must short wire the MPU interface *(see page 44)* when using supply tracking line driver. Otherwise detected interference may cause unexpected measured values.

⚠ WARNING

UNEXPECTED VALUES

Be sure to short wire the MPU interface when using supply tracking line driver.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

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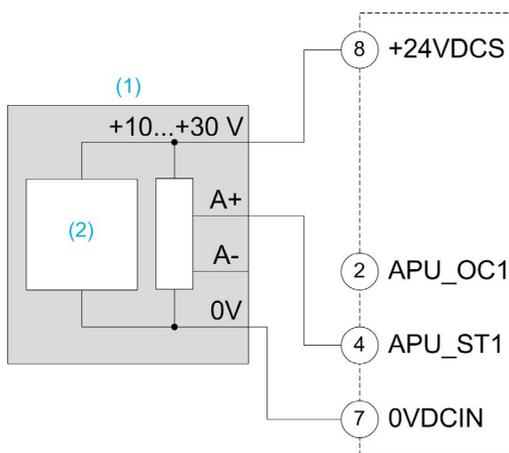
1 Incremental encoder line driver type
2 Optical detector

Power Supplies and Actuators Wiring

Introduction

Use the BMXFTB2800 or BMXFTB2820 28-pin terminal blocks to connect power supplies and actuators to the module.

⚠ ⚠ DANGER
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH
● Ensure that the turbomachinery is stopped while connecting or disconnecting the module or the terminal block. ● Connect or disconnect the terminal block with sensor and pre-actuator voltage switched off.
Failure to follow these instructions will result in death or serious injury.

Power Supplies and Actuators Wiring

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Use the sensor and actuator power supply only for supplying power to sensors or actuators connected to the module.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠ CAUTION
LOSS OF INPUT FUNCTION OR OUTPUT FUNCTION
Install the correct type of power supply fuse with the correct rating.
Failure to follow these instructions can result in injury or equipment damage.

Wiring a single power supply:
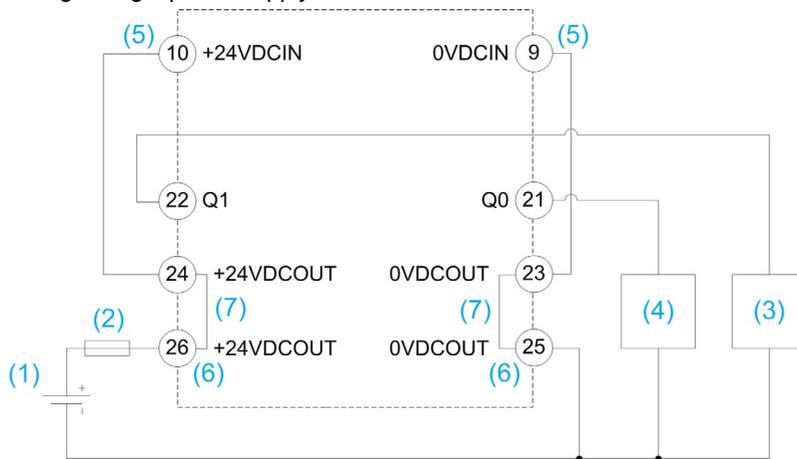
1   24 Vdc power supply SELV
2   Fast-acting fuse 2 A (to protect against overvoltage greater than 36 Vdc)
3   Actuator for the Q1 output of channel 1
4   Actuator for the Q0 output of channel 0
5   Supply active pickup (APU) sensors interface
6   Supply outputs interface
7   Internal wiring

NOTE: To separate supplies for inputs and outputs, connect a second power supply on pin 10 and pin 9.

Part II
BMXETM0200H Module Functionality

Overview

This part describes the functionality of the module, and details the accuracy and performance of the output.
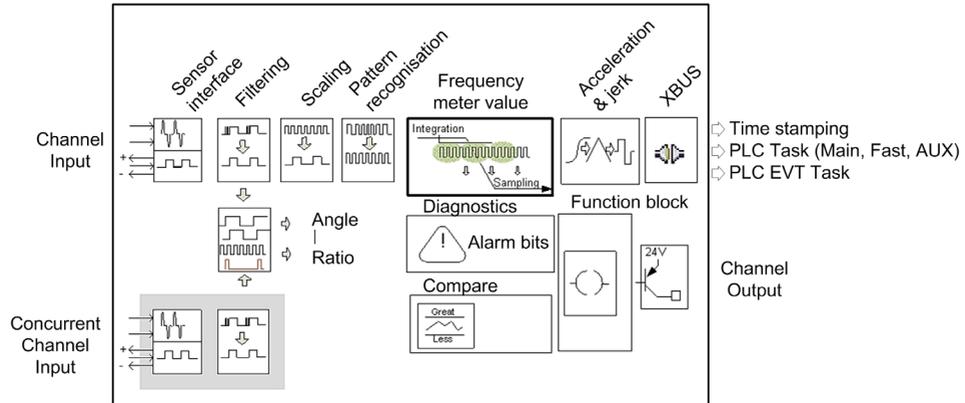
What Is in This Part?

This part contains the following chapters:

Chapter 5
Signal Pre-treatment

Overview

This chapter presents the functionality to prepare the input signal before calculating the frequency values.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Sensor Interface	56
Signal Filtering	58
Signal Scaling	60

Sensor Interface

Description

One sensor is connected per channel:

- Magnetic pickup (MPU) sensor on the differential input
- Active pickup (APU) sensor on the three wire input

The sensor interface of the module can only be configured for MPU sensors.

MPU Signal Detection

The minimum signal detection value for MPU sensor can be configured by setting the parameter **MPU input Mode** to one of the following modes:
- In **Sensitive** mode, the minimum signal detection value is 0.3 V peak to peak.
- In **Noisy** mode, the minimum signal detection value is 2.8 V peak to peak.

MPU Broken Wire Detection

The module can return random frequency values or zero in case of wrong connection with the MPU sensor. The `COUNTER_STATUS` bit `VALIDITY_FREQUENCY` is false in both cases.

In addition, when the MPU broken wire detection is configured, the module can detect the wrong connection of an MPU sensor while a random frequency or zero frequency is measured. The MPU broken wire detection returns a fault when not detecting the normal condition as for an MPU sensor properly connected.

The parameter **MPU input Mode** must be set in **Sensitive** mode when using the MPU broken wire detection and the connected MPU sensor must satisfy the following characteristic table:

Expected characteristic	Value	From
Serial self	Minimum 10 mH	Internally to the MPU sensor
Serial resistor	Minimum 150 Ω	Internally to the MPU sensor
Parallel resistor	Minimum 2 kΩ	Optional signal resistor
Parallel capacitor	Maximum 3 nF	Cable from sensor to the terminal block

Setting the parameter **MPU Line detection** to **With** for sensors with other characteristics can give an unexpected detection error.

Fast frequency changes from pulse to pulse must be avoided when using the MPU broken wire detection. However when those variations are corrected using the pattern recognition, the broken wire detection can be used.

⚠ CAUTION

UNEXPECTED EQUIPMENT OPERATION

- Do not enable the MPU broken wire detection when not using MPU sensor.
- Before enabling the MPU broken wire detection:
  - Check the characteristics of the magnetic pickup sensor.
  - Ensure that the machinery do not provide fast frequency changes from pulse to pulse.

Failure to follow these instructions can result in injury or equipment damage.

Signal Filtering

Description

A programmable debounce filter with 4 levels (**Without**, **Low**, **Medium**, and **High**) is available at every input. Filtering the input signal discards from glitches superimposed on the pickup signal.

The filter can limit the frequency within the application range, and remove higher frequencies before filtering.

Selecting the Filtering Level

The following table specifies the effect of the selected level of filtering:

Filtering level	Effect on the input signal
Without[1]	Pulse detected: 1 µs Frequency detected: 500 kHz
Low[2]	Pulse rejected: Less than 4 µs Frequency cut: 100 kHz
Medium	Pulse rejected: Less than 40 µs Frequency cut: 10 kHz
High	Pulse rejected: Less than 400 µs Frequency cut: 1 kHz
(1) When the **Input Sensor filter** parameter is set to **Without**, the pulse rejection is not specified and the frequency cut is above 500 kHz. This option may be used for incremental encoders only. **(2)** Default value for **Input Sensor filter** parameter in Control Expert configuration screen.	
NOTE: Frequencies are given for square wave signal.	

Debounce Filter Diagrams

The figure below shows an example of MPU signal, filtered in **Low** mode:
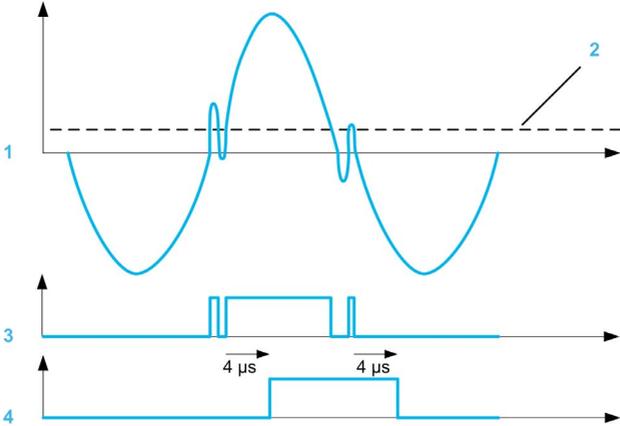
1 Noisy MPU signal
2 Threshold
3 Input signal
4 Signal filtered

In **Low** mode, the system delays all transitions until the signal is stable for 4 µs.

The figure below shows an example of APU signal, filtered in **Low** mode:
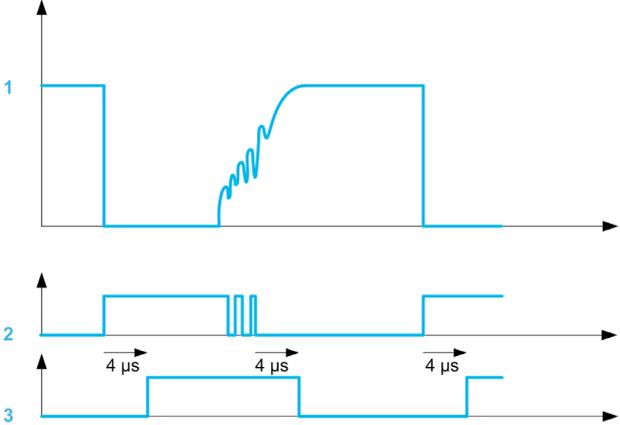
1 Noisy APU signal
2 Input signal
3 Signal filtered

In **Low** mode, the system delays all transitions until the signal is stable for 4 µs.

Signal Scaling

Scaling Functionality Description

The scaling function divides the input frequency prior to be measured.

Setting the parameter **Scaling factor** to 1 disables the scaling function and the frequency meter value is the frequency of input signal.

Setting the parameter **Scaling factor** to a value N (2...1024) makes the frequency meter value scaled with user unit. Each unit of frequency meter value equals N pulses received in the input signal.

Scaling Example

For an application where one gear revolution equals 100 input pulses and the parameter **Scaling factor** set to 100, the frequency meter value is the number of revolution per 1000 seconds.

Chapter 6
Frequency Meter Function

Overview

This chapter presents the frequency meter function which:
- Calculates the frequency meter value at defined sampling rate.
- When necessary, adapts the frequency meter value to the machinery thanks to the pattern learning and pattern recognition capabilities.
- Provides the acceleration and jerk values.

What Is in This Chapter?

This chapter contains the following topics:

Frequency Meter Value

Precautions

⚠ WARNING
UNEXPECTED FREQUENCY VALUE
Before using frequency values in the application: ● Check that the sensors are installed according to the supplier recommendations. ● Confirm that the sensors are connected to the terminal block according to the wiring rules. ● Confirm that the signal filtering *(see page 58)* function is correctly configured.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Sampling Period Configuration

The parameter **Sampling Factor** defines the sampling period value.

The sampling period (1 / sampling rate) can be configured to 10...200 ms in steps of 10 ms.

By default, the sampling period value is 10 ms (sampling rate = 100 Hz).

Adaptive Integration Period

For each sampling period value, the module considers the best integration period to calculate the frequency value with the best accuracy *(see page 81)*.

NOTE: The integration period calculated contains at least one pulse.

The figure below shows how the module considers the best Integration period depending on frequencies of the input signals:
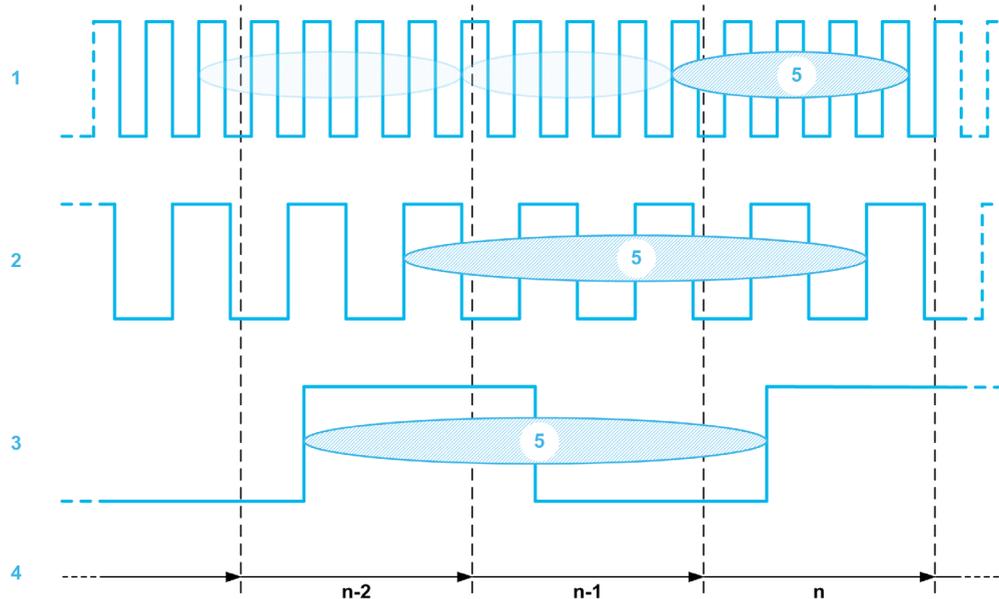
1, 2 and 3 Input signal for various frequencies
4 Sampling periods
5 Best integration periods corresponding to the input frequency.

NOTE:
- The integration period is close to the last sampling period when the frequency of the input signal is greater than the sampling rate.
- The integration period is close to the last input signal when the frequency of the input signal is less than the sampling rate.

The maximum value for the integration period does not exceed 1 s and the minimum measurable frequency is 1 HZ.

Frequency Value

Frequency value = N pulses / integration period * 10E6 (pulses per 1000 seconds)

Pattern Recognition

Pattern Recognition Definition

⚠ WARNING
UNEXPECTED FREQUENCY VALUE
Ensure that the MPU sensor provides the minimum input voltage *(see page 23)* for pattern recognition.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

At a stabilized speed, a gear can generate a dedicated pulse delay for each tooth. During repetitive cycles, the machinery generates irregular pulses. The module functionality can correct the calculation mode of the frequency value for irregular pulse.

To be corrected:
● The same pattern of irregular pulses must be reproduced at each cycle. That means, one cycle of the pattern equals one revolution of the gear.
● The pattern of irregular pulses must be learned with a learning sequence.
  NOTE: The velocity of the machinery must be stable during the learning sequence.

For best accuracy:
● The faster pulse should not exceed 40 kHz
● The ratio of faster to slower pulse should not exceed 20

The figure below show a repetitive cycle:
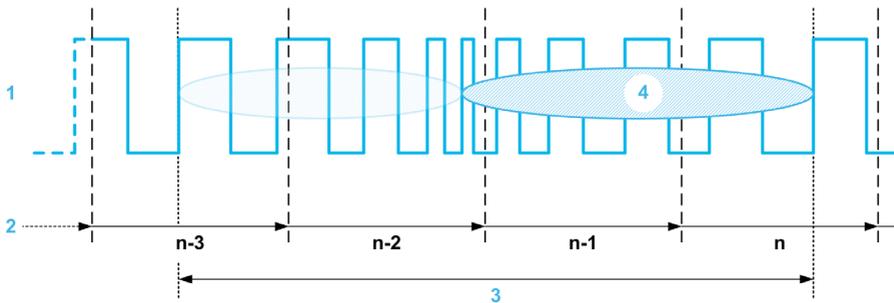
1 Sampling period
2 Pattern of the repetitive cycle
3 Integration period

When the pattern recognition is activated, the frequency value derives from a corrected integration period instead of the measured integration period.

For each sampling period, the integration period is corrected according to the received pulses within the measured period.

As for conditions:
- A fixed number of teeth have been configured.
- The correction ratio of each pulse has been internally memorized during the learning sequence.

Pattern Recognition Configuration

The parameter **Pattern Resolution** defines the quality of the pattern recognition correction:
- when the parameter is set to 1:1000 (Default):
  - Accuracy of the frequency value is impacted by 0.1% during the run time.
  - The minimum speed must be 60 rotations per minute during the learning sequence.

- when the parameter is set to 1:10000:
  - Accuracy of the frequency value is impacted by 0.01% during the run time.
  - The minimum speed must be 600 rotations per minute and the maximum recommended frequency is 4 kHz during the learning sequence.

The parameter **Pattern Number** defines the number of pulses within the pattern. According to the number of pulses declared, the pattern recognition is configured into one of the following modes:
- Continuous mode when the number of pulses within the pattern is set to 2...256.
  In this mode the pattern learning cycles while the control bit `FORCE_PATTERN_LEARN` is active.
- Triggered mode when the number of pulses within the pattern is set to 257...512.
  In this mode the pattern learning is executed once on rizing edge of the control bit `FORCE_PATTERN_LEARN`.

How to Control the Pattern Recognition

The following figure shows how to control the pattern recognition with the application:

Sequence	Description
1	When the pattern recognition is not required: ● `ENABLE_PATTERN_RECOGNITION` is false **or** ● The configuration parameter **Pattern Number** is set to 1. The frequency value is calculated without corrected integration period (The pattern recognition function is disabled). The `VALIDITY_FREQUENCY` bit is true (that is frequency, acceleration, and jerk values are guaranteed).
2	The pattern recognition is required but not possible: ● `ENABLE_PATTERN_RECOGNITION` is true **and** ● The configuration parameter **Pattern Number** is set to a value > 1 **and** ● The pattern learning is not completed. The frequency value is still calculated without corrected integration period. The `VALIDITY_FREQUENCY` bit is false (uncertain) and the application has to trigger the pattern learning process.
3	The pattern recognition is required and possible: ● `ENABLE_PATTERN_RECOGNITION` is true **and** ● The configuration parameter **Pattern Number** is set to a value > 1 **and** ● Pattern learning is done The frequency value is calculated with corrected integration period. The `VALIDITY_FREQUENCY` bit is true (that is frequency, acceleratrion, and jerk values are guaranteed).
4	The step 2 is not mandatory, the application can enable the pattern recognition after the pattern learning done (`PATTERN_LEARNT` is true).

Pattern Learning System

Pattern learning must be executed once after the machinery have started and before applying the pattern recognition. The velocity of the machinery must be stable during the learning sequence.

The variable COUNTER_STATUS (%IW.r.m.c.0) reports the state of the pattern learning system to the application. The application implements the recommended sequence to control the pattern learning before enabling the correction.

How to Control the Pattern Learning

Application can implement the following sequence to control the pattern learning:

Sequence	Description
1	The machinery has started and reached a stable velocity conducive to learn the pattern.
2	Application triggers the pattern learning. After the pattern learning is started, the application can reset the control bit FORCE_PATTERN_LEARN.
3	Module is executing the pattern learning once for the first time.This is the learning sequence.
4	Pattern learning is completed according to the number of pulses defined in the configuration. The ratio of each pulse within the pattern is now held until the next power cycle. The frequency value can be corrected with the pattern recognition and reports the velocity of the machinery into the regulation area.
5	Application can trigger again the pattern learning. Depending on the mode set in the configuration screen, the pattern recognition can be interrupted: ● In continuous mode, the pattern recognition is possible while the pattern learning cycles. ● In triggered mode, the pattern recognition stops during each new learning sequence.

Acceleration and Jerk Values

Acceleration and Jerk

In addition to the frequency value, the module provides an acceleration value (ACC) and a jerk value (JRK) at the same sampling rate of the frequency meter value:

FM =	X_0	X_1	X_1	X_2	X_3
ACC =	$f_a(X_0-X_{...})$	$f_a(X_1-X_0)$	$f_a(X_1-X_0)$	$f_a(X_2-X_1)$	$f_a(X_3-X_2)$
JRK =	$f_b(X_0-X_{...})$	$f_b(X_1-X_0)$	$f_b(X_1-X_0)$	$f_b(X_2-X_1)$	$f_b(X_3-X_2)$
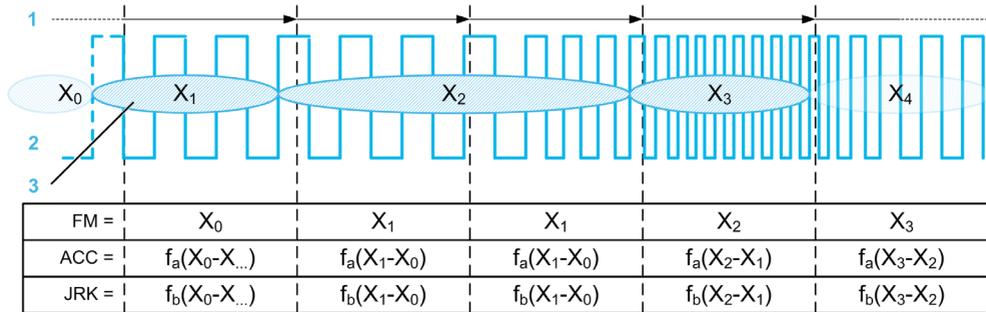
1 Sampling period
2 Input signal
3 Integration period
FM Frequency meter value in pulses/1000 seconds
ACC Acceleration value (in pulses/s^2) is the rate of change of the refreshed frequency meter value.
JRK Jerk value (in 1000*pulses/s^3) is the rate of change of the refreshed acceleration value.

Acceleration and Deceleration Maximum Values

The maximum acceleration value is 32767 pulses/s^2.

NOTE: For acceleration values exceeding the maximum value, the module returns 32767 pulses/s^2.

To illustrate, consider the example of turbo machinery which starting period takes 10 seconds to reach the maximum velocity (32000 pulses per second). During the ramp up, the module will return the acceleration value 3200 pulses/s^2.

The maximum deceleration value is -32767 pulses/s^2.

NOTE: For deceleration values exceeding the maximum value, the module returns -32767 pulses/s^2.

Application Example

Illustration

The following graphic presents how a turbo machinery application can manage the velocity of a diesel engine or reciprocating machine with no regular pulses over one revolution:
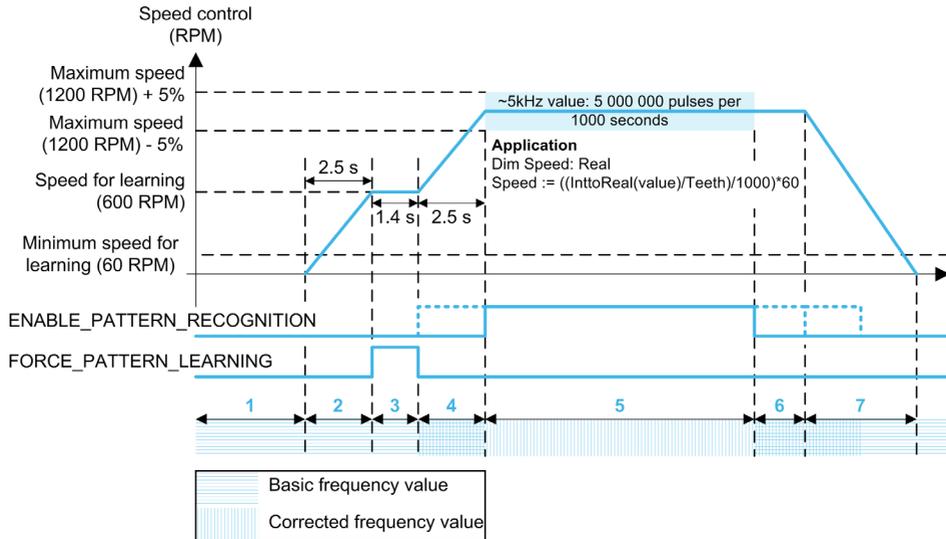
Example Steps Description

The following table describes the above steps of the example:

Step	Description
1	Machine is idle
2	Application controls the machinery for starting. The velocity increases to reach the nominal speed in 2.5 s.
3	Application stops increasing the velocity and maintains a constant speed. At this step, the application commands the module to learn the pattern wave form at a stable speed of revolution.
4	Application can increase the velocity after the module has learned the pattern. Pattern recognition is available right now. It could be enabled while the application brings speed next to nominal position. For more detail, refer to chapter *RPM during Pattern learning (see page 82)*.
5	The application fine governs the machinery for nominal velocity. At this step, the pattern recognition must be enabled to provide the best accuracy of the measure. Typical system accuracy for RPM is +/- 5 %.
6	Application controls the machinery stopping with or without application of the pattern recognition.
7	The pattern recognition is not mandatory in step 7.

Chapter 7
Compare Function

Compare Function

Description

The frequency value can be checked with two defined limits (lower and upper).

The result of the compare function can provide:
- Alarm
- Event sending
- Change for the physical output

Compare Limits

The compare function has two limits:

- The lower limit: `MINIMUM_FREQUENCY` double word (`%QDr.m.c.2`)
- The upper limit: `MAXIMUM_FREQUENCY` double word (`%QDr.m.c.4`)

The upper limit value must be greater than the lower limit value. If the upper limit value is less than or equal to the lower limit value, the lower limit does not change but it is ignored.

The default value for both `MAXIMUM_FREQUENCY` and `MINIMUM_FREQUENCY` is 0.

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Set parameters `MINIMUM_FREQUENCY` and `MAXIMUM_FREQUENCY` to right values before enabling the compare function.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Compare Result

The results are stored in the `COMPARE_STATUS` register which is updated at the same time than the frequency value.

The possible results are:
- `FREQUENCY_METER_LESS`: The frequency value is less than the lower limit value.
- `FREQUENCY_METER_WINDOW`: The value is between the upper and lower limits or equal to one of the two limits.
- `FREQUENCY_METER_GREAT`: The value is greater than the upper limit.

Modification of the Limits During the Operational Phase

If the application needs to modify the limits, the `COMPARE_SUSPEND` bit holds the `COMPARE_STATUS` (`%IWr.m.c.1`) register during the modification.

`COMPARE_STATUS` register needs the `COMPARE_ENABLE` bit (`%Qr.m.c.5`) set active (1) and `COMPARE_SUSPEND` bit (`%Qr.m.c.4`) set inactive (0) to be updated.

Care must be exercised when limit compares are active to avoid unintended or unexpected results from the outputs or from sudden event task execution. If the compare function is disabled, limit values can be modified freely since `COMPARE_STATUS` is forced to 0. However, if the compare function is enabled, suspend at least the compare function while modifying the limit values.

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Do not change limit values without using the `COMPARE_SUSPEND` bit if `COMPARE_ENABLE` bit is set to 1.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Chapter 8
Reflex Output Function Block

Reflex Output Function Block

Overview

Each channel of the module has one programmable output function block that operates with the compare status register and affects the behavior of physical outputs.

In addition, the output function block enables the output mirroring of the internal scaling pulse.

There are two ways to control the output:

From the application: The output corresponds to the status of the output bit from the output command bit.

From the output function block: The user must enable the output block function. Then, the output corresponds to the status of the output bit from the function block.

The following figure shows the output function block collaborating with the physical output:
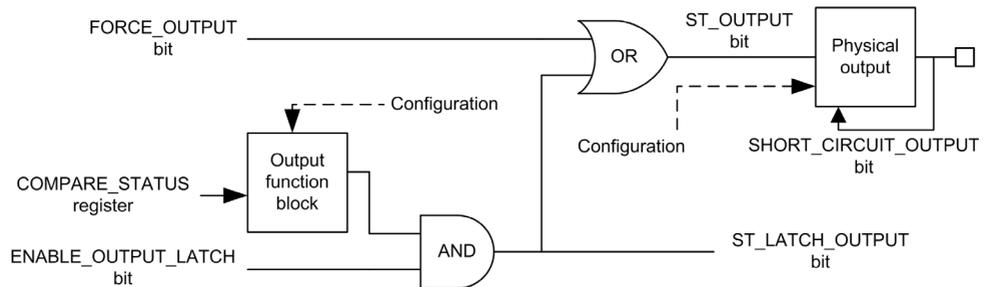
Output Block Configuration

The operational latch mode must be chosen among 11 functions in configuration tab.

As stated, the output comes:
- Directly, from the application software (Normal Output): One function.
- From the output function block (Reflex Output): 10 functions.
  The output matches the state of the output bit in the output function block result.

The following table shows the configurable functions:

Function code	Programming
0	No reflex action (default)
1	**Frequency meter Less** The logical output to 1 when frequency value is less than the lower threshold.
2	**Frequency meter Window** The logical output to 1 when frequency value is between the upper and lower thresholds or equal to one of the two thresholds.
3	**Frequency meter Great** The logical output is 1 when frequency value is greater than the upper threshold.
4	**Frequency meter Stopped** The logical output is 1 when no input frequency is detected.
5	**Frequency meter Under Limit** The logical output is 1 when the input frequency is too slow.
6	**Frequency meter Over Limit** The logical output is 1 when the input frequency is too fast.
7	**Pulse = Frequency meter Less** The logical output to 1 during the time delay after frequency value is less than the lower threshold. The time delay is defined by the **PulseWidth** parameter.
8	**Pulse = Frequency meter Window** The logical output to 1 during the time delay after frequency value is between the upper and lower thresholds or equal to one of the two thresholds. The time delay is defined by the **PulseWidth** parameter.
9	**Pulse = Frequency meter Great** The logical output to 1 during the time delay after frequency value is greater than the upper threshold. The time delay is defined by the **PulseWidth** parameter.
10	**Scaling Pulse** The logical output follows the internal scaling pulse (up to 10 kHz). **NOTE:** The **Scaling Pulse** can't work when the parameter **Scaling factor** is set to 1.

Output Properties

It is possible to configure the following parameters for each output:

- The module response for detected error recovery.
- The output polarity (positive or negative polarity).
- The fallback mode.

Detected Error Recovery

Outputs are current limited (0.5 A maximum).

A thermal shutdown protects each output.

When a short-circuit is detected on one of the channel outputs, the module enables one of the two following actions according to the configuration:

- Setting the parameter **Fault recovery** to **Latched off**: The module latches off the output channel.
- Setting the parameter **Fault recovery** to **Autorecovery**: The module latches off the output channel and automatically attempts to recover the detected error and resume operation on the channel when the detected error is corrected.

In case of the **Fault recovery** parameter is set to **Latched off**, if an output channel has been latched off because of short-circuit detection, the module recovers from the short-circuit after the following is processed:

- The short-circuit has been corrected
- To reset the detected error, the application must:
  - ○ Reset the `ENABLE_OUTPUT_LATCH` bit if it is active
  - ○ Command the output to 0 Vdc (depends on the polarity).

In case of the **Fault recovery** parameter is set to **Autorecovery**, an output channel that has been turned off because of error detection starts operating again as soon as the detected error is corrected. No user intervention is required to reset the channels.

NOTE: A minimum delay of 10 s occurs before the detected error is cleared in both latched off and auto recovery modes.

Output Polarity Programming

It is possible to configure the **Polarity** parameter for each output during the channel configuration:

- Setting the parameter **Polarity** to **Polarity +**: The physical output is 24 Vdc when the output is at high level (`ST_OUTPUT` = 1; `%I.r.m.c.0`)
- Setting the parameter **Polarity** to **Polarity -**: The physical output is 24 Vdc when the output is at low level (`ST_OUTPUT` = 0; `%I.r.m.c.0`)

   NOTE: To be applied, the negative polarity required the module is running.

By default, the output channel is in positive polarity.

⚠ CAUTION
UNEXPECTED OUTPUT VALUE
Do not use the output polarity configuration for controlling an energized safe actuator.
Failure to follow these instructions can result in injury or equipment damage.

Output Fallback Modes

The fallback modes are the predefined states to which the output channels revert when the channel is not controlled by the processor (for example, when communications are lost or when the processor is stopped).

The fallback mode of output channel can be configured as one of the following modes:

- Setting the parameter **Fallback** to **With**: you may configure the **Fallback value** parameter as 0 or 1
- Setting the parameter **Fallback** to **Without**: the output block function continues to operate according to the last received commands.

NOTE: By default, the fallback mode of the output channels is set to **With** and the parameter **Fallback value** is set to 0.

Chapter 9
Dual Channel Function

Dual Channel Function

Overview

The module enables signal comparisons between one channel and the concurrent channel in the module. Each input channel gives ratio and angle values calculated with the concurrent input channel and reciprocally.

Ratio and angle values are provided together at the rate of the concurrent channel, with a maximum of 10 measures per second.

Dedicated validity bits for both ratio and angle values are provided in the variable COUNTER_STATUS ($\%IW.r.m.c.0$). In addition, after the ratio or the angle measure done an event can be generated .

Neither configuration nor programming is required to provide the ratio and angle. However the function provides ratio and angle values related to one channel as long as the input frequency on the concurrent channel does not exceed what received on this channel.

Ratio

Ratio gives the number of received pulses on one channel within two pulses received on the concurrent channel. An example is given below:

1 Channel input
2 Concurrent channel input
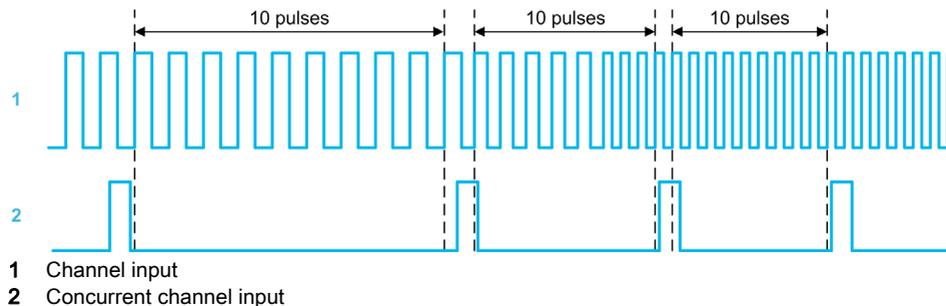
In the typical use case:
- The dual channel function is to calculate mechanical ratio between gears,
- The ratio remains stable for one application,
- The concurrent channel receives a signal from metal detection of the crank of machinery while the channel input receives a signal from speed detection of a gear.

Hence, the ratio value gives the number of teeth for one gear revolution.

In an application trying to measure ratio greater than 65535, the module provides unexpected values.

⚠ WARNING

UNEXPECTED APPLICATION BEHAVIOR - INCORRECT INTERPRETATION OF DATA

Do not measure a ratio greater than 65535.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Angle

Angle is given by the time delay between the last received pulse on one input channel and the pulse on the concurrent input channel. An example is given below:

1 Channel input
2 Concurrent channel input
3 Time delay
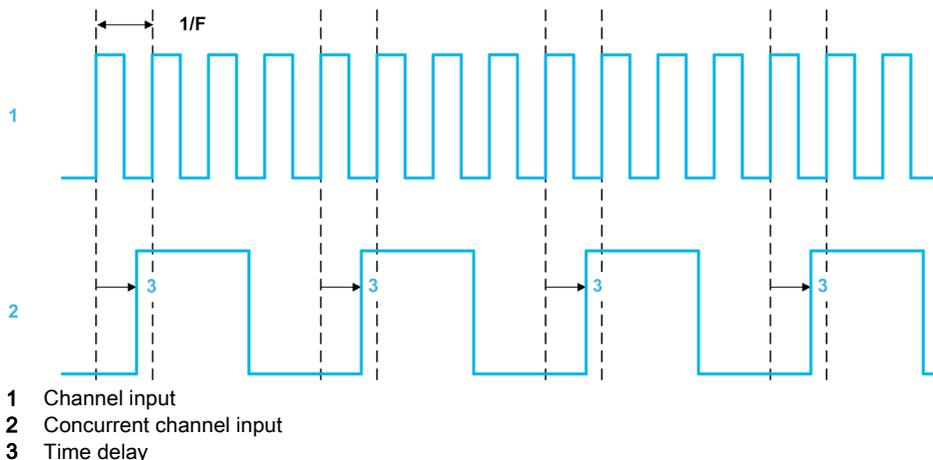
Angle value is calculated according to the formula: Time delay = Angle x 0.5 µs

In the typical use cases:
● The pulse ratio (between gears) is regular,
● The velocity is stable when the application considers the angle value.

Hence, the application can retrieve the mechanical angle between gears on assessing the angle value versus the input signal period (1/F).

In other application, the value can report the phase angle between two same frequencies (for example 50/60 Hz)

The Angle value is calculated for input signal frequency greater than 40 Hz. For input signal frequency less than 40 Hz, the Angle value is forced to 65535.

Chapter 10
Module Performance

Overview

This chapter gives the accuracy, limits and performance of the module.

What Is in This Chapter?

This chapter contains the following topics:

Frequency Range and Accuracy

Frequency Range

The minimum frequency of the input signal is N (pulses per second) - 5%. Where N is the value set for the parameter **Scaling Factor**.

The minimum frequency meter value is 950 pulses per 1000 seconds. As a result, the module holds the frequency value to 0 while not receiving N pulses during 1.1 second.

The maximum frequency of the input signal is 500 kHz. That corresponds to a maximum frequency meter value = 500,000,000 pulses per 1000 seconds.

The maximum frequency of the input signal depends on the **Sampling Factor**. It decreases to 200 kHz for sampling rate = 200 ms.

The following graphic represents the maximum frequency versus **Sampling Factor** (with **Scaling Factor** = 1):
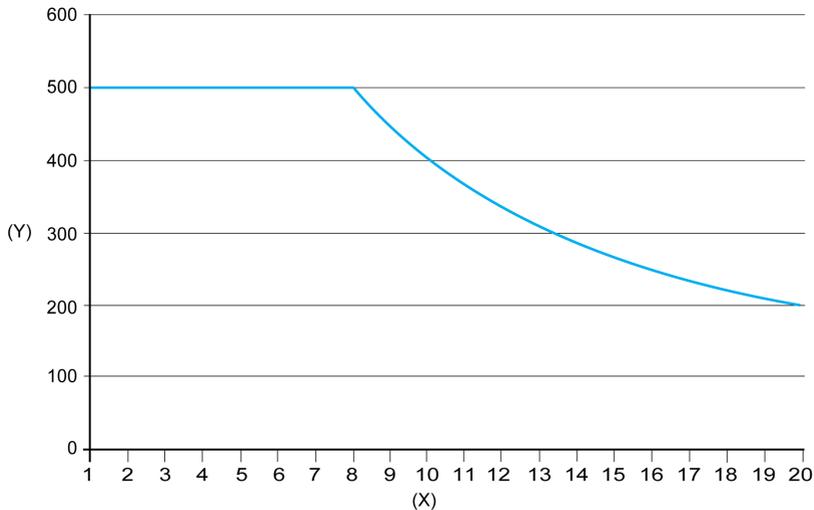
X Sampling factor
Y Maximum frequency (in kHz)

Frequency Accuracy

The figure below shows what is the module provided along the frequency range:
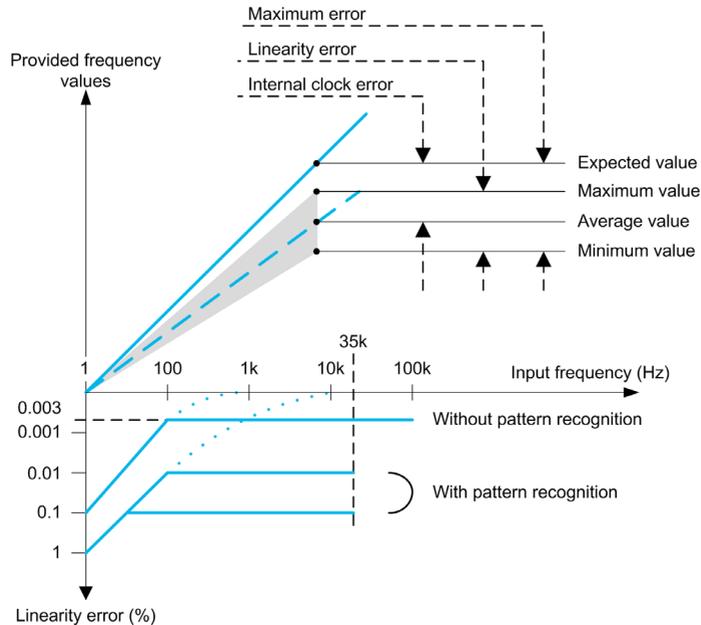
For each input frequency, the module provides frequency values close to the expected value (theoretical value).

Accuracy is defined with the relative error between the expected value and the group of provided values (maximum value, minimum value).

The linearity error is the gap between the maximum provided value and the minimum provided value. In usual turbomachinery speed, the linearity error is less than 0.003%.

The internal clock error (+/- 0.01%) is the absolute error due to the internal system clock (Quartz).

To estimate the maximum error of the module, you have to consider the internal clock error in addition to the linearity error.

The pattern recognition system introduces deterioration in accuracy of 0.1% with regular pattern resolution of 1:1000.

The pattern recognition system introduces deterioration in accuracy of 0.01% with fine pattern resolution of 1:10000.

The module round-down the frequency value to 10 mHz instead of 1 mHz when the pattern recognition is operating.

Pattern Learning Limits and Performance

RPM During Pattern Learning

The RPM is the rate of pattern per minute.

In order to reach the best performance:
- RPM must be stable during the learning sequence (about 3 seconds).
- RPM must be within the best window according to the number of pulses per pattern.

The following graphic defines the best windows:
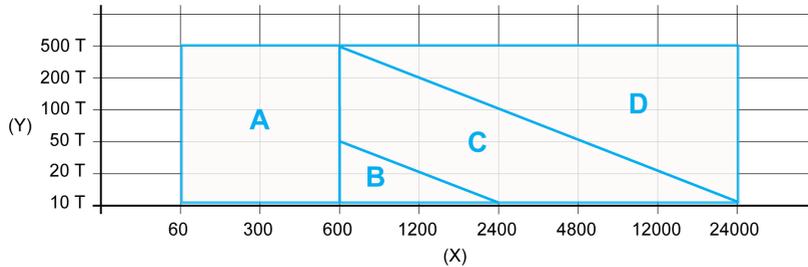
X   Rate of pattern per minute (RPM)
Y   Number of pulses per pattern (Teeth)

Window	Executing Pattern Learning
A	This window is only valid to execute a pattern learning sequence if the parameter **Pattern Resolution** is set to 1:1000.
B	This window is valid whatever the setting (1:1000 or 1:10000) for the parameter **Pattern Resolution**
C	In this window the learning sequence is executed with a pattern resolution of 1:1000 whatever the setting configured for the parameter **Pattern Resolution**.
D	Pattern learning is not guaranteed if the parameter **Pattern Resolution** is set to 1:10000.

NOTE: During the learning sequence, when the parameter **Scaling factor** is set to a value N (N > 1), the frequency meter value is not updated.

Pattern Learning Performance

The time delay to complete the pattern learning depends on the RPM and the gears (number of teeth = number of pulses to learn).

The following graphic provides the maximum delay to complete the learning sequence in second according to the RPM and the number of pulses per pattern(Teeth):
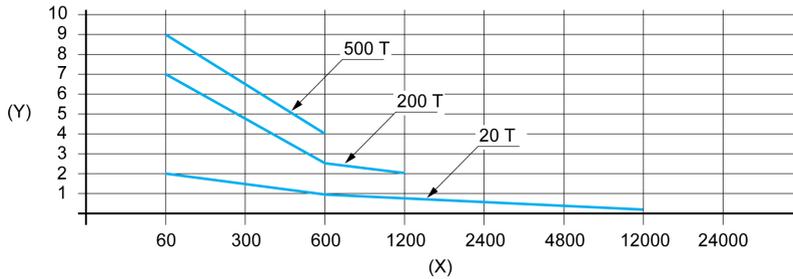
X Rate of pattern per minutes (RPM)
Y Maximum learning sequence duration in second

Part III
Module Software Implementation

Subject of this Part

This part describes the software implementation in Control Expert of the module BMXETM0200H.

What Is in This Part?

This part contains the following chapters:

Chapter 11
Configuration parameters

Overview

This chapter deals with the parameters necessary for configuring the module.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Data Model and Tasks	88
Configuration Screen for the Module BMXETM0200H	90

Data Model and Tasks

Introduction

The selection of the data model is done at module insertion in your Control Expert project. The data model choice is depending on the platform and localization of the module in the racks.

Topological or Device DDT

The following table compares the two data models:

	Topological	Device DDT
Variable number and creation	One variable per channel to be created with predefined T_CPT_FLM_IN2 type	One variable per module automatically created with T_CPT_FLM_IN2 type
Comply with M340 platform	Yes	No
Comply with M580: ● In local rack ● In remote I/O rack	Yes	Yes
Comply with M580: ● In Ethernet remote I/O rack ● In Hot Standby configuration	No	Yes
Task assignment	Per channel	Per module[1]
Enables event task	Yes	No
Enables time stamping	Yes	Yes
(1) Both channels of the module are always assigned to the same task.		

Task Assignment

The following table gives allowed type of task execution:

PLC	FAST	MAST	AUX0	AUX1
M340	Periodic	Periodic or cyclic	None	None
M580	Periodic	Periodic or cyclic	Cyclic	Cyclic

NOTE: Applications with the BMXETM0200H module preferably require periodic tasks.

The period of the periodic task should be equal or a multiple time of the configured Sampling rate .

Event Task

When using the topological data model (IODDT), the module can trigger the EVT PLC task at each sampling period.

The application can be fully synchronized with the refreshed data provided by the module. To do so, enable the event sources with the variable `EVENT_SOURCE_ENABLING` *(see page 99)*, and the module triggers the event task to be executed.

All variables with the `EVT` prefix are refreshed when the event task starts:

- Values *(see page 98)* on event.
- Boolean of the `EVT_SOURCES` *(see page 98)* word.

Configuration Screen for the Module BMXETM0200H

Configuration Screen

Module Configuration Window

The following table presents the various parts of the above screen:

Number	Element	Function
1	Tab	Indicate the type of tab displayed. In this case, it is the **Configuration** tab for the **Counter 0**.
2	Heading	Indicates the abbreviated heading of the module BMXETM0200H. In online mode, the same area displays three icons that reflect the current status of the following LEDs *(see page 17)*: ● **RUN** ● **ERR** ● **IO**
3	Module Selection	Allows you to select the module and displays: ● The **Overview** tab that gives the characteristics of the module ● The **I/O Objects** tab or **Device DDT** tab depending on the I/O data type selected *(see page 88)* at module insertion in the Control Expert project.
	Channel Selection	Allows you to select the channel (Counter) and displays: ● The **Configuration** tab that enables you to declare and configure each channel. ● The **Fault** tab that gives active faults detected on the channel.
4	**Function**	Indicates the function name associated with each channel. **NOTE:** On topological data model to access the **Configuration** tab, select **Frequency**. (by default it is **None**)
	Task	Indicates the task associated with each channel *(see page 88)*.
5	**Value**	If these fields have a downward pointing arrow, you can select the value of each variable from various possible values in these fields. The various values can be accessed by clicking the arrow. A menu containing all the possible values is displayed to select the required value of the variable.
	Unit	These fields contain the unit of each variable that may be configured. They may not be modified.

Channel Configuration Tab

Label Parameter	Default Value	Other Possible Values	Module Functionality
Input Sensor filter	Low	Without Medium High	Signal Filtering *(see page 58)*
Sensor supply Fault	Local	General IO fault	Sensor Interface *(see page 56)*
Actuator supply fault	General IO fault	Local	
MPU Line detection	Without	With	
MPU input Mode	Sensitive	Noisy	
Scaling factor	1	2...1024	Signal Scaling *(see page 60)*
Sampling Factor	1	2...20	Frequency Meter *(see page 61)*
Pattern Resolution	1:1000	1:10000	
Pattern Number	1	2...512	
OutputBlock	Off	Frequency Less Frequency Window Frequency Great Frequency Stopped Frequency Under Limit Frequency Over Limit Pulse = Frequency Less Pulse = Frequency Window Pulse = Frequency Great Scaling Pulse	Reflex Output Block *(see page 73)*
PulseWidth	1	2...65535	
Polarity	Polarity +	Polarity -	
Fault recovery	Latched off	Autorecovery	
Fallback	With	Without	
Fall Back Value	0	1	
Event	Disable	Enable	Event
Event number	0	63	

Chapter 12
The Language Objects

Overview

This chapter describes the language objects associated to the module tasks as well as the different ways of using them.

What Is in This Chapter?

This chapter contains the following topics:

Details of the Explicit Exchange Objects for the T_CPT_FLM_IN2-type IODDT

At a Glance

This section presents the explicit exchange objects for the T_CPT_FLM_IN2 - type IODDT which are applicable to the channels of the BMXETM0200H module. They includes word type objects whose bits have a specific meaning. These objects are described in detail below.

NOTE:
- in general, the meaning of the bits is given for bit status 1.
- not all bits are used.

Exchange Status: `EXCH_STS`

The table below presents the bits of the channel exchange status word `EXCH_STS` (`%MWr.m.c.0`).

Standard symbol	Type	Access	Meaning	Language object
STS_IN_PROG	BOOL	Read	Status parameter read in progress	`%MWr.m.c.0.0`
ADJ_IN_PROG	BOOL	Read	Adjust parameter exchange in progress	`%Mwr.m.c.0.2`
RECONF_IN_PROG	BOOL	Read	Reconfiguration in progress	`%MWr.m.c.0.15`

Channel Report: `EXCH_RPT`

The following table presents the bits of the channel exchange word `EXCH_RPT` (`%MWr.m.c.1`).

Standard symbol	Type	Access	Meaning	Language object
STS_ERR	BOOL	Read	Error while reading channel status	`%MWr.m.c.1.0`
ADJ_ERR	BOOL	Read	Error while adjusting the channel	`%Mwr.m.c.1.2`
RECONF_ERR	BOOL	Read	Error while reconfiguring the channel	`%MWr.m.c.1.15`

Channel Faults: `CH_FLT`

The table below presents the bits of the channel faults word `CH_FLT` (`%MWr.m.c.2`).

Standard symbol	Type	Access	Meaning	Language object
EXTERNAL_FLT_INPUTS	BOOL	Read	External error on inputs	`%MWr.m.c.2.0`
EXTERNAL_FLT_OUTPUTS	BOOL	Read	External error on outputs	`%MWr.m.c.2.1`
INTERNAL_FLT	BOOL	Read	Internal error: channel inoperative	`%MWr.m.c.2.4`
CONF_FLT	BOOL	Read	Hardware or software configuration error	`%MWr.m.c.2.5`
COM_FLT	BOOL	Read	Bus communication error	`%MWr.m.c.2.6`
APPLI_FLT	BOOL	Read	Application error	`%MWr.m.c.2.7`

Channel Faults Special: `CH_FLT_SP`

The table below presents the bits of channel faults special word `CH_FLT_SP` (`%MWr.m.c.3`).

Standard symbol	Type	Access	Meaning	Language object
`SENSOR_SUP_FLT`	BOOL	Read	Low input power supply for the sensors	`%MWr.m.c.3.2`
`ACTUATOR_SUP_FLT`	BOOL	Read	Low input power supply for the actuator	`%MWr.m.c.3.3`
`MPU_BROKEN_LINE`	BOOL	Read	Broken line to MPU detected	`%MWr.m.c.3.4`
`SHORT_CIRCUIT_OUTPUT`	BOOL	Read	Output short circuit or overload detected	`%MWr.m.c.3.5`

Details of Implicit Exchange Objects for the T_CPT_FLM_IN2-type IODDT

At a Glance

The following tables present the T_CPT_FLM_IN2 -type IODDT implicit exchange objects which are applicable to channels of the BMXETM0200H module.

Module Values

The following table presents the implicit exchange word objects:

Standard symbol	Type	Access	Meaning	Language object
FREQUENCY_VALUE	UDINT	Read	Frequency value in pulses per 1000 seconds	%IDr.m.c.2
ACCELERATION_VALUE	INT	Read	Frequency value variation per pulses per s^2	%IWr.m.c.4
JERK_VALUE	INT	Read	Acceleration value variation per 1000 pulses per s^3	%IWr.m.c.5
RATIO_VALUE	UINT	Read	Number of pulses within the concurrent channel period	%IWr.m.c.6
ANGLE_VALUE	UINT	Read	Delay of sensor last the concurrent channel	%IWr.m.c.7

%Ir.m.c.d

The following table presents the inputs %Ir.m.c.d:

Standard symbol	Type	Access	Meaning	Language object
CH_ERROR	BOOL	Read	Channel detected error	%Ir.m.c.ERR
ST_OUTPUT	EBOOL	Read	State of physical the output	%Ir.m.c.0
ST_LATCH_OUTPUT	EBOOL	Read	State of Output function block	%Ir.m.c.1
ST_SENSOR_INPUT	EBOOL	Read	State from the sensor	%Ir.m.c.2
ST_DUAL_INPUT	EBOOL	Read	State from the sensor next channel	%Ir.m.c.3
ST_ALARM_STOPPED	EBOOL	Read	Signals that the input frequency has been detected stopped for at least one second.	%Ir.m.c.4
ST_ALARM_UNDER_LIMIT	EBOOL	Read	Signals that the input frequency has been detected too slow	%Ir.m.c.5
ST_ALARM_OVER_LIMIT	EBOOL	Read	Signals that the input frequency has been detected too fast	%Ir.m.c.6

Standard symbol	Type	Access	Meaning	Language object
ST_ALARM_FREQUENCY_LESS	EBOOL	Read	Signals that the frequency value is less than the configured limits	%Ir.m.c.7
ST_ALARM_FREQUENCY_WINDOW	EBOOL	Read	Signals that the frequency value is in the window defined by the configured limits	%Ir.m.c.8
ST_ALARM_FREQUENCY_GREAT	EBOOL	Read	Signals that the frequency value is greater than the configured limits	%Ir.m.c.9

COUNTER_STATUS, %IWr.m.c.0 Word

The following table presents the bits of the COUNTER_STATUS word (%IWr.m.c.0):

Standard symbol	Type	Access	Meaning	Language object
VALIDITY_FREQUENCY	BOOL	Read	Frequency, acceleration, and jerk values guaranteed	%IWr.m.c.0.0
VALIDITY_RATIO	BOOL	Read	Ratio value done	%IWr.m.c.0.1
VALIDITY_ANGLE	BOOL	Read	Angle value done	%IWr.m.c.0.2
PATTERN_LEARN_RUNNING	BOOL	Read	Process learning on going	%IWr.m.c.0.3
PATTERN_LEARNT	BOOL	Read	Pattern recorded	%IWr.m.c.0.4
STOPPED	BOOL	Read	Input frequency stopped	%IWr.m.c.0.5
UNDER_LIMIT	BOOL	Read	Input frequency too low	%IWr.m.c.0.6
OVER_LIMIT	BOOL	Read	Input frequency too high	%IWr.m.c.0.7

COMPARE_STATUS, %IWr.m.c.1 Word

The following table presents the bits of the COMPARE_STATUS word (%IWr.m.c.1):

Standard symbol	Type	Access	Meaning	Language object
FREQUENCY_LESS	BOOL	Read	Frequency value less than lower threshold (%QDr.m.c.2)	%IWr.m.c.1.0
FREQUENCY_WINDOW	BOOL	Read	Frequency value is between lower threshold (%QDr.m.c.2) and upper threshold (%QDr.m.c.4)	%IWr.m.c.1.1
FREQUENCY_GREAT	BOOL	Read	Frequency value greater than upper threshold (%QDr.m.c.4)	%IWr.m.c.1.2

Module Values on Event

The following table presents the implicit exchange word objects:

Standard symbol	Type	Access	Meaning	Language object
EVT_FREQUENCY_VALUE	UDINT	Read	Frequency value on event	%IDr.m.c.12
EVT_ACCELERATION_VALUE	INT	Read	Acceleration value on event	%IWr.m.c.14
EVT_JERK_VALUE	INT	Read	Jerk value on event	%IWr.m.c.15
EVT_RATIO_VALUE	UINT	Read	Ratio value on event	%IWr.m.c.16
EVT_ANGLE_VALUE	UINT	Read	Angle value on event	%IWr.m.c.17

EVT_SOURCES, %IWr.m.c.10 Word

The following table presents the bits of the EVT_SOURCES word (%IWr.m.c.10):

Standard symbol	Type	Access	Meaning	Language object
EVT_FREQ_ACK_JERK_DONE	BOOL	Read	Frequency, acceleration, and jerk values in this event message	%IWr.m.c.10.0
EVT_RATIO_DONE	BOOL	Read	Ratio value in this event message	%IWr.m.c.10.1
EVT_ANGLE_DONE	BOOL	Read	Angle value in this event message	%IWr.m.c.10.2
EVT_STOPPED	BOOL	Read	Event is input frequency stopped	%IWr.m.c.10.3
EVT_UNDER_LIMIT	BOOL	Read	Event is input frequency too low	%IWr.m.c.10.4
EVT_OVER_LIMIT	BOOL	Read	Event is input frequency too high	%IWr.m.c.10.5
EVT_FREQUENCY_VALUE_LESS	BOOL	Read	Event is frequency value less the limits	%IWr.m.c.10.6
EVT_FREQUENCY_VALUE_WINDOW	BOOL	Read	Event is frequency value within the limits	%IWr.m.c.10.7
EVT_FREQUENCY_VALUE_GREAT	BOOL	Read	Event is frequency value greater than the limits	%IWr.m.c.10.8
OVER_RUN_EVENT	BOOL	Read	Event(s) lost	%IWr.m.c.10.9

Output Data, `%Qr.m.c.d`

The following table presents the output data `%Qr.m.c.d`:

Standard symbol	Type	Access	Meaning	Language object
ENABLE_OUTPUT_LATCH	EBOOL	Read/Write	Make the output function active	`%Qr.m.c.0`
FORCE_OUTPUT	EBOOL	Read/Write	Force the physical output to active	`%Qr.m.c.1`
ENABLE_PATTERN_RECOGNITION	EBOOL	Read/Write	Enable the pattern recognition corrector	`%Qr.m.c.2`
FORCE_PATTERN_LEARN	EBOOL	Read/Write	Request for pattern learning	`%Qr.m.c.3`
COMPARE_ENABLE	EBOOL	Read/Write	Authorize comparator to produce its result	`%Qr.m.c.4`
COMPARE_SUSPEND	EBOOL	Read/Write	Hold comparator at latest result	`%Qr.m.c.5`
RESET_ALARMS	EBOOL	Read/Write	Reset and disable all alarm signals	`%Qr.m.c.6`
RESET_ALARM_STOPPED	EBOOL	Read/Write	Reset and disable the alarm bit `ST_ALARM_STOPPED`	`%Qr.m.c.7`
RESET_ALARM_UNDER_LIMIT	EBOOL	Read/Write	Reset and disable the alarm bit `ST_ALARM_UNDER_LIMIT`	`%Qr.m.c.8`
RESET_ALARM_OVER_LIMIT	EBOOL	Read/Write	Reset and disable the alarm bit `ST_ALARM_OVER_LIMIT`	`%Qr.m.c.9`
RESET_ALARM_FREQUENCY_LESS	EBOOL	Read/Write	Reset and disable the alarm bit `ST_ALARM_FREQUENCY_LESS`	`%Qr.m.c.10`
RESET_ALARM_FREQUENCY_WINDOW	EBOOL	Read/Write	Reset and disable the alarm bit `ST_ALARM_FREQUENCY_WINDOW`	`%Qr.m.c.11`
RESET_ALARM_FREQUENCY_GREAT	EBOOL	Read/Write	Reset and disable the alarm bit `ST_ALARM_FREQUENCY_GREAT`	`%Qr.m.c.12`

`EVENT_SOURCES_ENABLING`, %QWr.m.c.1 Word

The following table presents the bits of the `EVENT_SOURCES_ENABLING` word (`%QWr.m.c.1`):

Standard symbol	Type	Access	Meaning	Language object
EVT_FREQ_ACC_JERK_EN	BOOL	Read/Write	Enable event detection when frequency, acceleration, and jerk values are produced	`%QWr.m.c.1.0`
EVT_RATIO_EN	BOOL	Read/Write	Enable event detection when ratio value is produced	`%QWr.m.c.1.1`
EVT_ANGLE_EN	BOOL	Read/Write	Enable event detection when angle value is produced	`%QWr.m.c.1.2`
EVT_STOPPED_EN	BOOL	Read/Write	Enable event detection when input frequency is stopped	`%QWr.m.c.1.3`

Standard symbol	Type	Access	Meaning	Language object
`EVT_UNDER_LIMIT_EN`	BOOL	Read/Write	Enable event detection when input frequency is too low	`%QWr.m.c.1.4`
`EVT_OVER_LIMIT_EN`	BOOL	Read/Write	Enable event detection when input frequency is too high	`%QWr.m.c.1.5`
`EVT_FREQUENCY_LESS_EN`	BOOL	Read/Write	Enable event detection when frequency value is less than the limits	`%QWr.m.c.1.6`
`EVT_FREQUENCY_WINDOW_EN`	BOOL	Read/Write	Enable event detection when frequency value is within the limits	`%QWr.m.c.1.7`
`EVT_FREQUENCY_GREAT_EN`	BOOL	Read/Write	Enable event detection when frequency value is greater than the limits	`%QWr.m.c.1.8`

Frequency Thresholds, `%QDr.m.c.d` Word

The following table presents the `%QDr.m.c` words:

Standard symbol	Type	Access	Meaning	Language object
`MINIMUM_FREQUENCY`	UDINT	Read/Write	Low limit for acceptable frequency values	`%QDr.m.c.2`
`MAXIMUM_FREQUENCY`	UDINT	Read/Write	High limit for acceptable frequency values	`%QDr.m.c.4`

Device DDT for BMXETM0200H Module

Introduction

The Device DDT is a predefined DDT that describes the I/O language elements of the I/O module. This data type is represented in a structure which provides bits and register view.

This topic describes the structure of the implicit Control Expert Device DDT for the frequency meter module BMXETM0200H.

T_M_CPT_FLM_IN2 Device DDT Description

The following table gives the structure of the T_M_CPT_FLM_IN2 Device DDT:

Name	Type	Description
MOD_HEALTH	BOOL	0 = the module has a detected error
		1 = the module is operating correctly
MOD_FLT	BYTE	Internal detected errors *(see page 104)* of the module.
CPT_CH_IN	Array [0...1] of T_M_CPT_FLM_CH_IN *(see page 101)*	I/O data for channel 0 and channel 1

T_M_CPT_FLM_CH_IN

The following table gives the structure of T_M_CPT_FLM_CH_IN:

Name	Type	Bit	Description	Access
FCT_TYPE	WORD		1 = Frequency	Read
CH_HEALTH	BOOL		0 = the channel has a detected error	Read
			1 = the channel is operating correctly	
ST_OUTPUT	EBOOL		State of the physical output Voltage level applied to the 24 Vdc channel output: ● 0 = 0 Vdc ● 1 = 24 Vdc	Read
ST_LATCH_OUTPUT	EBOOL		State of the output function block	Read
ST_SENSOR_INPUT	EBOOL		State from the sensor	Read
ST_DUAL_INPUT	EBOOL		State from the sensor on concurrent channel	Read
ST_ALARM_STOPPED	EBOOL		Alarm input frequency stopped	Read
ST_ALARM_UNDER_LIMIT	EBOOL		Alarm input frequency too low	Read
ST_ALARM_OVER_LIMIT	EBOOL		Alarm input frequency too high	Read
ST_ALARM_FREQUENCY_LESS	EBOOL		Alarm frequency value less than limits	Read

Name	Type	Bit	Description	Access
ST_ALARM_FREQUENCY_WINDOW	EBOOL		Alarm frequency value within limits	Read
ST_ALARM_FREQUENCY_GREAT	EBOOL		Alarm frequency value greater than limits	Read
COUNTER_STATUS	INT		Main status register.	Read
VALIDITY_FREQUENCY	BOOL	0	Frequency, acceleration, and jerk values guaranteed	
VALIDITY_RATIO	BOOL	1	Ratio value done	
VALIDITY_ANGLE	BOOL	2	Angle value done	
PATTERN_LEARN_RUNNING	BOOL	3	Process learning on going	
PATTERN_LEARNT	BOOL	4	Pattern profile recorded	
STOPPED	BOOL	5	Input frequency stopped	
UNDER_LIMIT	BOOL	6	Input frequency too low	
OVER_LIMIT	BOOL	7	Input frequency too high	
SENSOR_SUP_FLT	BOOL	8	Sensor supply fault	
ACTUATOR_SUP_FLT	BOOL	9	Actuator supply fault	
MPU_BROKEN_LINE	BOOL	10	MPU broken input line	
SHORT_CIRCUIT_OUTPUT	BOOL	11	Short circuit or overload on the output	
COMPARE_STATUS	INT		Field of comparison result bits.	Read
FREQUENCY_LESS	BOOL	0	Frequency value less than limits	
FREQUENCY_WINDOW	BOOL	1	Frequency value within limits	
FREQUENCY_GREAT	BOOL	2	Frequency value greater than limits	
FREQUENCY_VALUE	UDINT		Frequency value in pulses per 1000 seconds	Read
ACCELERATION_VALUE	INT		Frequency value variation per pulses per s^2	Read
JERK_VALUE	INT		Acceleration value variation per 1000 pulses per s^3	Read
RATIO_VALUE	UINT		Number pulses within concurrent channel period	Read
ANGLE_VALUE	UINT		Delay of sensor on concurrent channel	Read
ENABLE_OUTPUT_LATCH	EBOOL		Make the output function active	Read/Write
FORCE_OUTPUT	EBOOL		Force the physical output to active	Read/Write
ENABLE_PATTERN_RECOGNITION	EBOOL		Enable the pattern recognition corrector	Read/Write
FORCE_PATTERN_LEARN	EBOOL		Request for pattern learning	Read/Write

Name	Type	Bit	Description	Access
COMPARE_ENABLE	EBOOL		Enable comparator	Read/Write
COMPARE_SUSPEND	EBOOL		Hold comparator at latest result	Read/Write
RESET_ALARMS	EBOOL		Reset all alarm bits	Read/Write
RESET_ALARM_STOPPED	EBOOL		Reset alarm bit stopped	Read/Write
RESET_ALARM_UNDER_LIMIT	EBOOL		Reset alarm bit frequency too low	Read/Write
RESET_ALARM_OVER_LIMIT	EBOOL		Reset alarm bit frequency too high	Read/Write
RESET_ALARM_FREQUENCY_LESS	EBOOL		Reset alarm bit frequency value less than limits	Read/Write
RESET_ALARM_FREQUENCY_WINDOW	EBOOL		Reset alarm bit frequency value within the limits	Read/Write
RESET_ALARM_FREQUENCY_GREAT	EBOOL		Reset alarm bit frequency value greater than the limits	Read/Write
MINIMUM_FREQUENCY	UDINT		Low limit for acceptable frequency values	Read/Write
MAXIMUM_FREQUENCY	UDINT		High limit for acceptable frequency values	Read/Write

MOD_FLT Byte Description

MOD_FLT Byte in Device DDT

MOD_FLT byte structure:

Bit	Symbol	Description
0	MOD_FAIL	• **1:** Internal detected error or module failure detected. • **0:** No detected error
1	CH_FLT	• **1:** Inoperative channels. • **0:** Channels are operative.
2	BLK	• **1:** Terminal block detected error. • **0:** No detected error. **NOTE:** This bit may not be managed.
3	–	• **1:** Module in self-test. • **0:** Module not in self-test. **NOTE:** This bit may not be managed.
4	–	Not used.
5	CONF_FLT	• **1:** Hardware or software configuration detected error. • **0:** No detected error.
6	NO_MOD	• **1:** Module is missing or inoperative. • **0:** Module is operating. **NOTE:** This bit is managed only by modules located in a remote rack with a BME CRA 312 10 adapter module. Modules located in the local rack do not manage this bit that remains at 0.
7	–	Not used.

Chapter 13
Diagnostics

Overview

This chapter describes diagnostic tool in Control Expert.

What Is in This Chapter?

This chapter contains the following topics:

Control Expert Diagnostic Screens for the Module

At a Glance

The diagnostic screen for a channel of a BMXETM0200H module in Control Expert is presented in a **Fault** tab. This tab may only be accessed in online mode.

Description of the Tab

The figure below presents an example of **Fault** tab for the channel 0 of the module BMXETM0200H:
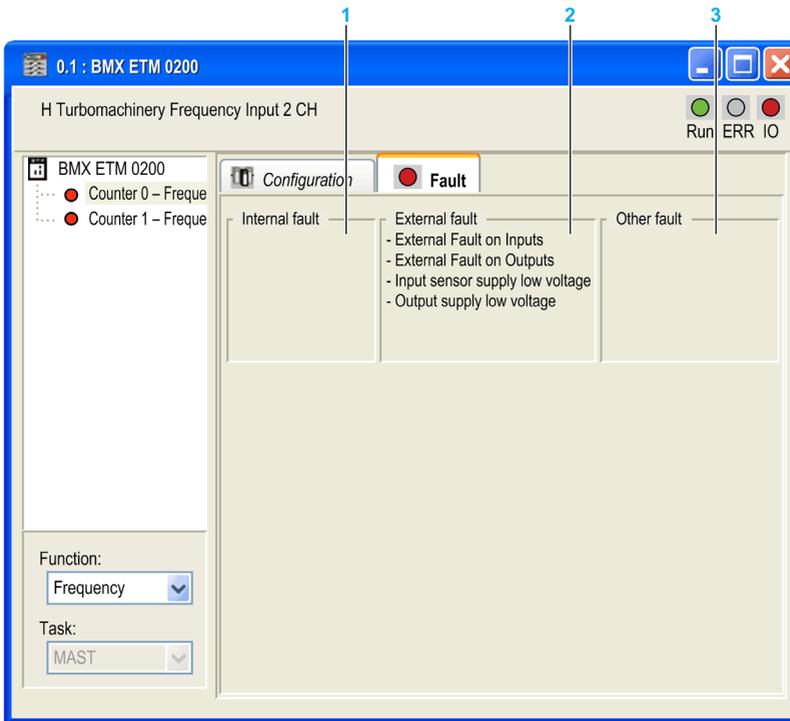
1 Display the active detected internal errors on the channel.
2 Display the active detected external errors on the channel.
3 Display the active detected errors on the channel, other than internal and external detected errors.

Description of the Fault Type

The following table presents the list of detected error types:

Fault type	Name	Display
Internal fault	`INTERNAL_FLT`	Faulty channel
	`CONF_FLT`	Detected hardware or software configuration fault
	`COM_FLT`	Module missing or off (interruption of communication with PLC)
	`APPLI_FLT`	Application mistake (configuration or adjustment)
External fault	`EXTERNAL_FLT_INPUTS`	External Fault on Inputs
	`EXTERNAL_FLT_OUPUTS`	External Fault on Outputs
	`SENSOR_SUP_FLT`	Input sensor supply low voltage
	`ACTUATOR_SUP_FLT`	Output supply low voltage
	`MPU_BROKEN_LINE`	Broken line to MPU sensor
	`SHORT_CIRCUIT_OUTPUT`	Reflex Output (24 Vdc) inoperative after Short Circuit

Diagnostics and Alarms

General Diagnostics

The module reports in the status bits for a general diagnostic of the module and its channels:

Detected error or detected fault	IODDT (T_CPT_FLM_IN2) Where: - r = rack number - m = module number - c = channel number		Device DDT (T_CPT_FLM_IN2) Where: c = channel number
	Label	Address	Label
Module detected error [1]	–	`%Ir.m.MOD.ERR`	`MOD_HEALTH`
Channel detected error [1]	`CH_ERROR`	`%Ir.m.c.ERR`	`CPT_CH_IN[c].CPT_CH_IN_CH_HEALTH`
Error detected while reading channel status	`STS_ERR`	`%MWr.m.c.1.0`	–
External detected fault on inputs[2]	`EXTERNAL_FLT_INPUTS`	`%MWr.m.c.2.0`	–
External detected fault on outputs[2]	`EXTERNAL_FLT_OUTPUTS`	`%MWr.m.c.2.1`	–
Sensor supply detected fault[2]	`SENSOR_SUP_FLT`	`%MWr.m.c.3.2`	`CPT_CH_IN[c].SENSOR_SUP_FLT`
Actuator supply detected fault[2]	`ACTUATOR_SUP_FLT`	`%MWr.m.c.3.3`	`CPT_CH_IN[c].ACTUATOR_SUP_FLT`
MPU broken input line[2]	`MPU_BROKEN_LINE`	`%MWr.m.c.3.4`	`CPT_CH_IN[c].MPU_BROKEN_LINE`
Short circuit or overload on the output [2]	`SHORT_CIRCUIT_OUTPUT`	`%MWr.m.c.3.5`	`CPT_CH_IN[c].SHORT_CIRCUIT_OUTPUT`
(1) Implicit language objects: Global diagnostic bits maintained by the system. **(2)** In topological data model (with IODDT), the application has to trigger the elementary function READ_STS to make those status bits refreshed from the module.			

Application Diagnostic

The following bits of the `COUNTER_STATUS` word provides details on the validity of the produced values:

| Bit Position	Label	Meaning
0	VALIDITY_FREQUENCY	0 reports that the frequency value is no more refreshed for any reason 1 when the frequency value can be used
1	VALIDITY_RATIO	0 reports that the ratio value is no more refreshed for any reason 1 when the ratio value can be used
2	VALIDITY_ANGLE	0 reports that the angle value is no more refreshed for any reason 1 when the angle value can be used
5	STOPPED	Input frequency is stopped for more than 1 second
6	UNDER_LIMIT	Input frequency too low The frequency is less than 100 Hz when the sampling period is 10 ms. In general the frequency is less than the sampling rate. Frequency value still provided and valid until the input frequency detected stopped
7	OVER_LIMIT	Input frequency too high Input frequency reaches 80% or more than the input bandwidth. Bandwidth depends on the configured input filter. Value still provided and valid until the input frequency detected stopped because the input frequency fast

Alarm Bits

The alarm bits enable the module to latch events until the application has treated it.

The events checked to provide an alarm are:
● Frequency stopped
● Under module limits
● Over module limits
● Results of compare function

Alarm bits are provided in Ebool format via the variable interface and can be stamped into a SOE managed with M580 CPU which the module is declared into the MAST task.

The following diagram gives the principle:
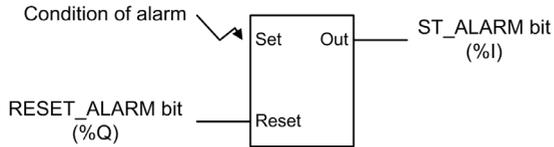
The following table presents the alarm bits (%I):

Bit (%I)	Label	Meaning
4	`ST_ALARM_STOPPED`	Signals that the input frequency has been detected stopped for at least one second.
5	`ST_ALARM_UNDER_LIMIT`	Signals that the input frequency has been detected too slow
6	`ST_ALARM_OVER_LIMIT`	Signals that the input frequency has been detected too fast
7	`ST_ALARM_FREQUENCY_LESS`	Signals that the frequency value is less than the configured limits
8	`ST_ALARM_FREQUENCY_WINDOW`	Signals that the frequency value is in the window defined by the configured limits
9	`ST_ALARM_FREQUENCY_GREAT`	Signals that the frequency value is greater than the configured limits

The following table presents the commands to reset the alarm bits (%Q):

Bit (%Q)	Label	Meaning
6	`RESET_ALARMS`	Reset and disable all alarm signals
7	`RESET_ALARM_STOPPED`	Reset and disable the alarm bit `ST_ALARM_STOPPED`
8	`RESET_ALARM_UNDER_LIMIT`	Reset and disable the alarm bit `ST_ALARM_UNDER_LIMIT`
9	`RESET_ALARM_OVER_LIMIT`	Reset and disable the alarm bit `ST_ALARM_OVER_LIMIT`
10	`RESET_ALARM_FREQUENCY_LESS`	Reset and disable the alarm bit `ST_ALARM_FREQUENCY_LESS`
11	`RESET_ALARM_FREQUENCY_WINDOW`	Reset and disable the alarm bit `ST_ALARM_FREQUENCY_WINDOW`
12	`RESET_ALARM_FREQUENCY_GREAT`	Reset and disable the alarm bit `ST_ALARM_FREQUENCY_GREAT`

Chapter 14
Time Stamping

Time Stamping

Summary

In an M580 configuration, alarm bits *(see page 109)* provided by the module can be time stamped. For detail refer to the *System Time Stamping, User Guide*.

Using the **Data Editor** screen in Control Expert, the module device DDT enables selecting the alarm bit to time stamp and to assign the trigger condition.

Limitation and Performance

The event detection is processed on both value changes edge (rising and falling). No selection of transition edge is possible in the PLC system time stamping.

The events are detected and stamped at the same rate as the PLC task (only the MAST task).

NOTE: Time stamping of the alarm bits (ST_ALARM_•••) can only be set directly on the variable bit address (%I). The IODDT structure does not enable such setting for the same bits.

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