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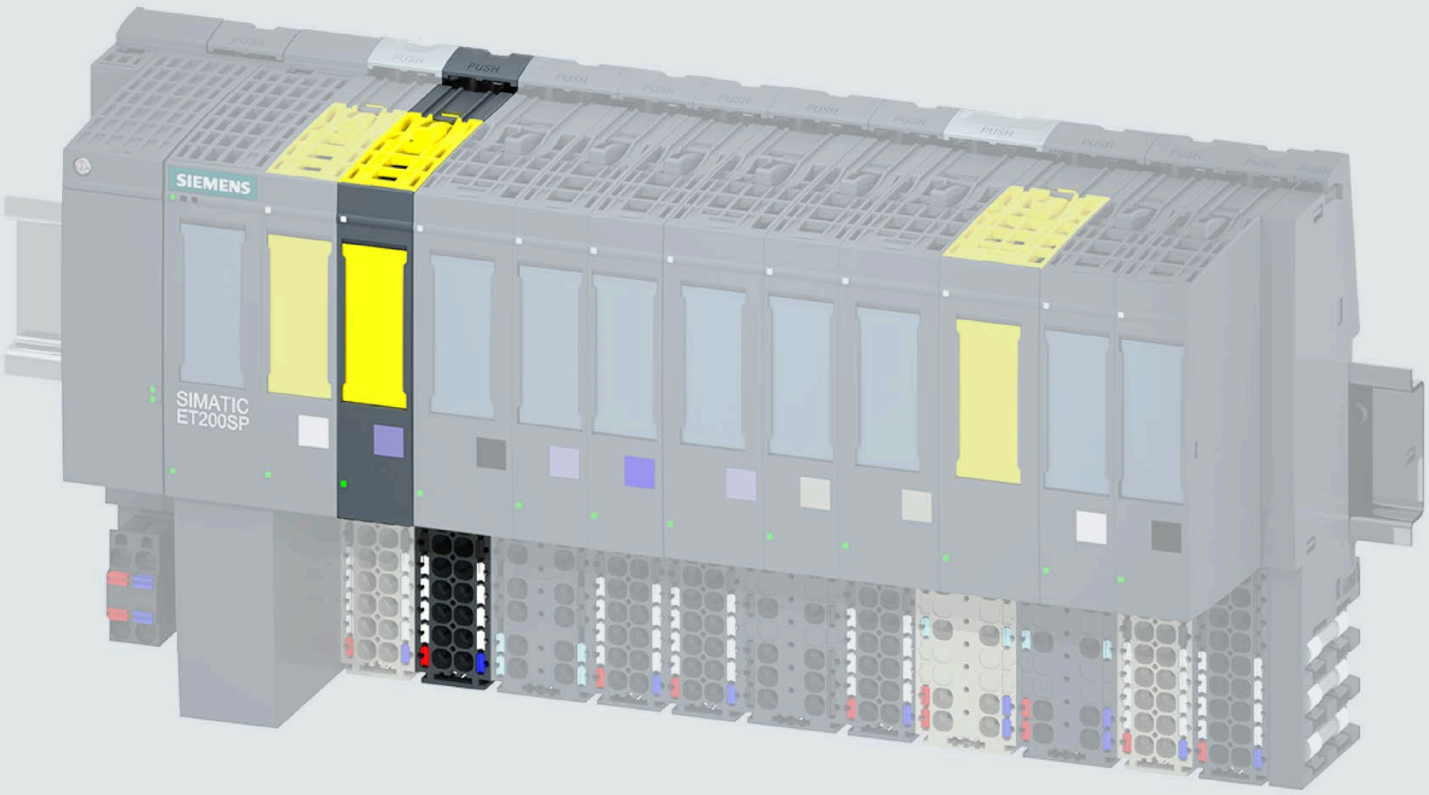

Manual

SIMATIC

ET 200SP

F-TM Count 1x1Vpp sin/cos HF
(6ES7136-6CB00-0CA0)

Edition 06/2022

support.industry.siemens.com

SIEMENS

SIMATIC

ET 200SP
ET 200SP F-TM Count 1x1Vpp sin/cos HF (6ES7136-6CB00-0CA0)

Equipment Manual

V1.0, 06/2022

A5E47073911-AF

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

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Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Preface

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customers' exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed visit (https://www.siemens.com/industrialsecurity).

Preface

Purpose of the documentation

This device manual complements the system manual ET 200SP distributed I/O system. General functions of the ET 200SP are described in the *ET 200SP Distributed I/O System* system manual (http://support.automation.siemens.com/WW/view/en/58649293).

The information provided in this device manual and the system manual enables you to commission the ET 200SP distributed I/O system.

The information in this manual and the system/function manuals provide support when you commission the system.

A description of the F-system SIMATIC Safety can be found in the *SIMATIC Safety – Configuring and Programming* programming and operating manual (https://support.industry.siemens.com/cs/ww/en/view/54110126).

Conventions

CPU: When the term "CPU" is used hereafter, it refers to the fail-safe CPUs of the S7-1200/1500 automation system, prior generation S7-300/S7-400 automation systems, and ET 200 CPUs.

STEP 7: In this documentation, "STEP 7" is used as a synonym for all versions of the configuration and programming software STEP 7 (TIA Portal).

Please observe notes marked as follows:

Note

A note includes important information on the product described in the documentation, on handling the product, or on the part of the documentation to which you ought to pay special attention.

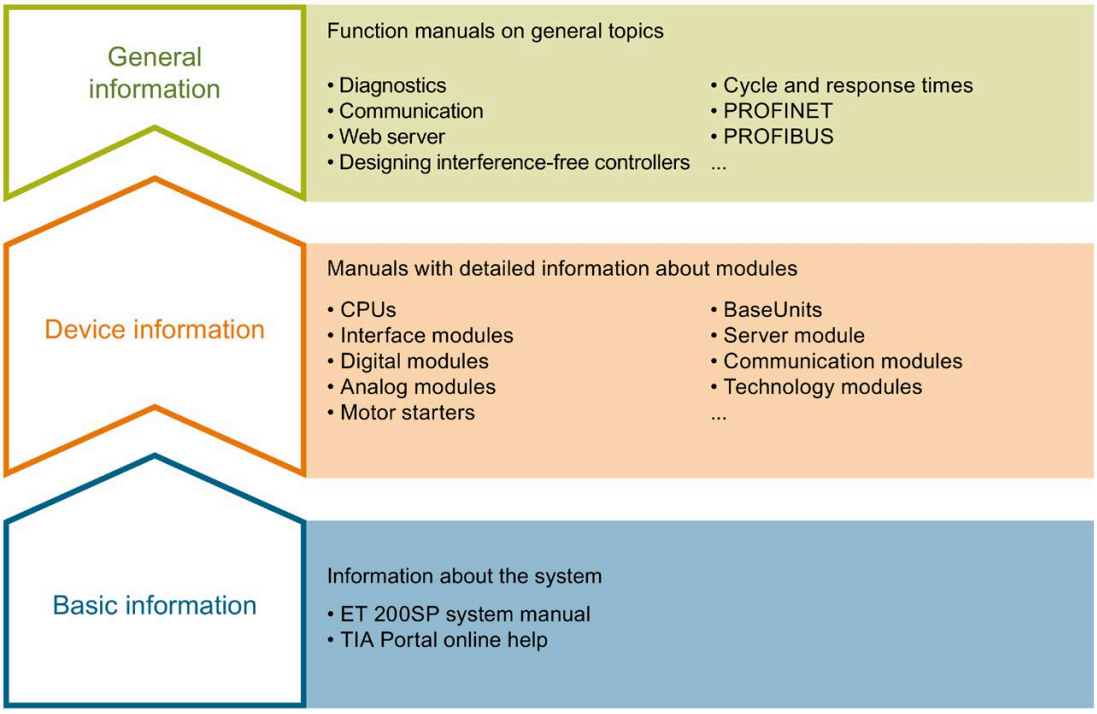
Table of contents

Documentation guide

1

1.1 ET 200SP Documentation guide

The documentation for the SIMATIC ET 200SP distributed I/O system is arranged into three areas.
This arrangement enables you to access the specific content you require.



Basic information

The system manual describes in detail the configuration, installation, wiring and commissioning of the SIMATIC ET 200SP distributed I/O system. The STEP 7 online help supports you in the configuration and programming.

Device information

Product manuals contain a compact description of the module-specific information, such as properties, wiring diagrams, characteristics, and technical specifications.

General information

The function manuals contain detailed descriptions on general topics regarding the SIMATIC ET 200SP distributed I/O system (for example, diagnostics, communication, Web server, motion control, and OPC UA).

You can download the documentation free of charge from the Internet (https://support.industry.siemens.com/cs/ww/en/view/109742709).

Changes and supplements to the manuals are documented in a Product Information.

You can download the product information free of charge from the Internet (https://support.industry.siemens.com/cs/us/en/view/73021864).

Manual Collection ET 200SP

The Manual Collection contains the complete documentation on the SIMATIC ET 200SP distributed I/O system gathered together in one file.

You can find the Manual Collection on the Internet (http://support.automation.siemens.com/ww/view/en/84133942).

"mySupport"

With "mySupport", your personal workspace, you make the most of your Industry Online Support.

In "mySupport" you can store filters, favorites and tags, request CAx data and put together your personal library in the Documentation area. Furthermore, your data is automatically filled into support requests and you always have an overview of your current requests.

You need to register once to use the full functionality of "mySupport".

You can find "mySupport" on the Internet (https://support.industry.siemens.com/My/ww/en).

"mySupport" - Documentation

In the Documentation area of "mySupport", you have the possibility to combine complete manuals or parts of them to make your own manual. You can export the manual in PDF format or in an editable format.

You can find "mySupport" - Documentation on the Internet (http://support.industry.siemens.com/My/ww/en/documentation).

"mySupport" - CAx Data

In the CAx Data area of "mySupport", you can access the latest product data for your CAx or CAe system.

You configure your own download package with a few clicks.

In doing so you can select:

- Product images, 2D dimension drawings, 3D models, internal circuit diagrams, EPLAN macro files
- Manuals, characteristics, operating manuals, certificates
- Product master data

You can find "mySupport" - CAx Data on the Internet (http://support.industry.siemens.com/my/ww/en/CAxOnline).

Application examples

The application examples support you with various tools and examples for solving your automation tasks. Solutions are shown in interplay with multiple components in the system - separated from the focus in individual products.

You can find the application examples on the Internet (https://support.industry.siemens.com/sc/ww/en/sc/2054).

TIA Selection Tool

With the TIA Selection Tool, you can select, configure, and order devices for Totally Integrated Automation (TIA).

This tool is the successor of the SIMATIC Selection Tool and combines the known configurators for automation technology into one tool.

With the TIA Selection Tool, you can generate a complete order list from your product selection or product configuration.

You can find the TIA Selection Tool on the Internet (https://support.industry.siemens.com/cs/us/en/view/109767888).

SIMATIC Automation Tool

You can use the SIMATIC Automation Tool to run commissioning and maintenance activities simultaneously on various SIMATIC S7 stations as a bulk operation independently of the TIA Portal.

The SIMATIC Automation Tool provides a multitude of functions:

- Scanning of a PROFINET/Ethernet network and identification of all connected CPUs
- Address assignment (IP, subnet, gateway) and station name (PROFINET device) to a CPU
- Transfer of the data and the programming device/PC time converted to UTC time to the module
- Program download to CPU
- Operating mode switchover RUN/STOP
- Localization of the CPU by means of LED flashing
- Reading out CPU error information
- Reading the CPU diagnostic buffer
- Reset to factory settings
- Updating the firmware of the CPU and connected modules

You can find the SIMATIC Automation Tool on the Internet (https://support.industry.siemens.com/cs/ww/en/view/98161300).

PRONETA

With SIEMENS PRONETA (PROFINET network analysis), you analyze the plant network during commissioning. PRONETA features two core functions:

- The topology overview independently scans PROFINET and all connected components.
- The IO check is a fast test of the wiring and the module configuration of a system.

You can find SIEMENS PRONETA on the Internet (https://support.industry.siemens.com/cs/ww/en/view/67460624).

SINETPLAN

SINETPLAN, the Siemens Network Planner, supports you in planning automation systems and networks based on PROFINET. The tool facilitates professional and predictive dimensioning of your PROFINET installation as early as in the planning stage. In addition, SINETPLAN supports you during network optimization and helps you to exploit network resources optimally and to plan reserves. This helps to prevent problems in commissioning or failures during productive operation even in advance of a planned operation. This increases the availability of the production plant and helps improve operational safety.

The advantages at a glance include the following items:

- Network optimization thanks to port-specific calculation of the network load
- Increased production availability thanks to online scan and verification of existing systems
- Transparency before commissioning through importing and simulation of existing STEP 7 projects
- Efficiency through securing existing investments in the long-term and optimal exploitation of resources

You can find SINETPLAN on the Internet (https://www.siemens.com/sinetplan).

Safety technology support

Siemens provides online comprehensive support for your use of safety technology. A Safety Evaluation Tool assists you in determining required safety levels, Functional Examples guide you in your safety applications, Siemens training (SITRAIN) classes offer training in safety standards and products, and you can calculate your maximum system response time using the SIMATIC STEP 7 Safety Advance F-Execution Times, F-Runtimes, F-Monitoring and Reaction Times Excel file (RT_calculator) Excel file.

You can find the Safety Evaluation Tool on the Internet (http://www.siemens.com/safety-evaluation-tool).

You can find Functional Examples on the Internet (http://www.siemens.com/safety-functional-examples).

You can find SITRAIN classes on the Internet (http://www.siemens.com/sitrain-safetyintegrated).

You can find the RT_calculator on the Internet (https://support.industry.siemens.com/cs/ww/en/view/58856512).

Product overview

2

2.1 Properties

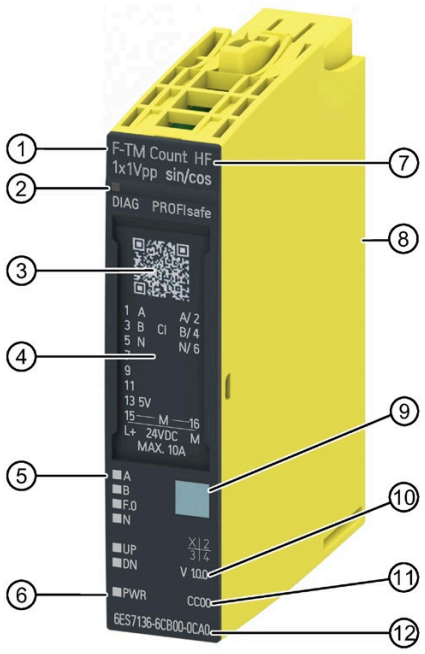
Article number

6ES7136-6CB00-0CA0

Firmware version

This manual describes the properties of the module with firmware version 1.00 or later.

View of the module



①	Module type and name	⑦	Function class
②	LED for diagnostics	⑧	Electronic coding element connector (not shown)
③	2D matrix code	⑨	Color coding module type
④	Wiring diagram	⑩	Function and firmware version
⑤	LEDs for channel status	⑪	Color code for selecting the color identification labels
⑥	LED for supply voltage	⑫	Article number

Figure 2-1 View of the F-TM Count 1x1Vpp sin/cos HF module

Use of the module

The F-TM Count module reports events and statuses based on configured parameters and external movement operations in the SIMATIC ET 200SP distributed I/O system. It provides a SIN/COS encoder interface that can safely count up to a maximum speed of 200 kHz.

The F-TM Count module features a 15-mm wide, ET 200SP module housing. Refer to *Connecting* (Page 21) for a list of compatible BaseUnits (BUs).

The F-TM Count module supports safety-related applications up to SIL CL 3 according to EN 62061, or Cat. 4, PL e according to EN 13849-1. The input and output values of the safety-related F-TM Count module are addressed using the process image. You need an F-CPU for safety processing.

Properties

The F-TM Count module has the following technical properties:

- Failsafe module
- PROFIsafe (under supported system functions)
- 200 kHz counter input
- SIL 3, Cat. 4, PL e
  - Diagnostic display (DIAG red/green LED)
  - Status display for each input (green LED)
  - Error display for each input (red LED)
- Single configurable channel:
  - Interfaces:
    Sin/Cos differential encoder signals A, A/, B, B/, N and N/

    5 V DC encoder supply that is short-circuit proof

    Module supply voltage L+ (24V)
  - Count range: 32 bits
  - Monitoring of encoder signals for wire break, short-circuit and signal quality
  - Monitoring of supply voltage
- Supported encoder/signal types:
  - Sin/Cos differential encoder with and without N signal
- Supported system functions:
  - Module and channel diagnostics
  - Firmware update
  - Identification and maintenance data (I&M 0-3)

Accessories

You can use the following accessories with the F-module; however, the accessories are not included in the product package:

- Labeling strips
- Color identification labels
- Reference identification labels
- Shield connector (article number 6ES7193-6SC00-1AM0)
- Cable (article number 6FX8008-1BD31-XXXX) sold by the meter or equivalent

Article numbers are provided for those items unique to the F-TM Count module. Additional information about accessories can be found in the *ET 200SP Distributed I/O System* system manual (http://support.automation.siemens.com/WW/view/en/58649293).

2.2 Functions

2.2.1 Safety

What are fail-safe automation systems?

Safety-related systems are primarily concerned with applications whose failure could have impact upon the safety of people and/or the environment. As a result, safety-related systems are used to mitigate hazards or failures that are likely to cause physical harm. Their intent is to achieve safety to an acceptable level of tolerable risk.

F-systems serve to control processes and ensure safe states upon detected failures. Failures are detected using very high levels of diagnostic coverage. Upon detection of failures, actions are taken to attempt to bring the respective application to a safe state.

F-systems provide improved fault detection and fault localization through detailed diagnostic identification and reporting. This is the primary difference between fail-safe systems and standard systems. Use of fail-safe systems should be considered for applications in which hazards are inherently present and may result in physical harm.

Supported safety monitoring functions

The F-TM Count module provides safety monitoring functions that may be used to monitor speed, position, and/or direction. These safety monitoring functions can be optionally enabled to report safety events if configured safety limits are exceeded. The safety monitoring functions include the following:

- Safe Direction (SDI) is used to monitor the direction of motion.
- Safety Limited Speed (SLS) is used to monitor that the motion does not exceed a preset speed limit.
- Safe Operating Stop (SOS) is used to monitor for unintentional movement.

WARNING

The F-TM Count module cannot take action that affects the safety functions.

The F-TM Count module reports when the parameter limits are exceeded to the F-CPU.

You must ensure code in your safety program does the following:

- Examines the safety-monitoring event data from the module
- Takes the necessary action to result in the appropriate outcome (for example, slowing down, or shutting down movement)

2.2.2 Detection of counting signals

The F-TM Count module monitors the encoder signals and evaluates them as quadrature encoded signals. The count direction is determined by the phase relationship of the encoder signals.

You can specify the counter characteristics using the functions described below.

Counting limits

You can configure the behavior of the counter at the counting limits. The counting limits define the counter value range used.

Start value

You can configure a start value within the counting limits.

2.2.3 Measured value determination

You can select one at a time from the following measured values reported:

- Frequency measurement with the unit of millihertz (-800000000 to +800000000 meaning -800000.000 to +800000.000 Hz)
- Period measurement with the unit of microseconds (-25000000 to +25000000 meaning -25.000000 to +25.000000 seconds)
- Velocity measurement is the calculated velocity * 1000 to include fractional portion of the calculation (-2147483648 to 2147483647 meaning -2147483.648 to +2147483.647 velocity unit)

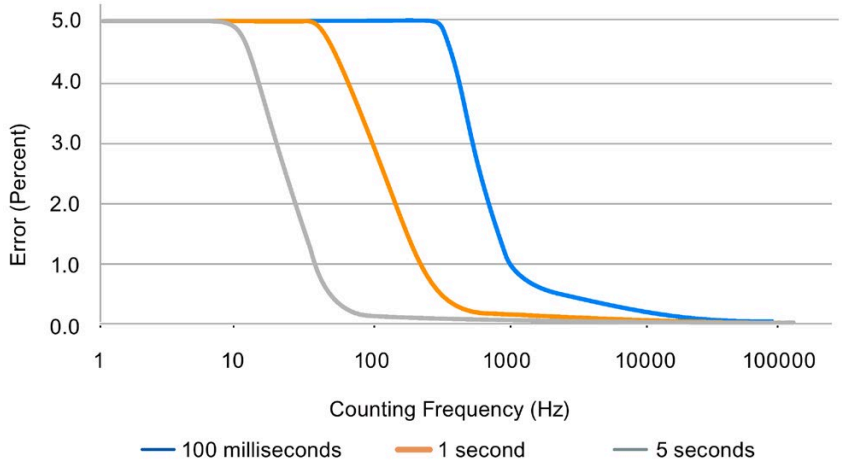
All measured values are returned as scaled integers with the units noted above.

Negative values are reported when counting down, positive values are reported when counting up.

Update time

Calculated measured value accuracy is influenced by the duration of selected update times. You can configure the interval at which the technology module updates the measured values cyclically to the F-CPU. Setting a longer update time interval allows the module to collect more data to calculate a more accurate measured value, but reaction time increases.

The following figure illustrates the effect of update time on the approximate accuracy of measured value calculations:



For example: the figure shows that at a frequency of 100 Hz, the percent error in the measured value is about 10 times greater at a 1 second update time as compared to a 5 second update time.

Note

The safety reaction time is influenced by the chosen update time when using measured values as part of your safety program (for example, at about 100 Hz, the relative error with a 1 second update time is approximately three times greater than a 5 second update time). For additional information, refer to Response times of the F-TM Count module (Page 81).

Note

The user should consider the measured value accuracy at the user's specified counting frequency range when determining the Safety Limited Speed "Speed limit" setting.

Gate control

Software (SW) gating is required to control when counting is permissible. When the SW gate is open, counting is enabled.

When the SW gate is closed the following occurs:

- Counting is disabled until the gate is opened again. Position is not maintained if movement occurs.
- Measured value calculations are still performed, but the last reported measured value is continually reported until the gate is opened again.
- Safety monitoring operations will still be performed. However, their progress is paused until the gate is again opened. Movement that violates specified limits will not be detected.

You can configure the reaction to the gate opening.

Examples of determining measured values

Use STEP 7 device configuration to set the values for the module in the following examples. For your velocity in meters per second, you set the "Time Base for Velocity Measurement" field to the value "1 second" and the "Counts per Unit for Velocity" to how many counts per meter the encoder will generate. The velocity value returned to your safety program will be the meters per second value * 1000. Multiplying the meters per second value by 1000 ensures the velocity value has sufficient resolution to show the fractional portion of the calculation.

Setting "Velocity" in meters per second

You set the parameter values as follows:

- "Measured value" to "Velocity"
- "Update Time" to 1000 milliseconds - Provides an updated velocity calculation to your safety program every second (1000 milliseconds)
- "Time Base for Velocity Measurement" value to "1 second"
- "Counts per Unit for Velocity" to 100 if your encoder generates 100 counts per meter

In this example, if you measured 452 counts during the one second update time and there are 100 counts per meter, the movement distance is 4.52 meters during the one second update time. Since the desired unit is meters per second, the velocity returns as a scaled value (velocity * 1000) and your safety program sees the velocity as 4520. You would then interpret the value as 4.520 meters per second.

Setting the "Update Time" to "100 milliseconds"

Use the same setup as the previous example, but set the "Update Time" to 100 milliseconds.

In this example, if you measure about 45 counts during the update time, convert this to meters per second. The result is a velocity measurement of 4500 which is 4.500 meters per second.

The module measured 4.5 meters per second, which is fewer than the previous measurement 4.52 meters per second. This results in you losing some resolution in the velocity measurement because of the shorter update time.

Setting the "Time Base for Velocity Measurement" to "100 milliseconds"

Use the same setup as the first example, but set the "Time Base for Velocity Measurement" to meters per 100 milliseconds.

In this example, if you measure 452 counts during the one second update time and there are 100 counts per meter, the movement distance is 4.52 meters during the one second update time. Since you want meters per 100 milliseconds, the velocity returns as a scaled value (velocity * 1000) and your safety program sees the velocity as 452. You would then interpret the value as 0.452 meters per 100 milliseconds.

2.2.4 Counter control and feedback

The safety-related counter input (feedback) and output (control) data are transferred to and from the F-CPU, via the PROFIsafe protocol to ensure the configured system operates safely.

Control

The following commands are set by your safety program and sent from the F-CPU to the F-TM Count module:

- Open SW Gate
- Reset Other Events
- Reset Safe Speed
- Reset Safe Stop
- Reset Safe Direction
- Set Start Value
- Enable Safe Speed
- Enable Safe Stop
- Enable Safe Direction
- Safe Direction

Feedback

The following feedback status and event data are sent from the F-TM Count module to the F-CPU:

- Direction Status
- Count Status
- Set Start Value Status
- Reset Other Events Status
- Reset Safe Speed Status
- SW Gate Status
- Reset Safe Stop Status

- Reset Safe Direction Status
- Value status (CQ HSC0)
- Zero Event
- Underflow Event
- Overflow Event
- Safe Speed Event
- Safe Stop Event
- Safe Direction Event
- HSC0 Current Value
- HSC0 Measured Value

See also

Refer to "Explanation of parameters (Page 34)" for additional information on the F-TM Count module control interface commands and feedback status and event data.

2.2.5 Counter input diagnostics

Counter discrepancy

The module uses multiple internal counters to monitor the single counter-module input. Discrepancy tests are performed to ensure respective internal counter values are compared for acceptable equivalency. If these evaluations do not provide expected results, a channel diagnostic event is generated.

After generating the diagnostic event, the module reinitializes its internal count to the last valid count before the discrepancy was detected. The module then continues monitoring the encoder and accumulating counts while the diagnostic is present.

A count value of zero and status values of zero (safe state values) are provided to your safety program while the diagnostic is present. When the error is resolved and the channel is reintegrated, the module will return the accumulated count and status values to your safety program.

WARNING

Discrepancy errors may result in a loss of counts due to the count being set back to the last known good values.

Your safety program must determine whether the reported count value remains representative of actual position.

If the position is lost, your safety program must do a homing operation and then reset the counter to its respective start value.

Maximum signal frequency

The F-TM Count module evaluates the input frequency. When encoder signal frequency reaches the maximum frequency rating (200 kHz), a reintegratable frequency error is generated.

⚠ WARNING

The count value can potentially be affected when exceeding the maximum supported signal frequency.

Your safety program must determine whether the reported count value remains representative of actual position. If position is lost, your safety program must do a homing operation and then reset the counter to its respective start value.

In situations where encoder signal frequency exceeds 250 kHz, the module generates a module is defective buffer diagnostic message. However, the module is not defective since the fatal error was caused by external events. The module must be power cycled to recover from the error.

N signal plausibility monitoring

This feature is only available when the encoder signal type is selected as an "A, B, N" signal and the "Pulses per revolution" is set to a non-zero value during module configuration in STEP 7. The test uses the "Pulses per revolution" parameter to determine the expected number of counts per revolution of the encoder. In situations where the N signal is not received at the configured "Pulses per revolution", a channel diagnostic event is generated.

The module continues monitoring the encoder and accumulating counts while the diagnostic is present. While the diagnostic is present, a count value of zero and status values of zero (safe state values) are provided to your safety program. When the error is resolved and the channel is reintegrated the module will return the accumulated count and status values to your safety program.

⚠ WARNING

It is possible for a channel fault to occur that is not readily detected by the module diagnostics if N signal plausibility monitoring is disabled.

Loss of the safety function can result in unexpected machine or process operation, which can cause death, severe personal injury, and/or property damage.

If N signal plausibility monitoring is disabled, N signal or wire break errors detected are not reported and you might not achieve your required level of safety. You must provide your own safety measures if you disable these features.

A and B signal monitoring

Signal monitoring evaluates the quality of the A and B signals. The following A and B signal quality faults can cause a channel diagnostic event to be generated.

- Phase angle of A and B signal has shifted from 90°
- Signal amplitude (voltage) is too great or too small
- Wire break, shorted signals, or encoder failure

Note

If only one of the wires of the differential pair is disconnected (for example, A or A\), a wire break may not be immediately detected, and a slight movement of the encoder position is required to detect the break. Breaking both wires of the differential pair will always be immediately detected.

The module continues monitoring the encoder and accumulating counts while the diagnostic is present. While the diagnostic is present, a count value of zero and status values of zero (safe state values) are provided to your safety program. When the error is resolved and the channel is reintegrated the module will return the accumulated count and status values to your safety program.

WARNING

The count value can potentially be affected when a signal quality fault occurs.

Your safety program must determine whether the reported count value remains representative of actual position. If position is lost, your safety program must do a homing operation and then reset the counter to its respective start value.

WARNING

Signal monitoring allows the module to meet SIL, Cat., PL rating. It is possible for a channel fault to occur that is not readily detected by the module diagnostics if signal monitoring is disabled.

Disabling this feature reduces the safety rating to SIL 1, Cat. 2, PL c, which causes a loss of the safety function. Disabling this feature can result in unexpected machine or process operation, which can cause death, severe personal injury, and/or property damage.

If signal monitoring is disabled, A and B signal or wire break errors detected are not reported and you might not achieve your required level of safety. You must provide your own safety measures if you disable these features.

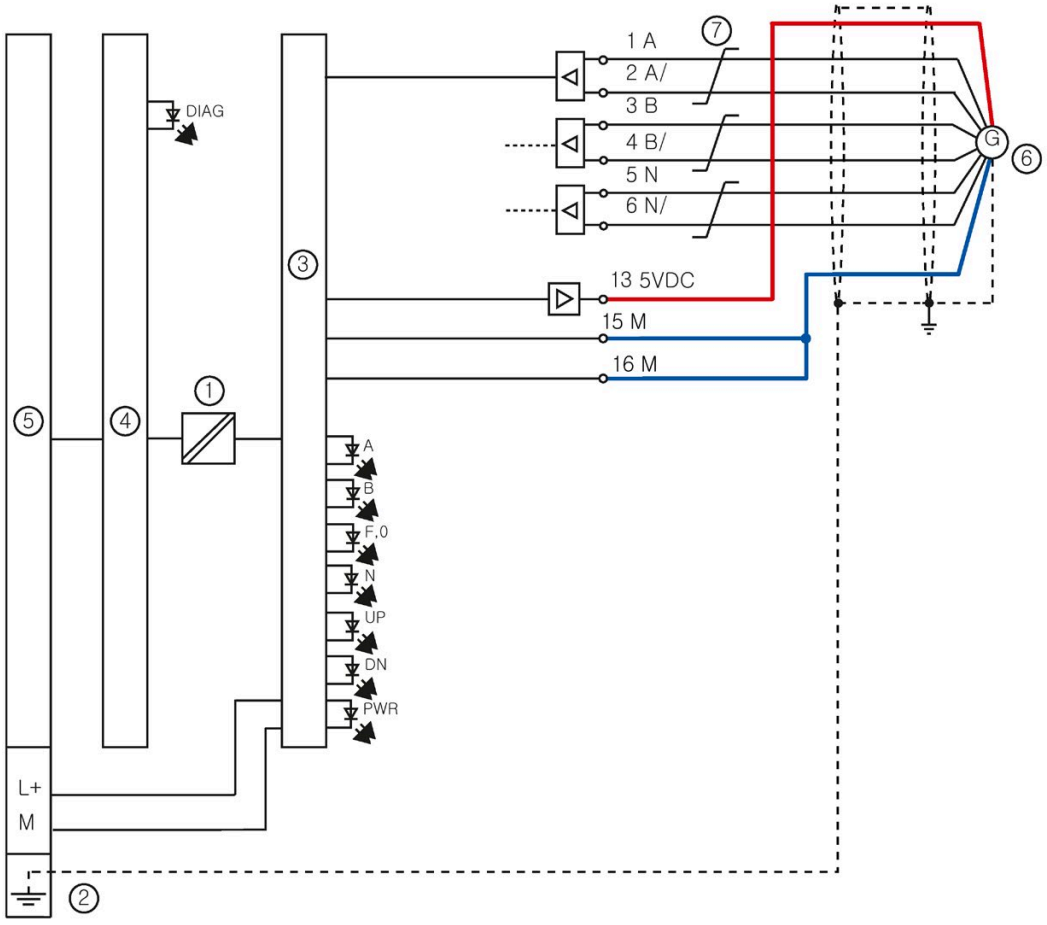
Connecting

3

3.1 Wiring and block diagram

This section provides the block diagram of the F-TM Count 1x1Vpp sin/cos HF module with the terminal assignment.

Block diagram



① Electrical isolation
② Shield connection on the BaseUnit
③ Technology
④ Backplane bus interface module of the F-TM Count module
⑤ Backplane bus
⑥ Sin/Cos encoder
⑦ Twisted in pairs

Figure 3-1 Block diagram with sin/cos encoder

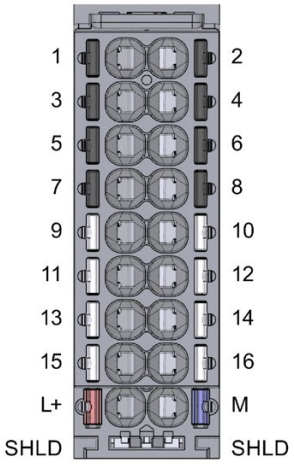
BaseUnit

The BaseUnit is not included with the delivery of the module.

You can find information on wiring the BaseUnit, connecting cable shields, etc. in the Connecting section of the *ET 200SP Distributed I/O System*, system manual (https://support.industry.siemens.com/cs/pl/en/view/58649293).

Pin assignment of the BaseUnit

Table 3- 1 Pin assignment of BaseUnit BU15-P16+A10+2B, BU type A0

Designation SIN/COS differential encoder with or without signal N	Signal name		View	Signal name		Designation
Encoder signal A	A	1		2	A/	Encoder signal A/
Encoder signal B	B	3		4	B/	Encoder signal B/
Encoder signal N	N	5		6	N/	Encoder signal N/
—	—	7		8	—	—
—	—	9		10	—	—
—	—	11		12	—	—
Encoder supply 5 V DC	5 VDC	13		14	—	—
Encoder supply ground	M	15		16	M	Encoder supply ground
Supply voltage 24 V DC	L+				M	Ground for supply voltage
Shield	—				—	Shield

Supply voltage L+/M

You connect the supply voltage to terminals L+ and M on a light BaseUnit. For a dark BaseUnit, the supply voltage of the module to the left is used. An internal protection circuit protects the F-TM Count module from reverse polarity of the supply voltage. The F-TM Count module monitors whether the supply voltage is connected.

CAUTION

Electrical noise risk

Electrical noise on the 24 V DC voltage supply lines can result in minor injury. For example, inserting and removing modules into an I/O base that is powered on can generate electrical noise.

Avoid actions that have the possibility to generate electrical noise on the 24 V DC voltage supply lines. Electrical noise can occur when I/O connectors make and break contact between the base and module. This noise can become visible to all modules and sensors connected within the potential group. For F-TM Count applications, sensors include encoders, especially externally powered 24 V DC sensors. The electrical noise could result in unexpected influences, such as A and B signal failures. In this situation Siemens recommends a separate potential group for the F-TM Count module and encoder.

Encoder supply

The encoder supply from the F-TM Count module provides 5 V DC encoder sensor supply voltage. The encoder supply is only switched off during the following occurrences:

- There is a fatal error
- There is a firmware update in progress

Note

The F-TM Count module can only support 5 V DC encoders using the module's internal sensor supply. However, 10 to 30 V DC incremental encoders can be supported when externally powered.

3.2 Requirements for the Encoder

Encoder Characteristics

The selected incremental encoder must include the following capabilities:

- encoder generated signals at 1Vpp centered at 2.5V
- encoder generated A and B differential sinusoidal signals
- differential signals between A and A/, B and B/
- A and B signals are 90° phase-shifted
- N signal support is optional; the N terminals are unconnected when not used

Encoder signal names are defined by the encoder manufacturer and can differ from the signal names used in this manual. Signals herein are designated with the letters A, A/, B, B/, N and N/.

Due to anticipated safety application requirements when using the F-TM Count module, the connected encoder is evaluated in a safety-related manner. Encoder-generated faults, including correct A-to-B signal phase offsets, incorrect output signal voltages (1Vpp), wire breaks, parasitic oscillations, etc., are detected by the F-TM Count module. These faults are detected for any connected encoder, whether safety-rated or non-safety-rated.

To determine the achievable safety rating for the application, the encoder's functional safety failure characteristics must be determined--i.e., SIL, CAT, PL, $MTTF_d$, and $B10_d$. If such information cannot be found on the encoder manufacturer's data sheet, then the failure response data must be requested from the encoder manufacturer.

If encoders are used that specify no safety ratings, it is recommended that the failure response of the selected encoders causes the encoder signals to fall outside of the valid 1Vpp range. This allows the F-TM Count module to detect the encoder failure. Failure scenarios must be clarified with encoder manufacturers.

Siemens-specific encoder references may be found within the following SIOS entry:

SINAMICS S120 drive system for SINUMERIK Safety Integrated
(https://support.industry.siemens.com/cs/de/en/view/33512621)

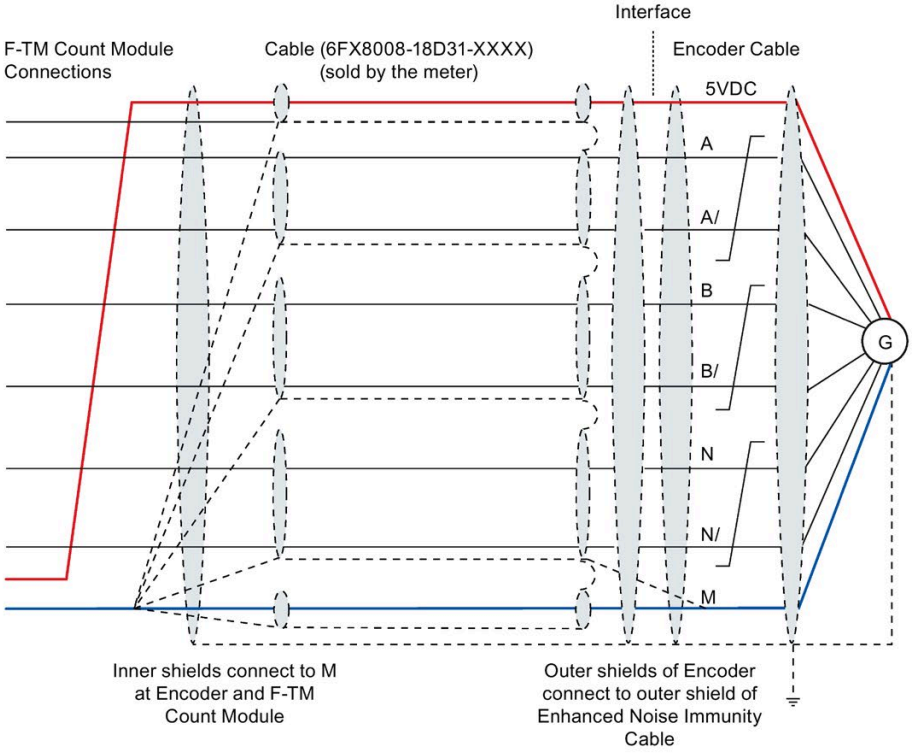
Immunity

⚠ WARNING

Failure to use properly shielded cable will result in degraded performance of the module because of lack of immunity.

To meet noise immunity standards, it is necessary to use cable (article number 6FX8008-1BD31-XXXX) sold by the meter for cable lengths greater than 1 meter or equivalent.

Wiring using the cable is shown in the following figure:



NOTICE

The right side of the F-TM Count module may exhibit some sensitivity to electrostatic discharge (ESD).

Care should be taken to avoid exposure to ESD. If possible, it is recommended the F-TM Count module is not the last module on the right of the mounted configuration.

Radio frequency (RF) interference on encoder cables

Some encoders are sensitive to conducted RF on encoder cables. This can occur if the encoder cable is in a cable tray with other cables that can cause RF interference (for example, control cables).To prevent interference with the encoders, route control and encoder/sensor cables separately from each other. In the unlikely event that the encoder is still affected, you can place Type 28B ferrite clamp filters on the encoder cable at the encoder.

Parameters/address space

4

4.1 Configuring the F-TM Count module

All connected fail-safe I/O must have their operating properties configured by the STEP 7 Safety.

You have the responsibility to ensure that no unconfigured modules are connected in a fail-safe automation system.

Refer to the Configuring chapter of the *SIMATIC Safety - Configuring and Programming* manual (https://support.industry.siemens.com/cs/ww/en/view/54110126) for step-by-step instructions.

Fail-Safe CPUs

You can use any of the following F-CPUs with the F-TM Count module:

- S7-1200/1500 F
- S7-300/400 F
- ET 200SP F
- ET 200S F
- ET 200pro F

Hardware components for PROFINET fail-safe system

You can use the following fail-safe PROFINET hardware components in a fail-safe system:

- F-CPUs with built-in PROFINET interface
- F-CPUs with optional PROFINET communication module (CM) interface modules
- Fail-Safe inputs and outputs (F-I/O), such as:
  - ET 200SP fail-safe modules
  - Fail-Safe GSDML-based, PROFIsafe-capable I/O devices (for example, a light curtain or laser scanner)

Hardware components for PROFIBUS DP fail-safe system

You can use the following fail-safe PROFIBUS DP components in a fail-safe system:

- F-CPUs with built-in PROFIBUS interface (PROFIBUS DP master)
- F-CPUs with optional PROFIBUS DP CM interface modules
- Fail-Safe inputs and outputs (F-I/O), such as:
  - ET 200SP fail-safe modules
  - Fail-Safe GSD-based, PROFIsafe-capable DP slaves (for example, a light curtain or laser scanner)

4.1.1 Using STEP 7 (TIA Portal V17 or greater)

Assigning a PROFIsafe address

These are the three basic steps for assigning PROFIsafe addresses:

1. Configure the F-destination address and F-source address in the hardware configuration in STEP 7 Safety and download the hardware configuration.
2. Identify the F-TM Count modules to which you want to assign the configured F-destination and F-source addresses.
3. You must assign the PROFIsafe address (F-destination address together with F-source address) to the F-module before you put it into operation as follows:
   - Right click on the F-TM Count module in the Device view in STEP 7.
   - Select "Assign PROFIsafe address" in the context menu.
   - Select the desired "Identification" method (LED flashing or serial number).
   - Select the check box on the left-hand side for the F-TM Count to assign an address to.
   - Click the "Identification" button.
   - Verify that the "Identification" method is correct (i.e. A and B channel LEDs flashing or serial number is correct).
   - Click the "Assign PROFIsafe addr..." button.
   - Click "Yes" in the prompt that follows.
   - If successful, the module is now operational.

Note

Refer to the *SIMATIC Safety - Configuring and Programming* manual (https://support.industry.siemens.com/cs/ww/en/view/54110126) for further information about PROFIsafe address identification and assignment.

Configuring F-TM Count module parameters

You specify the properties of the F-TM Count module in STEP 7 using various parameters. Depending on the settings, not all parameters are available.

You set the parameters of the module as follows:

1. Insert an ET 200SP CPU or an ET 200SP PROFINET or PROFIBUS interface module from the hardware catalog.
2. Insert the F-TM Count module from the hardware catalog under "Technology modules->Counting->F-TM Count".
3. Select the F-TM Count module (on the Device view or Device overview) and view the module's "Properties" tab.
4. In the "Properties" view, on the "General" tab, select the drop-down arrows for "Module parameters" and "TM-C parameters" to and see a subset of the properties of the "F-parameters" and "TM-C parameters".
5. Select "F-parameters" property or one of the "TM-C parameters" properties in the left-side property tree and then set values in the right-side property fields.
6. A successful compile and download of your hardware configuration to an F-CPU automatically configures your F-TM Count module.

4.1.2 Using STEP 7 (TIA Portal) with GSDML (versions of TIA Portal prior to V17)

Configuring F-modules with a GSDML file

If you need to configure F-modules with a GSDML file, you need the *S7-FCT* in order to calculate the F_iPar_CRC and assign the PROFIsafe addresses. Operating instructions and additional information for the *S7-FCT V2.0 - Fail-safe Configuration Tool* can be found on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109763833).

You can find *S7-FCT* on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109762827).

Assigning a PROFIsafe address

These are the three basic steps for assigning PROFIsafe addresses:

1. Configure the F-destination address and F-source address in the hardware configuration in STEP 7 Safety and download the hardware configuration.
2. Identify the F-TM Count modules to which you want to assign the configured F-destination and F-source addresses. F-destination addresses are generally assigned with lower numbers (for example, less than 100) for GSDML configured devices, and should be within the range of the F-CPU F-destination address range for PROFIsafe address type 1 devices.
3. Use "Assigning the F-source address and F-destination addresses to the F-I/Os" section in the instructions for the *S7-FCT V2.0 - Fail-safe Configuration Tool* on the Internet (https://support.industry.siemens.com/cs/ww/en/view/109763833) to assign the PROFIsafe address (F-destination address together with F-source address) to the F-module before you put it into operation.

Note

Refer to the *SIMATIC Safety - Configuring and Programming* manual (https://support.industry.siemens.com/cs/ww/en/view/54110126) for further information about PROFIsafe address identification and assignment.

Configuring F-TM Count module parameters

You specify the properties of the F-TM Count module in STEP 7 using various parameters. Depending on the settings, not all parameters are available.

You set the parameters of the module as follows:

1. Insert the IM 155-6 PN interface module from the hardware catalog under "Other field devices->PROFINET I/O->I/O->SIEMENS AG->ET 200SP->Interface modules".
2. Insert the F-TM Count module from the hardware catalog under "Module->TM->Counting->F-TM Count". Select PROFIsafe V2.4 if you are using an S7-300 or S7-400 F-CPU. Select PROFIsafe V2.6 version if you are using an S7-1200 or S7-1500 F-CPU.
3. Select the F-TM Count module (on the Device view or Device overview) and view the module's "Properties" tab.
4. In the "Properties" view, on the "General" tab, select the drop-down arrows for "Module parameters" and "TM-C parameters" to see a subset of the properties of the "F-parameters" and "TM-C parameters".
5. Select "F-parameters" property or one of the "TM-C parameters" properties in the left-side property tree and then set values in the right-side property fields.
6. Start the S7-FCT for the F-TM Count module and calculate the F_iParCRC.
7. Copy the F_iParCRC into the intended PROFIsafe parameter of the F-TM Count module.
8. A successful compile and download of your hardware configuration to an F-CPU automatically configures your F-TM Count module.

4.2 Reinitialize on parameterization download

Each time parameterization of the F-module occurs, reinitialization of internal module states is required. This means that internal module states are equivalent to power-up states. Reinitializing results in the following changes in the module:

- Process image status and event bits are reset
- Counter value is reinitialized to the start value
- Measured value calculations are reinitialized
- Process image command enables are reset
- Safety monitoring intermediate values are reset (for example, intermediate values associated with SOS, SDI, and SLS calculations)

In addition to a user commanded download of parameters from STEP 7 (TIA Portal), parameters will be downloaded, and the counter module will be reinitialized in the following circumstances:

- Power cycling of the F-CPU
- Pull/Plug of the module
- Power cycling the 24V user power to the module
- Power cycling of the IM on a remote rack
- Pull/Plug of the PROFInet cable to the IM remote rack

4.3 Reaction to CPU STOP

You set the response of the F-TM Count module to CPU STOP for the module in the device configuration.

Table 4- 1 Response of technology module to CPU STOP

Option	Meaning
Continue counting	The F-TM Count channel continues to count pulses while the F-CPU is in STOP mode or while PROFIsafe communication is lost.
Stop counting	The F-TM Count channel does not continue to count. This is equivalent to closing the SW gate.

⚠ WARNING

In situations where the F-CPU is in STOP mode, the count value can potentially be affected.

The count value can be affected by the following behaviors:

- Your safety program states that may result during the commanded transition to STOP mode.
- External channel-related errors that could occur while the F-CPU is in STOP mode.
- Power cycling of the module while the F-CPU is in STOP mode.
- Your safety program control of the software gate signal when transitioning again to RUN mode. Closing of the software gate results in the loss of counts during external movement.

Your safety program must determine whether the reported count value remains representative of actual position when the behaviors above occur. If the position is lost, your safety program must do a homing operation and then reset the counter to its respective start value.

4.4 Reactions to counting limit violation

A counting limit can be violated when the counter value exceeds the high or low counting limit. Reactions to violating a counting limit are as follows:

Table 4- 2 Response of technology module to counting limit violation

Option	Meaning
Continue counting	The F-TM Count channel continues to count pulses while the counting limit is violated after setting the count to either the opposite limit or to the start value.
Stop counting	The F-TM Count channel does not continue to count. This is equivalent to closing the SW gate.

4.5 Parameters of the F-TM Count

The following parameter settings are possible:

Table 4- 3 Settable parameters and their default setting

Parameter	Value range	Default setting	Parameter reassignment in RUN	Scope
				STEP 7 (TIA Portal); STEP 7; GSD file
F-parameters				
Manual assignment of F-monitoring time	Check box: • Enable • Disable	Disable	No	Module
F-monitoring time [1]	14 to 65535 ms in 1 ms steps	150 ms	No	Module
F-destination address	1 to 65534	Address supplied by F-CPU (Always enabled)	No	Module
TM-C parameters				
Signal Monitoring	• Disable • Enable	Enable	No	Channel
Encoder related parameters				
Signal type [2]	• Sin/Cos encoder (A, B, N) • Sin/Cos encoder (A, B)	Sin/Cos encoder (A, B, N)	No	Channel
Invert direction	• Disable • Enable	Disable	No	Channel
Pulses per revolution	0 to 32767	1024	No	Channel
Reaction to signal N	• No reaction to signal N • Synchronization at signal N	No reaction to signal N	No	Channel
Counter parameters				
High counting limit	-2147483647 to 2147483647	2147483647	No	Channel
Start value	-2147483648 to 2147483647	0	No	Channel

Parameter	Value range	Default setting	Parameter	Scope
Low counting limit	-2147483648 to 2147483646	-2147483648	No	Channel
Reaction to violation of a counting limit	• Continue counting • Stop counting	Continue counting	No	Channel
Reset when counting limit is violated	• Start value • Opposite counting limit	Start value	No	Channel
Reaction to gate start	• Set to start value • Continue with current value	Set to start value	No	Channel
Safety monitoring				
Measured value	• Frequency • Velocity • Period duration	Frequency	No	Channel
Update time	0 ms to 25000 ms	100 ms	No	Channel
Time base for velocity measurement [3]	• 1 millisecond • 10 milliseconds • 100 milliseconds • 1 second • 60 seconds	1 second	No	Channel
Counts per unit for velocity measurement [3]	1 to 65535	1	No	Channel
Safety Function - Safe Stop	• Enable • Disable	Disable	No	Channel
Standstill tolerance	0 to 65535 (counts)	0	No	Channel
Safety Function - Safe Direction	• Enable • Disable	Disable	No	Channel
Monitoring tolerance	0 to 65535 (counts)	0	No	Channel
Safety Function - Limited Speed [2]	• Enable • Disable	Disable	No	Channel
Speed limit [3]	0 - 2147483647 (Velocity * 1000)	0	No	Channel
Reaction to CPU STOP				
Reaction to CPU STOP	• Continue counting operation • Discontinue counting operation	Continue counting operation	No	Channel

1 STEP 7 uses this number to set the F-monitoring time in each F-TM Count module unless you select the check box for "Manual Assignment of F-monitoring time" in that module configuration and assign a different time.

2 If (A, B) is selected, then "Pulses per revolution" and "Reaction to N signal" are disabled.

3 Velocity must be selected to configure this parameter.

4.6 Explanation of parameters

4.6.1 F-parameters

Manual assignment of F-monitoring time

This is a selection to enable the "Manual assignment of F-monitoring time".

F-monitoring time

The monitoring time of safety-related PROFIsafe communication occurring between the F-CPU and the F-I/O module.

F-source address

A unique network-wide address for the fail-safe CPU assigned to the F-CPU with the "Central F-source address" parameter.

F-destination address

A unique F-destination address for each fail-safe module.

F-parameter signature (with addresses)

A signature for all F-parameters including F-addresses; used to easily determine whether parameterization changes have occurred.

F-parameter signature (without addresses)

Signature for all F-parameters without F-addresses; used to easily determine whether parameterization changes have occurred.

Behavior after channel fault

Specifies a passivation response by the F-TM Count module to channel faults. (Always set to "Passivate channel" for the F-TM Count module since there is a single channel.)

Reintegration after channel fault

Specifies a switchover from fail-safe values to process data (reintegration) after channel faults are eliminated. (Always set to "All channels manually" for the F-TM Count module since RIOforFA is not supported.)

RIOforFA safety

Specifies whether the module supports the "RIOforFA-Safety" profile. (Always set to "No" for the F-TM Count module since RIOforFA is not supported.)

PROFIsafe mode

Specifies the PROFIsafe mode being used by the F-module.

PROFIsafe protocol version

Specifies the PROFIsafe protocol version being used by the F-module.

F-I/O DB manual number assignment

You must select the check box to manually set the DB number of the F-I/O DB. An F-I/O DB is automatically created during compilation for each configured F-I/O module.

F-I/O DB number

The number of the F-I/O DB that is created during compilation.

F-I/O DB name

Specifies the symbolic name of the F-I/O DB that is created during compilation.

See also

S7-FCT V2.0 - Fail-safe Configuration Tool Operating Instructions (https://support.industry.siemens.com/cs/ww/en/view/109763833)

SIMATIC Industrial Software SIMATIC Safety - Configuring and Programming (https://support.industry.siemens.com/cs/ww/en/view/54110126)

4.6.2 TM-C parameters

Selection of channel activation

Enables channel activation. The counter channel is always activated since there is only a single channel.

Selection of operating type: Counting/Position input

Enables whether to provide integer counter value. This selection is always enabled for the counter module and a counter value is always returned.

Selection of operating type: Measuring

Enables whether to provide an additional counter measured value. This selection is always enabled for the counter module and a measured value is always returned.

Signal monitoring

Allows you to enable or disable signal monitoring. Signal monitoring evaluates the quality of A and B signals for phase, voltage, and wire break. If signal monitoring is disabled, you must evaluate and provide safety measures suitable for your application. See "A and B signal monitoring" in "Counter input diagnostics (Page 18)" for the effects on safety and the precautions you must make if you disable signal monitoring.

WARNING

It is possible for a channel fault to occur that is not readily detected by the module diagnostics if signal monitoring is disabled.

Disabling this feature reduces the safety rating to SIL 1, Cat. 2, PL c, which causes a loss of the safety function. Disabling this feature can result in unexpected machine or process operation, which can cause death, severe personal injury, and/or property damage.

If signal monitoring is disabled, A and B signal or wire break errors detected are not reported and you might not achieve your required level of safety. You must provide your own safety measures if you disable these features.

Signal Type

Specifies whether the encoder is providing A, B, or A, B, N signals. If (A, B) is selected, then Pulses per revolution and Reaction to N signal are disabled.

Invert direction

Specifies whether to reverse the counting direction.

Pulses per revolution

Specifies the total number of Sin/Cos pulses per revolution of the encoder. This is used for N signal plausibility monitoring. This field is only enabled when the "Signal type" selected is sin/cos encoder (A, B, N). Specifying a 0 value in this field disables N signal plausibility monitoring.

Signal evaluation

Specifies how many events per Sin/Cos pulse are counted. Only quadrature mode is supported. Quadrature mode evaluates all zero crossings of the sin/cos encoder signals, so that counts per revolution equal pulses per revolution times four.

Reaction to signal N

Specifies whether the reaction is to ignore the N signal or set the count to the start value. This field is only enabled when the "Signal type" selected is sin/cos encoder (A, B, N).

High counting limit

You limit the counting range by setting the high counting limit. An overflow event is triggered in the feedback interface when the current count exceeds the high counting limit. The current count will then be set to the start value or the low counting limit depending on parameterization. You can also select whether counting stops or continues after exceeding the high counting limit. The high counting limit must be greater than or equal to the start value and must be greater than the low counting limit. The allowed range is -2147483647 to 2147483647. The default setting is 2147483647.

Start value

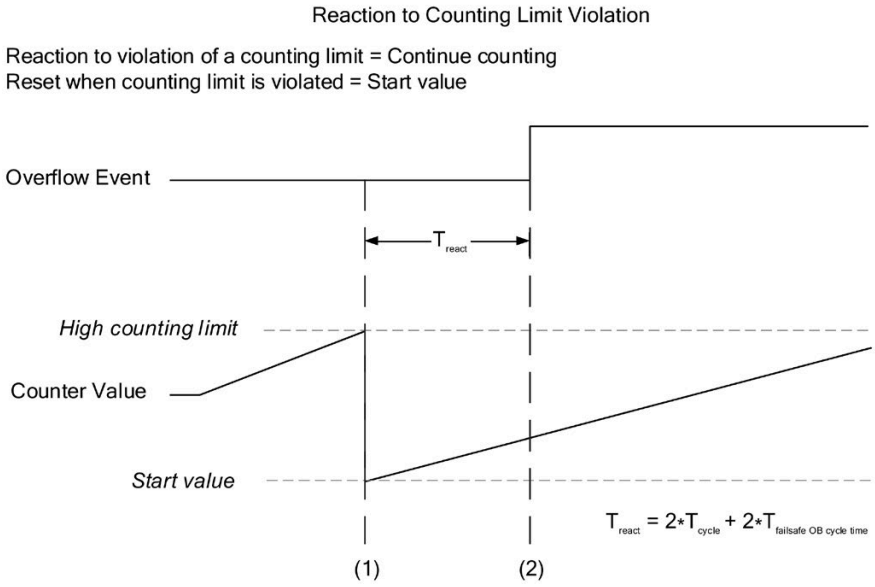
You specify the initial count value when counting starts by configuring the start value. The current count will be set to the start value after power up, after downloading parameters, when explicitly set, and other situations depending on configuration. The start value must be a value between or equal to the counting limits. The allowed range is -2147483648 to 2147483647. The default setting is 0.

Low counting limit

You limit the counting range by setting the low counting limit. An underflow event is triggered in the feedback interface when the current count exceeds the low counting limit while counting down. The current count will then be set to the start value or the high counting limit depending on parameterization. The allowed range is -2147483648 to 2147483646. The default setting is -2147483648.

Reaction to violation of a counting limit

Specifies the reaction when either the high or low counting limit is exceeded. You can choose to either continue counting or to stop counting. If you choose to stop counting, you must close and reopen the software gate to resume counting.



1 Counter value exceeds the configured high counting limit, is reset to the start value, and counting continues.

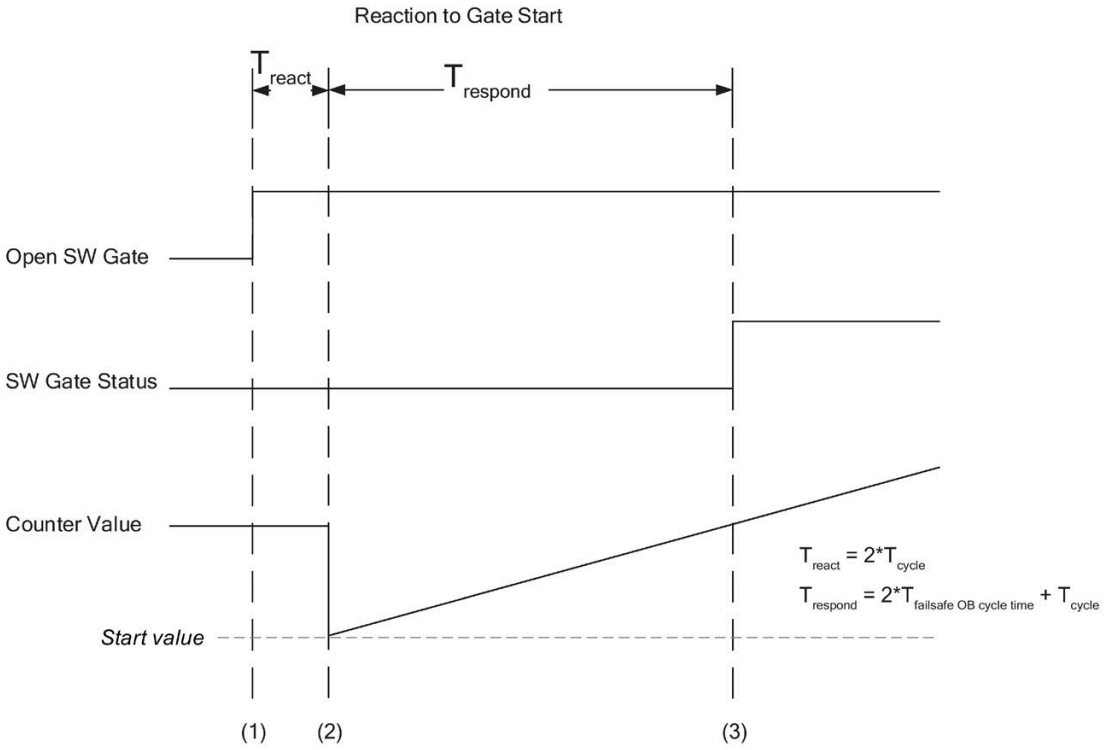
2 User program sees "Overflow Event" go high to indicate the high counting limit was exceeded and sees an updated counter value.

Reset when counting limit is violated

Specifies whether the count value is set to the start value or opposite counting limit when a counting limit is exceeded.

Reaction to gate start

Specifies whether the count value is set to the start value or continues with the current value when the SW gate is opened. This action occurs each time the SW gate changes from closed to open.



1 User program sets "Open SW Gate" high to open the software gate and enable counting.

2 Module sees the "Open SW Gate" command, opens the software gate, and sets the counter value to the start value.

3 User program sees "SW Gate Status" go high and an updated counter value.

Measured value

Specifies one of a possible three different engineering unit conversions as follows:

- **Frequency**: The average number of counts per second reported in millihertz (hertz * 1000)
- **Period duration**: The average period between two counts in microseconds (seconds * 1000000)
- **Velocity**: The speed of movement in a given direction. Velocity represents the units of measure per time base * 1000.

Negative values are reported when counting down, positive values are reported when counting up.

Note

Fields directly associated with velocity calculations are only enabled when velocity is selected.

Update time

Specifies the interval at which the F-TM Count module updates the measured values to the F-CPU. Setting a longer update time interval allows the module to collect more data to calculate a more accurate measured value, but increases the reaction time.

Note

The safety reaction time is influenced by the chosen update time when using measured values, and SLS as part of the safety application program.

Time base for velocity measurement

Specifies the time base unit for the velocity you want for the calculation output in increments of milliseconds or seconds.

Counts per unit of measure

Specifies the number of counts from the incremental encoder per relevant distance unit for the velocity measurement.

Safety Function - Safe Stop

Enables safe operating stop (SOS) monitoring.

Standstill tolerance

Specifies the acceptable standstill tolerance allowed for the SOS function measured in counts.

Note

The standstill tolerance selection is disabled if "Safety Function - Safe Stop" is disabled.

Safety Function - Safe Direction

Enables safe direction (SDI) monitoring.

Monitoring tolerance

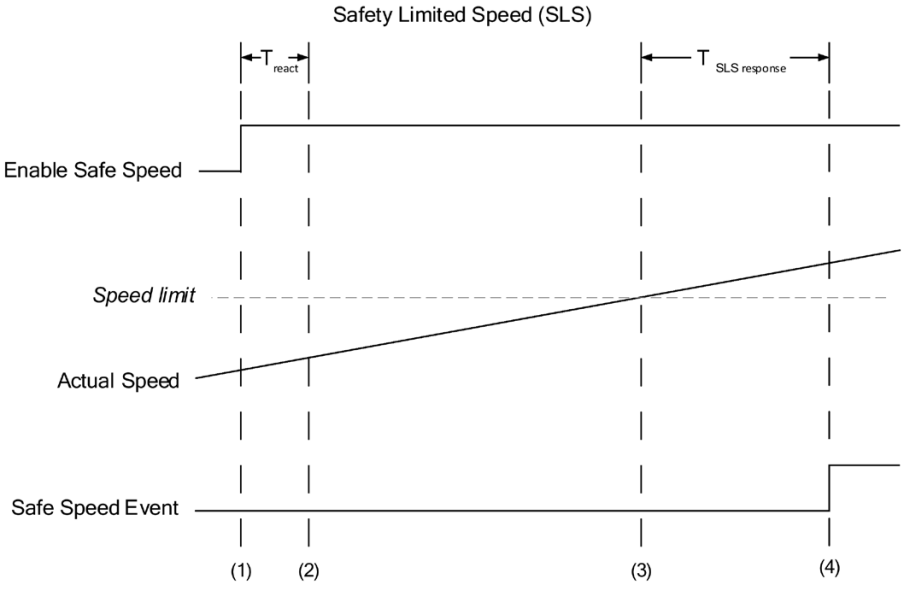
Specifies the acceptable tolerance in the unsafe direction for the SDI function measured in counts.

Note

The monitoring tolerance selection is disabled if "Safety Function - Safe Direction" is disabled.

Safety Function - Limited Speed

Enables safety limited speed (SLS) monitoring only when "Velocity" is selected as the measured value.



$T_{react} = 2*T_{cycle}$

$T_{SLS\ response} = 2*T_{failsafe\ OB\ cycle\ time} + T_{cycle} + T_{update}$

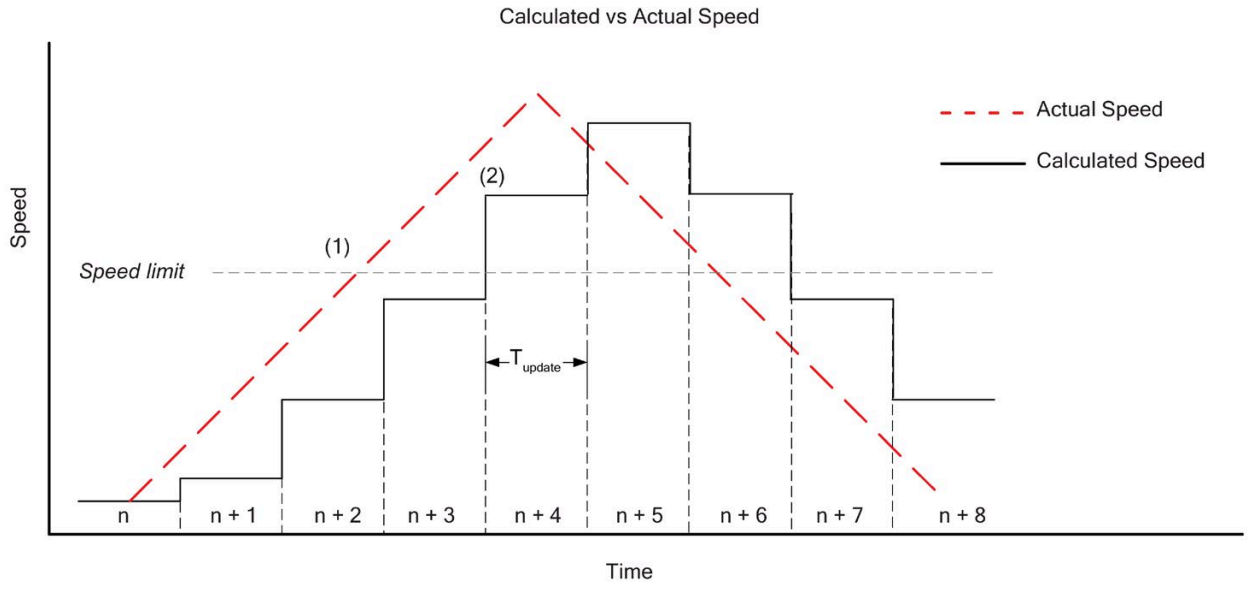
1 User program set "Enable Safe Speed" high to initiate SLS monitoring

2 Module process the "Enable Safe Speed" value and SLS monitoring is started.

3 Calculated speed exceeds the configured speed limit, "Safe Speed Event" set in the module.

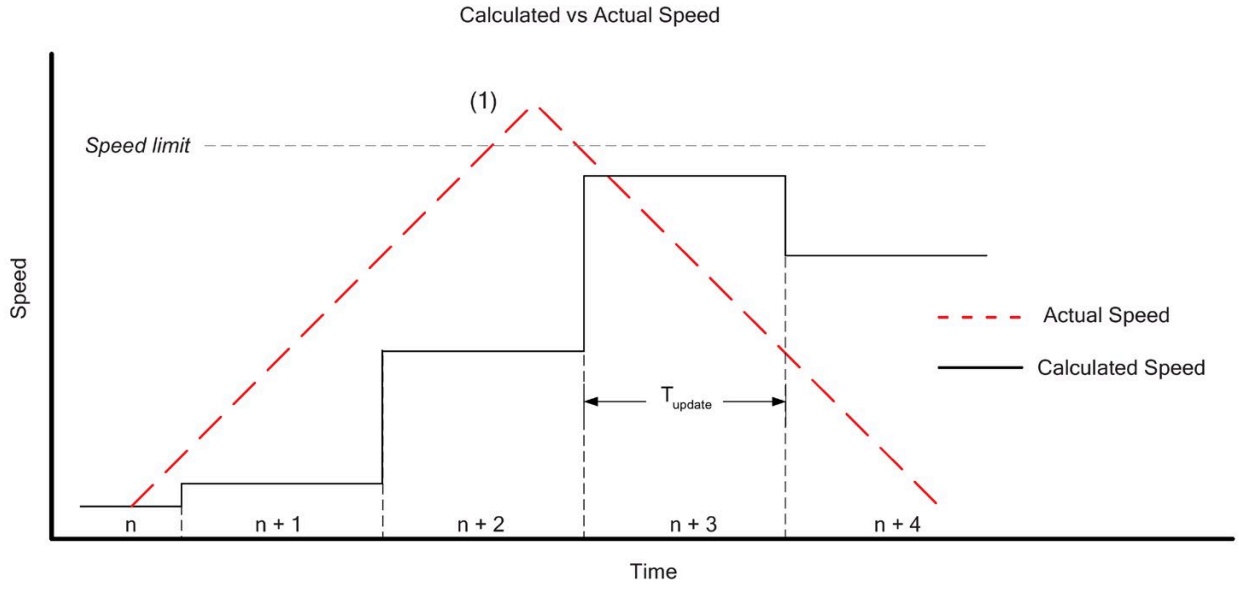
4 User program sees "Safe Speed Event" go high to indicate an overflow occurred.

The calculated speed is updated once per configured update time and represents the average speed over the preceding interval. When determining what update time to use, it is important to consider the update time's effect on filtering of momentary speed limit violations and the overall response time of the SLS monitoring. Larger update time values result in more filtering of speed limit violations as well as an extended response time.



1 Actual speed exceeds the configured speed limit during the "n+2" update interval. Due to the averaging of the calculated speed, the measured value does not yet exceed the limit so no safe speed event is issued by the module now.

2 The calculated speed first exceeds the speed limit during the "n+4" update interval. A safe speed event will be issued by the module now.



1 The actual speed exceeds the configured speed limit during the "n+2" update interval. Due to the averaging of the measured value, the calculated speed never exceeds the speed limit so no safe speed event is issued by the module. Larger update times effectively filter out short speed limit violations. Therefore, if the application needs to detect momentary speed limit violations, a shorter update time should be configured.

Speed limit

Specifies the maximum acceptable speed in velocity units for the SLS function only when velocity is selected.

Note

The speed limit selection is disabled if "Safety Function - Limited Speed" is disabled.

Reaction to CPU STOP

Specifies whether the channel continues to count pulses while the F-CPU is in STOP mode.

4.7 Behavior at the counting limits

"Reaction to violation of a counting limit" selections are defined as follows:

- **"Continue counting"**: After a violation of a counting limit, counting surpasses the limit and goes to either the start value or the opposite counting limit (depending upon configuration), and then continues.
- **"Stop counting"**: After a violation of a counting limit, counting surpasses the limit and goes to either the start value or the opposite counting limit (depending upon configuration), and then stops. To restart counting, the SW gate must be closed and reopened.

⚠ WARNING

The "Stop counting" selection may not allow the module to react at counting limits.

Configuring the "Reaction to violation of a counting limit" selection to stop counting may have a direct and detrimental influence upon configured safety monitoring and measured value.

You must ensure your safety program has provisions for the immediate stopping of counting and any potential influence upon configured safety monitoring functions and measured value.

Violation of a counting limit

The high counting limit is violated when the current counter value is equal to the high counting limit and another up-count is received. The low counting limit is violated when the current counter value is equal to the low counting limit and another down-count is received.

The appropriate status bit is set in the feedback interface in the event of limit violation:

Counting limit violated	Status bit
High counting limit	"Overflow Event" bit is set
Low counting limit	"Underflow Event" bit is set

You can reset the status bits with "Reset Other Events" bit.

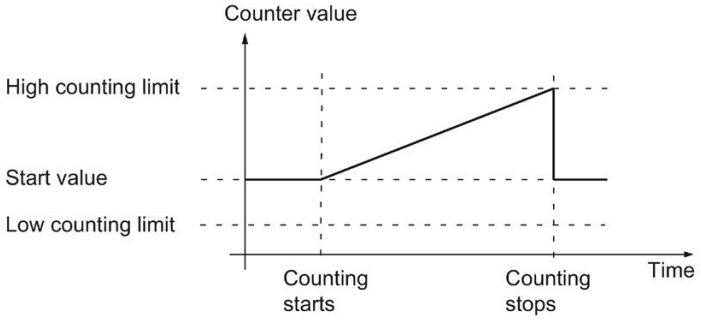
Following a counting limit violation, you can configure whether counting is to continue and whether counting is continued at the start value or at the opposite counting limit.

Note

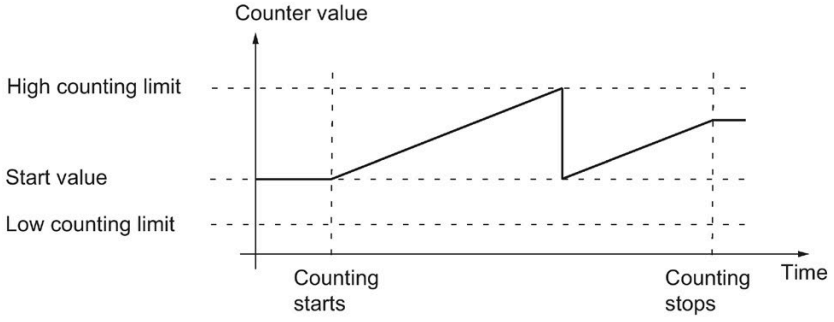
The high and low counting limits define the value range of the counter.

Examples

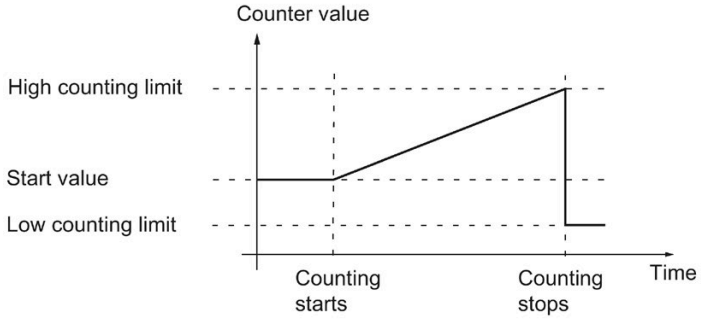
The figure below shows an example for terminating the counting process after an overflow and setting the counter to the start value:



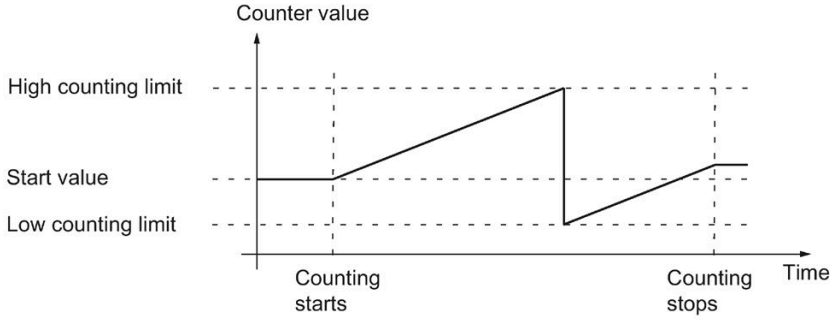
The figure below shows an example for continuing the counting process after an overflow and setting the counter to the start value:



The figure below shows an example for terminating counting after an overflow and setting the counter to the opposite counting limit:



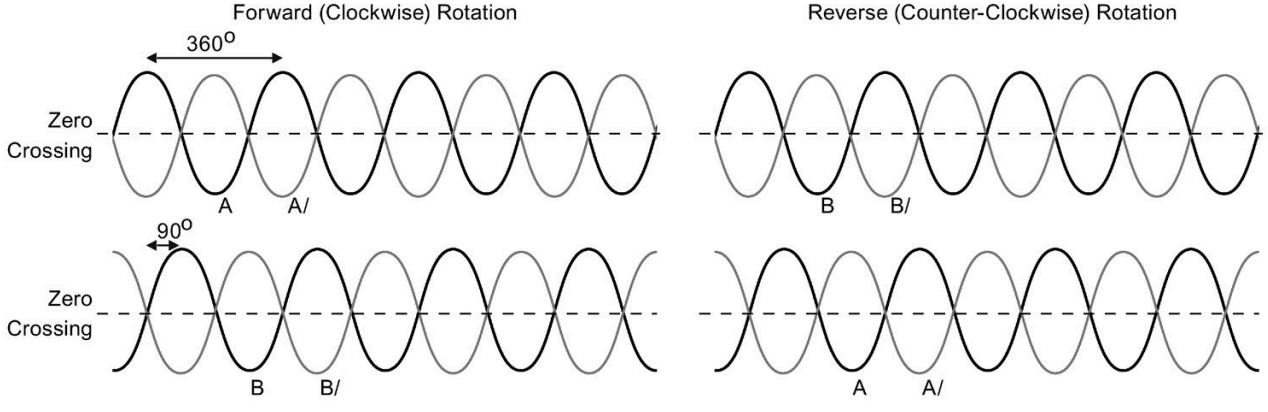
The figure below shows an example for continuing the counting process after an overflow and setting the counter to the opposite counting limit:



4.8 Quadrature evaluation of differential signals

With quadrature evaluation, the A and B signals are shifted by 90 degrees in relation to each other. When the A signal is leading, the movement is in the forward direction. When the B signal is leading, the movement is in the reverse direction.

Counting occurs at each "zero-crossing" of the A and B signals. As a result, each complete waveform has a total effect of 4 counts. For example, given a 200 kHz frequency, 800K counts per second can be achieved. These relationships are illustrated in the figure below:



4.9 Safety functions

This provides a quick overview of the principle mode of operation of the F-TM Count module safety functions.

The description of the safety functions is based on the definition according to standard EN 61800-5-2 and some simple examples for using the function.

The description of the functions is simplified, as far as possible, to clearly show essential properties and configuration options.

4.9.1 Safe Operating Stop (SOS)

SOS monitoring

SOS monitoring is initiated whenever the "Enable Safe Stop" bit is set in the control interface and subsequently processed by the F-TM Count module. SOS monitoring terminates whenever the "Enable Safe Stop" bit is reset in the process output image and subsequently processed by the module.

Each time SOS monitoring is initiated, the current position is stored. A "Safe Stop Event" is set whenever any movement is detected in either direction that exceeds the configured "Standstill tolerance" as measured from the stored position.

Standstill tolerance is configured in counts.

Once set, the "Safe Stop Event" bit remains set and counting continues after the event is triggered. The "Safe Stop Event" remains set until the "Reset Safe Stop" bit is set to 1, until a power cycle, or until a new parameterization is loaded.

Configuring a value of 0 for the standstill tolerance results in the "Safe Stop Event" being set immediately after the first pulse in either direction.

WARNING

Safe stop monitoring continues when counting is suspended and SOS monitoring is enabled.

Since there is no active counting operation, this safety function becomes ineffective. This can result in unexpected machine or process operation, which can cause death, severe personal injury, and/or property damage.

You must ensure steps outlined in safety standards applicable to your system are followed before the event bit is reset.

Using SOS monitoring

The safe stop position is stored when SOS monitoring is initiated by turning on the "Enable Safe Stop" bit and is used for the entire SOS monitoring session.

Your safety program examines the "Safe Stop Event" bit in the feedback interface and takes appropriate action during the SOS monitoring session.

Set the "Reset Safe Stop" bit to 1 to clear the "Safe Stop Event" bit in the feedback interface.

If you want to start a new SOS monitoring session, the "Enable Safe Stop" bit must be cleared in the module and then once again set in the module by separate executions of you safety program.

Note

The "Safe Stop Event" bit is also cleared by a power cycle, or when a new STEP 7 hardware configuration is downloaded.

If you reset the "Safe Stop Event" and the safe stop is still in violation, the "Safe Stop Event" bit will immediately set back to 1.

SOS suspension by external events

Suspension of counting operations can result from the following external events:

- SW gate closure
- Counting limit violation if module is configured to stop counting when the limit is violated. Refer to "Reactions to counting limit violation (Page 32)" for additional information.

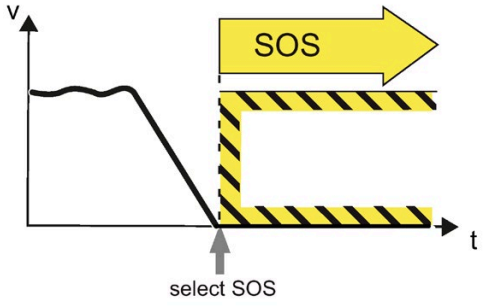
Note

Counting operations that set the start value or exceed configured counting limits shall have no effect in determining whether a safe stop violation has occurred.

This means that regardless of how the "Reaction to violation of a counting limit" is configured and the current count is subsequently manipulated, the "Safe Stop Event" is only initiated upon violation of the specified "Standstill tolerance".

4.9.1.1 Function of SOS

The SOS function monitors the count value and notifies the user if the encoder/count deviates more than a defined amount from the stopped position.



SOS Selection

Example of how the function can be used

Example	Possible solution
A protective door can only be opened if a machine is in the safe standstill state.	• Stop the movement of the hazard from your safety program. • Ensure no further movement as follows: – Engage/energize (brake/motor) – Engage the safety related actuator • Enable SOS monitoring in the counter module via the safety program in the F-CPU • Disable the door lock to permit access to the machine • Perform an appropriate safety reaction if the "Safe Stop Event" ever occurs

4.9.1.2 Example using SOS monitoring

The protected machine areas can be entered without having to shut down the machine as long as SOS is active.

Machine stopping is monitored using an SOS tolerance window. At the instant this function becomes enabled, the current position is stored as the comparison position until SOS is disabled again.

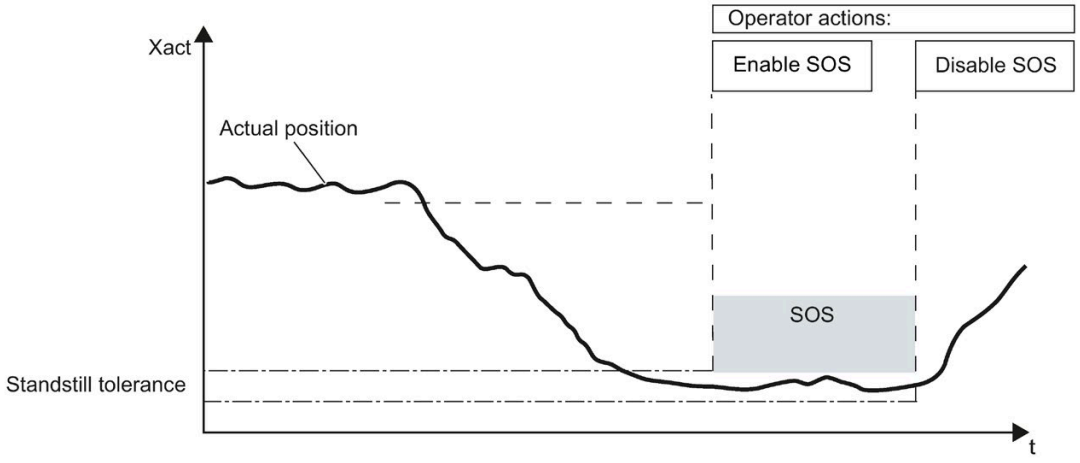


Figure 4-1 Standstill tolerance

4.9.1.3 Configuring SOS

In STEP 7 do the following to configure SOS monitoring:

- Configure "Safety Function - Safe Stop"
- Configure the "Standstill tolerance" in counts
- Download this project to the F-CPU

4.9.1.4 Enabling SOS

In your safety program, set the "Enable Safe Stop" bit to 1 to begin SOS monitoring.

From that point, if the module ever detects a movement in either direction that exceeds the configured "Standstill tolerance", the "Safe Speed Event" bit is set to 1.

4.9.1.5 Responding to SOS

Your safety program examines the "Safe Stop Event" bit and takes appropriate action when the bit is seen as 1. Once set, the "Safe Stop Event" bit remains set to 1 until either of the following actions occur:

- Your safety program sets the "Reset Safe Stop" bit to 1
- A power cycle
- A new STEP 7 hardware configuration is downloaded

4.9.2 Safety Limited Speed (SLS)

Safe speed monitoring

SLS monitoring is initiated whenever the "Enable Safe Speed" bit is set in the control interface and subsequently processed by the F-TM Count module. SLS monitoring terminates whenever the "Enable Safe Speed" bit is reset in the process output image and subsequently processed by the module.

A "Safe Speed Event" is set whenever the calculated speed in either direction is greater than the configured "Speed limit". Once set, the "Safe Speed Event" bit remains set and counting continues after the event is triggered. The "Safe Speed Event" remains set until the "Reset Safe Speed" control bit to 1, until a power cycle, or until a new parameterization is loaded.

Configuring a "Speed limit" value of 0 results in the "Safe Speed Event" being set immediately after the first pulse in either direction.

Note

Triggering a "Safe Speed Event" is also dependent on the measured value, configured as "Velocity", that updates your safety program once every update time.

WARNING

Safe speed monitoring continues when counting is suspended and SLS monitoring is enabled.

Since there is no active counting operation when counting is suspended, this safety function becomes ineffective. This can result in unexpected machine or process operation, which can cause death, severe personal injury, and/or property damage.

You must ensure steps outlined in safety standards applicable to your system are followed before the event bit is reset.

Using SLS monitoring

SLS monitoring is initiated by turning on the "Enable Safe Speed" bit.

Your safety program examines the "Safe Speed Event" bit in the feedback interface and takes appropriate action during the SLS monitoring session.

Set the "Reset Safe Speed" bit to 1 to clear the "Safe Speed Event" bit in the feedback interface.

If you want to start a new SLS monitoring session, clear and enable the "Enable Safe Speed" bit must be cleared in the module and then once again set in the module by separate executions of you safety program.

Note

Once set, the "Safe Speed Event" bit is also cleared by a power cycle, or when a new STEP 7 hardware configuration is downloaded. If you reset the "Safe Speed Event" and the safe speed is still in violation, the "Safe Speed Event" bit will immediately set back to 1.

SLS suspension by external events

SLS monitoring suspension can result from the following external events:

- SW gate closure
- Counting limit violation if module is configured to stop counting when the limit is violated. Refer to "Reactions to counting limit violation" for additional information.

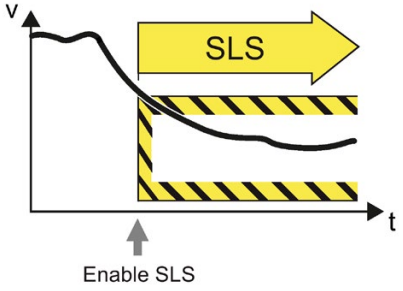
Note

Counting operations that set the start value or exceed configured counting limits have no effect in determining whether a safe speed violation has occurred.

This means that regardless of how the "Reaction to violation of a counting limit" is configured and the current count is subsequently manipulated, the "Safe Speed Event" is only initiated upon actual violation of the specified "Speed limit".

4.9.2.1 Function of Safety Limited Speed (SLS)

The SLS function monitors the encoder and notifies the user if the calculated speed exceeds the specified speed limit in either direction.



Examples of how the function can be used

Example	Possible solution
The machine operator must be able to enter the machine after the protective door has been opened and slowly move a horizontal conveyor with an acknowledgment button in the danger zone.	• Enable SLS in the counter via your safety program in the F-CPU. • The counter monitors the velocity of the horizontal conveyor.
A spindle drive, depending on the selection of the cutting tool, must not exceed a specific maximum speed.	• Enable SLS in the counter via your safety program in the F-CPU.

4.9.2.2 Configuring SLS

In STEP 7 do the following to configure SLS:

- Configure the "Measured Value" to be "Velocity" and specify the desired values for the following:
  - "Update time"
  - "Time base for velocity measurement"
  - "Counts per unit for velocity measurement"
- Configure "Safety Function - Limited Speed"
- Configure the "Speed limit"
- Download this project to the F-CPU

Note

SLS speed can only be configured if the measured value is set to velocity.

4.9.2.3 Enabling SLS

In your safety program, set the "Enable Safe Speed" bit to 1 to begin SLS monitoring.

From that point, if the module ever detects a speed in either direction that exceeds the configured "Speed limit", the "Safe Speed Event" bit is set to 1.

4.9.2.4 Responding to SLS

Your safety program examines the "Safe Speed Event" bit and takes appropriate action when the bit is seen as 1. Once set, the "Safe Speed Event" bit remains set until either of the following actions occur:

- Your safety program sets the "Reset Safe Speed" bit to 1
- A power cycle
- A new STEP 7 hardware configuration is downloaded

4.9.3 Safe Direction (SDI)

Safe direction (SDI) monitoring

SDI monitoring is initiated whenever the "Enable Safe Direction" bit is set in the control interface and subsequently processed by the F-TM Count module. SDI monitoring terminates whenever the "Enable Safe Direction" bit is reset in the process output image and subsequently processed by the module.

Each time safe direction monitoring is initiated, the current position and the specified safe direction are stored. The "Safe Direction Event" bit is set whenever a movement is detected in the unsafe direction and exceeds the configured "Monitoring tolerance". The "Monitoring tolerance" is measured from the farthest position achieved in the safe direction. As movement progresses in the safe direction, the tolerance of movement in the unsafe direction shall be measured from this farthest position.

Monitoring tolerance is configured in counts. The safe direction is specified in the process output image.

Once set, the "Safe Direction Event" bit remains set and counting continues after the event is triggered. The "Safe Direction Event" remains set until the "Reset Safe Direction" bit is set to 1, until a power cycle, or until a new parameterization is loaded.

Configuring a value of 0 for the monitoring tolerance results in the "Safe Direction Event" being set immediately after the first pulse in the unsafe direction.

⚠ WARNING

Safe direction monitoring continues when counting is suspended and SDI monitoring is enabled.

Since there is no active counting operation when counting is suspended, this safety function becomes ineffective. This can result in unexpected machine or process operation, which can cause death, severe personal injury, and/or property damage.

You must ensure steps outlined in safety standards applicable to your system are followed before the event bit is reset.

Using SDI monitoring

The safe direction is stored when SDI monitoring is initiated by enabling the "Enable Safe Direction" bit and is used for the entire SDI monitoring session. While the SDI monitoring session is in progress, subsequent changes to the "Safe Direction" bit are ignored.

Your safety program examines the "Safe Direction Event" bit in the feedback interface and takes appropriate action during the SDI monitoring session.

Set the "Reset Safe Direction" bit to 1 to clear the "Safe Direction Event" bit in the feedback interface.

If you want to start a new SDI monitoring session, clear and enable the "Enable Safe Direction" bit must be cleared in the module and then once again set in the module by separate executions of you safety program.

Note

Once set, the "Safe Direction Event" bit is also cleared by a power cycle, or when a new STEP 7 hardware configuration is downloaded. If you reset the "Safe Direction Event" and the safe direction is still in violation, the "Safe Direction Event" bit will immediately set back to 1.

SDI suspension by external events

SDI monitoring suspension can result from the following external events:

- Software gate closure
- Counting limit violation if module is configured to stop counting when the limit is violated. Refer to "Reactions to counting limit violation" for additional information.

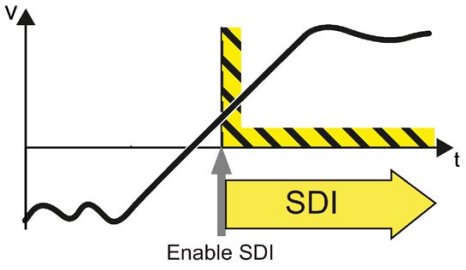
Note

Counting operations that set the start value or exceed configured counting limits have no effect in determining whether a safe direction violation has occurred.

This means that regardless of how the "Reaction to violation of a counting limit" is configured and the current count is subsequently manipulated, the "Safe Direction Event" is only initiated upon actual violation of the specified "Monitoring tolerance".

4.9.3.1 Function of Safe Direction (SDI)

The SDI function monitors the encoder and notifies the user if the encoder/count moves more than a defined amount in the unintended direction.



Examples of how the function can be used

Example	Possible solution
A protective door can only be opened if a conveyor belt moves in the safe direction (away from the operator).	• Specify the safe direction using the "Safe Direction" control bit in your safety program in the F-CPU. • Enable SDI in the counter via your safety program in the F-CPU. • Enable the locking mechanism of the protective doors via the PROFIsafe status bit of the counter.
When replacing the pressure cylinders of the plates, the conveyor can only move in the safe direction.	• Specify the safe direction using the "Safe Direction" control bit in your safety program in the F-CPU. • Enable SDI in the counter via your safety program in the F-CPU. • Inhibit the direction of motion that is not permitted in the counter.
Once the protection against jamming has been triggered, a roller shutter gate can only start moving in one direction.	
At an operational limit switch, the trolley of a crane can only start moving in the opposite direction.	

4.9.3.2 Configuring SDI

In STEP 7 do the following to configure SDI:

- Configure "Safety Function - Safe Direction"
- Configure the "Monitoring tolerance"
- Download this project to the F-CPU

4.9.3.3 Responding to SDI

Your safety program examines the "Safe Direction Event" bit and takes appropriate action when the bit is seen as 1. Once set, the "Safe Direction Event" bit remains set until either of the following actions occur:

- Your safety program sets the "Reset Safe Direction" bit to 1
- A power cycle
- A new STEP 7 hardware configuration is downloaded

4.10 Address space

Address space of the technology module

Table 4- 4 Size of input and output addresses of the F-TM Count for PROFIsafe version 2.4 (with S7-300/S7-400)

	Control (Outputs)	Feedback (Inputs)
Range for control and feedback interface	6 bytes	14 bytes

Table 4- 5 Size of input and output addresses of the F-TM Count for PROFIsafe version 2.6.1 (with S7-1200/S7-1500)

	Control (Outputs)	Feedback (Inputs)
Range for control and feedback interface	7 bytes	15 bytes

4.11 Control and feedback interface

4.11.1 Assignment of the control interface

Your safety program uses the control interface to influence the behavior of the F-TM Count module.

Control interface

The following table shows the assignment of the control interface:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reset Safe Direction	Reset Safe Stop	Reserved	Reset Safe Speed	Reserved	Reserved	Reset Other Events	Open SW Gate
1	Safe Direction	Enable Safe Direction	Enable Safe Stop	Enable Safe Speed	Reserved	Set Start Value	Reserved	Reserved

Explanations

Byte	Bit	Control bit/value	Explanations
0	0	Open SW Gate	The "Open SW Gate" bit controls when the software gate is open and counting is enabled. • 0: SW gate is closed and counting is stopped • 1: SW gate is open and counting is allowed
0	1	Reset Other Events	The "Reset Other Events" bit is used to reset the following event bits in the feedback interface: • Zero Event • Underflow Event • Overflow Event As long as the "Reset Other Events" bit is set to 1, the "Zero Event", "Underflow Event", and "Overflow Event" bits are continually cleared.
0	4	Reset Safe Speed	The "Reset Safe Speed" bit is used to reset the "Safe Speed Event" bit in the feedback interface. • 0: No action • 1: Clear the "Safe Speed Event" bit As long as the "Reset Safe Speed" bit is set to 1, the "Safe Speed Event" bit is continually cleared.
0	6	Reset Safe Stop	The "Reset Safe Stop" bit is used to reset the "Safe Stop Event" bit in the feedback interface. • 0: No action • 1: Clear the "Safe Stop Event" bit As long as the "Reset Safe Stop" bit is set to 1, the "Safe Stop Event" bit is continually cleared.
0	7	Reset Safe Direction	The "Reset Safe Direction" bit is used to reset the "Safe Direction Event" bit in the feedback interface. • 0: No action • 1: Clear the "Safe Direction Event" bit As long as the "Reset Safe Direction" bit is set to 1, the "Safe Direction Event" bit is continually cleared.
1	2	Set Start Value	The "Set Start Value" bit sets the current count to the configured start value. • 0: No action • 1: Set the count to the start value The "Set Start Value" action is initiated whenever this bit is set. The current count value is continually set to the "Start Value" while the "Set Start Value" bit is set to 1.
1	4	Enable Safe Speed	The "Enable Safe Speed" bit enables the SLS monitoring function. The "Enable Safe Speed" is set in the control interface. • 0: Disabled • 1: Enabled SLS monitoring is initiated in the module whenever the "Enable Safe Speed" bit is set. SLS monitoring is active until the "Enable Safe Speed" bit is reset or a power cycle occurs. SLS monitoring is reinitialized when a new STEP 7 hardware configuration is downloaded.

Byte	Bit	Control bit/value	Explanations
1	5	Enable Safe Stop	The "Enable Safe Stop" bit enables the SOS monitoring function. The "Enable Safe Stop" is set in the control interface. • 0: Disabled • 1: Enabled SOS monitoring is initiated in the module whenever the "Enable Safe Stop" bit is set. SOS monitoring is active until the "Enable Safe Stop" bit is reset or a power cycle occurs. SOS monitoring is reinitialized when a new STEP 7 hardware configuration is downloaded.
1	6	Enable Safe Direction	The "Enable Safe Direction" bit enables the SDI monitoring function. The "Enable Safe Direction " is set in the control interface. • 0: Disabled • 1: Enabled SDI monitoring is initiated in the module whenever the "Enable Safe Direction" bit is set. SDI monitoring is active until the "Enable Safe Direction" bit is reset or a power cycle occurs. SDI monitoring is reinitialized when a new STEP 7 hardware configuration is downloaded.
1	7	Safe Direction	The "Safe Direction" bit in the control interface specifies the safe direction of movement for the safe direction monitoring function. • 0: Counting down is the safe direction • 1: Counting up is the safe direction Changing the safe direction requires you to reset the "Safe Direction Enable" bit. The safe direction must be set prior to setting the "Enable Safe Direction" bit.

4.11.2 Assignment of the feedback interface

Your safety program receives current values and status information from the F-TM Count module by means of the feedback interface.

Feedback interface

The following table shows the assignment of the feedback interface:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reset Safe Direction Status	Reset Safe Stop Status	SW Gate Status	Reset Safe Speed Status	Reset Other Events Status	Set Start Value Status	Count Status	Direction Status
1	Reserved	Safe Direction Event	Safe Stop Event	Safe Speed Event	Overflow Event	Underflow Event	Zero Event	Value status (CQ HSC0)
2...5	High Speed Counter 0 - Current Value DINT: Current counter value Value range: –2147483648 to 2147483647$_D$ or 80000000 to 7FFFFFFF$_H$							
6...9	High Speed Counter 0 - Measured Value Measured Value as a scaled DINT							

Explanations

Byte	Bit	Feedback bit/value	Explanations
0	0	Direction Status	The "Direction Status" bit reflects the direction of the last movement. • 0: Last count was down • 1: Last count was up After power-up, the "Direction Status" bit resets to 0 and reinitializes to the actual state upon the next movement.
0	1	Count Status	The "Count Status" bit reflects the current counting status. • 0: No counts in the previous 500 ms • 1: At least one count received in the previous 500 ms
0	2	Set Start Value Status	The "Set Start Value Status" bit is used to acknowledge that the module has received and reacted to the "Set Start Value" bit from the control interface as follows: • When the "Set Start Value" bit is set to 1, the module sets the count value to the start value, then sets the "Set Start Value Status" bit to 1 • When the "Set Start Value" bit is set to 0, the "Set Start Value Status" bit is also set to 0
0	3	Reset Other Events Status	The "Reset Other Events Status" bit is used to acknowledge that the module has received and reacted to the "Reset Other Events" bit from the control interface as follows: • When the "Reset Other Events" bit is set to 1, the module resets the "Overflow Event", "Underflow Event", and "Zero Event" bits, then the "Reset Other Events Status" bit is set to 1 • When the "Reset Other Events" bit is set to 0, the "Reset Other Events Status" bit is set to 0
0	4	Reset Safe Speed Status	The "Reset Safe Speed Status" bit is used to acknowledge that the module has received and reacted to the "Reset Safe Speed" bit in the control interface as follows: • When the "Reset Safe Speed" bit is set to 1, the module resets the "Safe Speed Event" bit, then the "Reset Safe Speed Status" bit is set to 1 • When the "Reset Safe Speed" bit is set to 0, the "Reset Safe Speed Status" bit is set to 0
0	5	SW Gate Status	The "SW Gate Status" bit is used to acknowledge that the module has received and reacted to the "Open SW Gate" bit from the control interface as follows: • When the "Open SW Gate" bit is set to 1, the module performs the configured gate action, then the "SW Gate Status" bit is set to 1 • When the "Open SW Gate" bit is set to 0, the "SW Gate Status" bit is also set to 0
0	6	Reset Safe Stop Status	The "Reset Safe Stop Status" bit is used to acknowledge that the module has received and reacted to the "Reset Safe Stop" bit from the control interface as follows: • When the "Reset Safe Stop" bit is set to 1, the module resets the "Safe Stop Event" bit, then the "Reset Safe Stop Status" bit is set to 1 • When the "Reset Safe Stop" bit is set to 0, the "Reset Safe Stop Status" bit is set to 0

Byte	Bit	Feedback bit/value	Explanations
0	7	Reset Safe Direction Status	The "Reset Safe Direction Status" bit is used to acknowledge that the module has received and reacted to the "Reset Safe Direction" bit from the control interface as follows: • When the "Reset Safe Direction" bit is set to 1, the module resets the "Safe Direction Event" bit, then the "Reset Safe Direction Status" bit is set to 1 • When the "Reset Safe Direction" bit is set to 0, the "Reset Safe Direction Status" bit is set to 0
1	0	Value status (CQ HSC0)	The value status bit provides information on the validity operational quality of the corresponding channel. • 0: Fail-safe values (0 values) are provided for the channel • 1: Valid process values are provided for the channel
1	1	Zero Event	The "Zero Event" bit is set whenever the current count value transitions to 0. • 0: No event • 1: Count transitioned to 0 The "Zero Event" occurs when the count transitions to 0 from either direction. The "Zero Event" bit remains set until the module's "Reset Other Events" bit is set to 1 and remains cleared as long as the "Reset Other Events" bit is set to 1.
1	2	Underflow Event	The "Underflow Event" bit is set whenever the current count value exceeds the configured "Low Counting Limit". • 0: No violation of limit • 1: Low counting limit was exceeded The "Underflow Event" bit remains set until the module's "Reset Other Events" bit is set to 1 and remains cleared as long as the "Reset Other Events" bit is set to 1.
1	3	Overflow Event	The "Overflow Event" bit is set whenever the current count value exceeds the configured "High Counting Limit". • 0: No violation of the limit • 1: High counting limit was exceeded The "Overflow Event" bit remains set to 1 until the module's "Reset Other Events" bit is set to 1 and remains cleared as long as the "Reset Other Events" bit is set to 1.
1	4	Safe Speed Event	The "Safe Speed Event" bit informs the safety program that a safe speed violation has occurred. • 0: No violation • 1: The calculated speed, in either direction, was detected to be greater than the configured "Speed limit" The "Safe Speed Event" bit is cleared following an event when the "Reset Safe Speed" bit is set to 1 in the control interface.

Byte	Bit	Feedback bit/value	Explanations
1	5	Safe Stop Event	The "Safe Stop Event" bit informs the safety program that a safe stop violation has occurred. • 0: No violation • 1: A movement was detected in either direction that exceeded the configured "Standstill tolerance" as measured from the stored position The "Safe Stop Event" bit is cleared following an event when the "Reset Safe Stop" bit is set to 1 in the control interface.
1	6	Safe Direction Event	The "Safe Direction Event" bit informs the safety program that a safe direction violation has occurred. • 0: No violation • 1: A movement was detected in the unsafe direction that exceeded the configured "Monitoring tolerance" The "Safe Direction Event" bit is cleared following an event when the "Reset Safe Direction" bit is set to 1 in the control interface.
2...5	31...0	High Speed Counter 0 - Current Value	This signed double integer (DINT) value shows the current count. The position corresponds to the sign and the count value (process value). The count value assumes values between -2147483648 and 2147483647 unless restricted by the high and low counting limits.
6...9	31...0	High Speed Counter 0 - Measured Value	The measured value is returned as a scaled integer (DINT) value shown as one of the following, depending upon configuration: • Frequency is in millihertz (hertz * 1000) • Period is in microseconds (seconds * 1000000) • Velocity is units of measure per time base you select (velocity * 1000) Note that negative values are reported when counting down, positive values are reported when counting up.

Applications of the F-I/O module

5

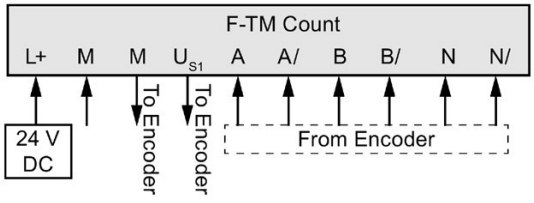
5.1 Application mode 1: A/B with N

Application mode 1: A/B with N

The F-TM Count module supports the following application mode:

- A, B differential encoder signals
- N pulse per revolution differential encoder signal

The figure below is an example of the A/B with N application mode:



Note

The encoder may also be powered from an external source. If an external source is used, only the M supply voltage "To Encoder" must be connected to the encoder's ground/external power source ground.

WARNING

An external source of power for the encoder must be at the same ground potential as the power source for the F-TM Count module.

Ensure that ground potential for the external power source for the encoder and the F-TM Count module power source are the same. Any potential differences in the two power sources will cause current to flow through the modules that can cause damage to F-TM Count module, power supplies and the encoder.

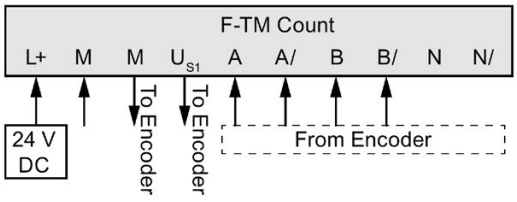
5.2 Application mode 2: A/B without N

Application mode 2: A/B without N

The F-TM Count module supports the following application mode:

- A, B differential encoder signals

The figure below is an example of the A/B without N application mode:



Note

The encoder may also be powered from an external source. If an external source is used, only the M supply voltage "To Encoder" must be connected to the encoder's ground/external power source ground.

WARNING

An external source of power for the encoder must be at the same ground potential as the power source for the F-TM Count module.

Ensure that ground potential for the external power source for the encoder and the F-TM Count module power source are the same. Any potential differences in the two power sources will cause current to flow through the modules that can cause damage to F-TM Count module, power supplies and the encoder.

Interrupts/diagnostic messages

6

6.1 Reactions to faults

Reactions to startup of the fail-safe system and to faults

The fail-safe concept depends on the identification of a safe state for all process variables.

The safety function requires that safe state values be applied to the fail-safe channel instead of process values (passivation of the fail-safe module or channel) in the following situations:

- When the fail-safe system is started up
- If module faults are detected, such as RAM or processor failures
- If errors are detected during safety-related communication between the fail-safe CPU and the fail-safe module through the PROFIsafe safety protocol (communication error)
- If module channel faults occur (for example, N signal plausibility monitoring or discrepancy errors)

The fail-safe CPU enters detected system faults into the diagnostic buffer.

Automatic safety measures and the PROFIsafe protocol ensure that the safe state is set if the system detects a fault.

Fail-safe modules do not remember errors upon power cycle. When the system is powered down and then restarted, the modules detect any faults that still exist.

Fail-Safe value for fail-safe modules

If the F-TM Count module input channel is passivated, the fail-safe system always provides "0" values for the count value, measured value, and event and status bits.

Timeout of the PROFIsafe message (F-monitoring time exceeded) passivates the module.

Response to faults in the fail-safe system

You should prepare maintenance procedures for your system to assure that returning to operation after a detected fault is controlled and documented.

The following steps must be performed:

1. Diagnosis and repair of the fault
2. Revalidation of the safety function
3. Recording in the service report

Reintegration of a fail-safe module

A channel or module can be reintegrated after successful diagnostics determine that a fault has cleared. The F-TM Count module requires that counting faults such as N-signal, discrepancy, frequency, and A and B signal monitoring must be cleared for at least 10 seconds before allowing reintegration. High and low voltage diagnostics require that the input voltage returns to the allowed range for 60 seconds before reintegration is possible.

The channel to be manually reintegrated must also be acknowledged in your safety program after the fault has cleared. The bits you use for this acknowledgement are referenced in the F-I/O data blocks (under the system blocks).

The "ACK_REQ" bit for that module goes true to indicate that reintegration is possible. After the "ACK_REQ" bit is true, your program can set the "ACK_REI" bit to allow the reintegration of all channels in that module that are ready to be reintegrated.

You can also acknowledge all faults in an F-runtime group using the "ACK_REI_GLOB" input of the "ACK_GL" instruction.

Fatal diagnostic errors require a power cycle with successful diagnostics.

Reintegration after high stress events

High temperature, high voltage, and excessive current stress can damage electronics, reducing the reliability while components continue to work apparently as expected. Passivation does not remove the potentially damaging effects of high ambient temperature or high applied voltage. Solid state switch outputs can be damaged by high currents prior to protective device activations. The reliability calculations assume the fail-safe module is operated within its specified operating parameters. When a module has passivated due to a high stress event, even though it apparently works correctly and passes all diagnostics, the probability of a future failure may be increased.

⚠ WARNING

It is possible to reintegrate a channel or module while some fault is still present that is not readily detected by the module diagnostics.

Reintegration of a faulty system can result in unexpected machine or process operation, which may cause death or serious injury to personnel, and/or damage to equipment.

After any reported fault, the steps outlined in this chapter and in safety standards applicable to your system should be followed to assure that the fault is completely understood and corrected before reintegration.

For an exact list of faults for the module, refer to the Diagnostic messages (Page 70) section.

At reintegration, the following occurs:

- Updated count value, measured value, and the event and status bits are provided to your safety program.
- Control outputs from your safety program are again transferred to the counter module.

Safety repair time

⚠ WARNING

The fail-safe performance characteristics in the technical specifications apply for a mission time life of 20 years and a repair time of 100 hours.

If a repair within 100 hours is not possible, remove the respective module from the BaseUnit or switch off its supply voltage before 100 hours expires. The module switches off independently after the 100 hours have expired.

Follow the repair procedure described in section Diagnostic messages (Page 70).

The repair time used for probability of dangerous failure per hour (PFH) and probability of dangerous failure on demand (PFD) calculations is 100 hours.

Passivation is designed to provide the safe state of the safety function in the event of a single fault. While a channel is passivated and energy is still available to the channel, there is a possibility that additional faults can cause a dangerous failure of the safety function. You should respond to passivations by repairing the fault or taking the passivated channel out of service in less than 100 hours to preserve the safety integrity level of your system.

If module or channel passivation persists for 100 hours, the module is taken to a fatal error state and the module's defective buffer diagnostic message is issued. The module is recovered through a power cycle.

If a repair within 100 hours is not possible, passivated fail-safe outputs should be taken out of service by physically disconnecting or opening circuits so that faults in the fail-safe module cannot apply energy to the load. To remove input channels from service in an operating PLC system, references to any passivated fail-safe inputs must be removed from any operating F-CPU Safety program logic that can result in activation of a safety function output.

Do not depend on channel or module passivation to maintain safe state for more than 100 hours.

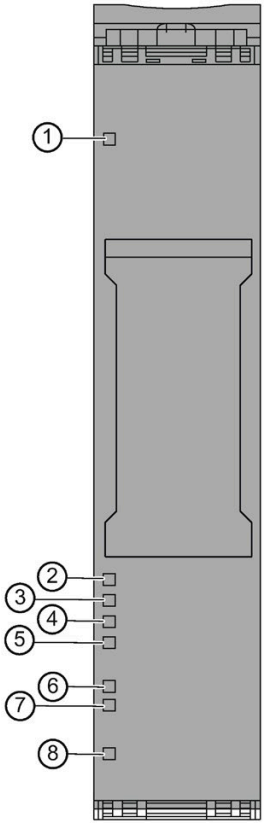
Additional information on passivation and reintegration

For further information about fail-safe module access, refer to the *SIMATIC Safety - Configuring and Programming* manual (https://support.industry.siemens.com/cs/ww/en/view/54110126).

6.2 Status and error display

LEDs

The following figure shows you the LED displays (status and error displays) of F-TM Count module:



①	DIAG (green/red)	⑤	N (green)
②	A (green)	⑥	UP (green)
③	B (green)	⑦	DN (green)
④	F.0 (red)	⑧	PWR (green)

Figure 6-1 LED displays of the F-TM Count

Meaning of the LED displays

The following tables explain the meaning of the status and error displays. Remedial measures for diagnostic alarms can be found in section Diagnostic messages (Page 70).

DIAG LED

The DIAG LED indicates system and module faults.

Table 6- 1 Meaning of the DIAG LED

DIAG	Meaning
Off	Backplane bus supply of the ET 200SP is not OK
Flashes	Module reintegratable diagnostic event has been resolved and the module or channel is awaiting reintegration. This can include the following events: • Reintegratable over-voltage error • Reintegratable under-voltage error • Module detected PROFIsafe CRC error • Module detected PROFIsafe timeout error • Reintegratable channel errors
Flashes	Module parameters are set, and module has active diagnostics (at least one error is present)
Flashes	Module parameters are not configured
On	Module parameters are configured, and module has no active diagnostics

Channel status/channel fault LEDs

The A and B LEDs indicate the current level of the associated input signals. At low counting speeds the A and B LEDs show the actual state of the signals. At higher counting speeds, the A and B LEDs will change at a limited rate to show activity. A and B LEDs flash when setting the profisafe address.

Table 6- 2 Meaning of the channel status/channel fault LEDs

A/B Channel	F.0	Meaning
Off	Off	Counter input signal is at 0 level and no active channel diagnostics
On	Off	Counter input signal is at 1 level and no active channel diagnostics
Off	On	Active channel diagnostics
Flashes		Prior diagnostic event has been resolved and the channel is awaiting reintegration

N LED

The N LED indicates the current level of the counter N pulse signal from the encoder. The N LED will show the state of the N signal only when the encoder is configured as A/B with N. The N LED will be in the ON state if the N signal is disconnected (but configured).

Table 6- 3 Meaning of the N LED

N	Meaning
□ Off	Counter N signal is at 0 level
■ On	Counter N signal is at 1 level

UP/DN LEDs

The UP and DN LEDs indicate the logical counting direction.

Table 6- 4 Meaning of the UP and DN LEDs

UP	DN	Meaning
□ Off	□ Off	No count has been detected within the last 0.5 s.
■ On	□ Off	The last count has incremented the counter and took place no more than 0.5 s ago.
□ Off	■ On	The last count has decremented the counter and took place no more than 0.5 s ago.

PWR LED

Table 6- 5 Meaning of the PWR LED

PWR	Meaning
□ Off	Supply voltage missing
■ On	Supply voltage is present and OK

6.3 Interrupts

Diagnostic interrupts

The F-module generates a diagnostic interrupt for each diagnostics alarm described in *Diagnostic messages* (Page 70).

The table below provides an overview of the diagnostic interrupts of the F-module. The diagnostic interrupts are assigned either to one channel or the entire F-module:

Table 6- 6 Diagnostic interrupts of the F-TM Count module

Diagnostic interrupt	Fault code	Scope of diagnostics interrupt	Configurable
Overtemperature	16#0005	F-module	No
Parameter failure (invalid parameters)	16#0010		
Supply voltage missing	16#0011		
Mismatch of safety destination address (F_Dest_Add)	16#0040		
Safety destination address not valid (F_Dest_Add)	16#0041		
Safety source address not valid (F_Source_Add)	16#0042		
CRC1 fault	16#0047		
Inconsistent iParameters (iParCRC error)	16#004B		
Transmission error: data inconsistent (CRC error)	16#004D		
Transmission error: timeout (watchdog time 1 or 2 elapsed)	16#004E		
Module is defective	16#0100		
Watchdog tripped	16#0103		
Invalid/inconsistent firmware present	16#011B		
Diagnostic queue overflow	16#013E		
F-address memory not accessible	16#030D		
No valid F-address available	16#030E		
Undertemperature	16#0312		
Supply voltage too high	16#0321		
Supply voltage too low	16#0322		
Load voltage too low	16#0324		
No pulses detected	16#030A	Channel	Yes
Failure in the input circuit	16#0313		No
Internal discrepancy failure	16#0315		
Illegal A/B signal ratio	16#0500		Yes
Frequency outside specification	16#0501		No

6.4 Diagnostic messages

Diagnostic alarms

The display of diagnostics is in plain text in STEP 7 in the online and diagnostics view. You can evaluate the error codes with your safety program.

Note

If you use a GSDML file for configuration, the diagnostic alarm text is only available in the project that installed the GSDML. The fault codes may be different, but the CPU diagnostic buffer will match the diagnostic alarm text in the table below.

Note

Some solutions below suggest pulling (removing) and plugging (reinserting) the module. For technology modules such as this one, L+ power must be switched off prior to pulling and plugging the module.

The following diagnostics can be signaled:

Table 6- 7 Diagnostics alarms, their meaning and possible remedies

Diagnostics alarm	Fault code	Meaning	Solution
Overtemperature	16#0005	An excessively high temperature was measured in the F-module.	• Operate the F-module within the specified temperature range (see Technical specifications). • Once the temperature has been reduced and returns to the specified range, the F-module must be removed and reinserted or the power switched OFF and ON.
Parameter failure (invalid parameters)	16#0010	On detection of invalid parameters, the module remains present in the system but goes to an unparameterized state and the module LEDs give an immediate indication of the fault. The module is included in STEP 7 (TIA Portal V17 or later), which includes detailed dependency checks. However, configuration may also be accomplished using the GSDML, which contains limited dependency checking. This error is seen when using the GSDML to configure the module since there is limited dependency checking performed by the GSDML. Possible causes: • i-Parameter CRC error • Invalid i-parameters (for example, invalid selection, parameter out-of-range, unsupported feature selected, and wrong value of reserved field) • Any PROFIsafe parameterization problem detected by the PROFIsafe driver	Check the i-Parameter CRC, i-parameter, and PROFIsafe parameter assigned to the F-module in the GSDML configuration.
Supply voltage missing	16#0011	Missing or insufficient supply voltage L+ Possible causes: • Operating the F-module outside the specified supply voltage range • Critical overvoltage range exceeded	• Operate the F-module within the specified supply voltage range. • After a critical over-voltage event, once the voltage returns to the specified range, the F-module must be removed and reinserted or the power switched OFF and ON.
Mismatch of safety destination address (F_Dest_Add)	16#0040	The PROFIsafe driver has detected a different F-destination address. Checked after new parameters received.	• Check the parameter assignment of the PROFIsafe address assigned to the F-module. • Reassign or reinitialize the PROFIsafe F-addresses using STEP
Safety destination address not valid (F_Dest_Add)	16#0041	The PROFIsafe driver has detected an invalid destination address. Checked after new parameters received.	

Diagnostics alarm	Fault code	Meaning	Solution
Safety source address not valid (F_Source_Add)	16#0042	The PROFIsafe driver has detected a source address mismatch or an invalid source address. Checked after new parameters received.	7.
CRC1 fault	16#0047	The firmware of the F-module has detected a CRC error. Possible causes: • The communication between the F-CPU and F-module is disturbed. • Impermissibly high electromagnetic interference is present.	• Check PROFINET or PROFIBUS communications between the F-module and F-CPU. • Eliminate the electromagnetic interference. • Power switched OFF and ON for station. • Reassign or reinitialize the PROFIsafe F-addresses using STEP 7.
Inconsistent iParameters (iParCRC error)	16#004B		
Transmission error: data inconsistent (CRC error)	16#004D		
Transmission error: timeout (watchdog time 1 or 2 elapsed)	16#004E	The firmware of the F-module has detected a timeout. Possible causes: • The F-monitoring time is set incorrectly. • A bus fault is present.	• Adjust F-monitoring time. • Adjust the F-runtime group cycle time. • Ensure that communication is functioning correctly.
Invalid/inconsistent firmware present	16#011B	The firmware is incomplete and/or firmware added to the F-module is incompatible. This leads to errors or functional limitations when operating the F-module.	• Perform a firmware update for all parts of the F-module and note any error messages. • Use only firmware versions released for this F-module. • Power cycle to restore the module to the firmware versions prior to getting the error.
Diagnostic queue overflow	16#013E	Overflow of the diagnostics memory. It was not possible to send all pending diagnostics. This error can lead to deactivation of the F-module.	Remedy the cause of the diagnostics surge.
No pulses detected	16#030A	The expected number of pulses was not received within a given revolution, where the revolution is determined by the module receiving an active N signal event. Possible causes: • There is a faulty N signal. • The "Pulses per revolution" configuration does not match the encoder's pulses per revolution. • The module is configured to use the N signal, but the encoder does not use an N signal or there is a wire break. • There is noise on the N signal line.	• Check the N signal process wiring. • Check the parameter is set to match the sinusoidal cycles per revolution.

Diagnostics alarm	Fault code	Meaning	Solution
F-address memory not accessible	16#030D	The F-source address and F-destination address stored in the coding element cannot be accessed.	Verify that the coding element is present or replace the coding element.
No valid F-address available	16#030E	The electronic coding element contains an invalid F-address.	Assign a PROFIsafe address to the F-module.
Module is defective	16#0100	Possible causes: • Impermissibly high electromagnetic interference is present. • The F-module has detected an internal error and has reacted in a safety-related manner. • Encoder frequencies received above 250kHz. In this situation, the module is not defective.	• Eliminate the interference. The module must then be pulled and plugged, or the power switched OFF and ON. • Ensure encoder frequencies below 200kHz and reapply power to the module. • Replace defective F-module.
Watchdog tripped	16#0103	Possible causes: • Impermissibly high electromagnetic interference is present. • The F-module has detected an internal error and has reacted in a safety-related manner.	
Undertemperature	16#0312	The minimum permissible temperature limit has been violated.	• Operate the F-module within the specified temperature range (see Technical Specifications). • Once the temperature has increased and returns to the specified range, the F-module must be removed and reinserted or the power switched OFF and ON.
Failure in the input circuit	16#0313	The F-module has detected an internal error in the input circuits. Possible cause: • F-module is defective	• Replace defective F-module.
Internal discrepancy failure	16#0315	The internal counters of the F-module have resulted in divergent count values. Possible causes: • Impermissibly high electromagnetic interference is present • Encoder failure • Excessive frequency • F-module is defective	• Eliminate the interference. The module must then be pulled and plugged, or the power switched OFF and ON. • Replace encoder. • Operate within specified frequency range. • Replace defective F-module.
Supply voltage too high	16#0321	The supply voltage is too high.	• Operate the F-module within the

Diagnostics alarm	Fault code	Meaning	Solution
Supply voltage too low	16#0322	The supply voltage is too low.	specified voltage range (see Technical Specifications). • After a critical over-voltage event, once the voltage returns to the specified range, the F-module must be removed and reinserted or the power switched OFF and ON.
Load voltage too low	16#0324	The encoder supply voltage is out of the allowed range. This could be because of an internal module problem or a problem external to the module.	Disconnect the encoder and power cycle the module. • If the error goes away, there could be a problem with the encoder that causes the encoder supply to be out of range. • If the error is still present after a power cycle with no encoder attached, replace defective F-module.
Illegal A/B signal ratio	16#0500	The encoder's A and B signals are outside the allowed phase shift tolerance, or the amplitude (voltage) tolerance. Possible causes: • Encoder faulty • Process wiring faulty • Wire break • F-module is defective	• Check process wiring. • Check encoder. • Replace defective F-module.
Frequency outside specification	16#0501	The maximum frequency for the F-module has been exceeded.	Reduce the frequency of the application (see Technical Specifications).

6.5 Value status (CQ HSC0)

Properties

In addition to the diagnostic messages and the status and error display, the F-module makes available information about the validity of the count and status values in the feedback interface. The value status is available in the process image along with the count and status values for the channel.

Value status for the F-TM Count module

The value status is additional binary information provided in the feedback interface. It is provided in the process image of the inputs (PII) at the same time as the process values. It provides information about the validity of the process inputs.

The value status is influenced by channel and module wide diagnostic results.

- 1_B: Valid process values are provided for the channel.
- 0_B: Fail-safe process values are provided for the channel.

If the F-TM Count module input channel is passivated, the fail-safe system always provides ("0") for the count value, measured value, and event and status bits.

Assignment of inputs for the value status in the PII

The input channel of the F-module is assigned a value status (CQ HSC0) in the process image of the inputs. You can find the assignment in section Address space (Page 55).

Reference

A detailed description of the evaluation and processing of the value status can be found in the *SIMATIC Safety – Configuring and Programming* manual (https://support.industry.siemens.com/cs/ww/en/view/54110126).

Technical specifications

7

7.1 Specifications

	6ES7136-6CB00-0CA0
General information	
Product type designation	F-TM Count, 1x1Vpp sin/cos HF
Firmware version	V1.0
FW update possible	Yes
Product version	V1.0
usable BaseUnits	BU type A0
Color code for module-specific color identification plate	CC01
Product function	
I&M data	Yes; I&M0 to I&M3
Engineering with	
STEP 7 TIA Portal configurable/integrated as of version	Step 7 V17 or higher: use GSDML for prior versions
Supply voltage	
Load voltage L+	
Rated value (DC)	24 V
permissible range, lower limit (DC)	20,4 V
permissible range, upper limit (DC)	28,8 V
Reverse polarity protection	Yes
Input current	
Current consumption, max.	50 mA; Without load, 150 mA with 300 mA Encoder load
Encoder supply	
5 V	Yes; 5.1 V ±3.5 %
Short-circuit protection	Yes; Electronic overload protection; no protection on applying a normal or counter voltage.
Output current, max.	300 mA
Power loss	
Power loss, typ.	1,25 W
Address area	
Address space per module	
Inputs	14 byte; S7-300/400F CPU, 13 byte
Outputs	5 byte; S7-300/400F CPU, 4 byte
Digital inputs	
Number of digital inputs	1; (Counter Input)
Digital inputs, parameterizable	Yes
Digital input functions, parameterizable	

	6ES7136-6CB00-0CA0
Gate start/stop	Yes
Counter for incremental encoder	Yes
Number, max.	1
Input voltage	
Type of input voltage	sin/cos 1 Vpp; monitored to +/- 20% resolution
Input delay (for rated value of input voltage)	
Minimum pulse width for program reactions	2.5 µs for parameterization "none"
for technological functions	
parameterizable	Yes
Cable length	
shielded, max.	150 m
Encoder	
Connectable encoders	
Incremental encoder (symmetrical)	Yes; up to 200 kHz depending on cable type and length
Encoder signals, incremental encoder (symmetrical)	
Input voltage	1 Vpp, centered at 2.5 V offset
Input frequency, max.	200 kHz
Counting frequency, max.	800 kHz; with quadruple evaluation
Cable length, shielded, max.	150 m
Incremental encoder with A/B tracks, 90° phase offset	Yes; sin/cos
Incremental encoder with A/B tracks, 90° phase offset and zero track	Yes; sin/cos/zero
Interrupts/diagnostics/status information	
Diagnostics function	Yes; see chapter "Diagnostic Messages" in the manual
Alarms	
Diagnostic alarm	Yes
Hardware interrupt	No
Diagnoses	
Monitoring the supply voltage	Yes
Wire-break	Yes
Short-circuit	Yes
A/B transition error at incremental encoder	Yes
Diagnostics indication LED	
RUN LED	Yes; green LED
ERROR LED	Yes; red LED
Monitoring of the supply voltage (PWR-LED)	Yes; green LED
Channel status display	Yes; green LED
for channel diagnostics	Yes; red LED
for module diagnostics	Yes; green/red DIAG LED
Integrated Functions	
Number of counters	1

	6ES7136-6CB00-0CA0
Counting frequency (counter) max.	800 kHz; with quadruple evaluation
Safety monitoring functions	
Safe Operating Stop (SOS)	Yes
Safely-Limited Speed (SLS)	Yes
Safe Direction (SDI)	Yes
Safe Speed Monitor (SSM)	Yes
Counting functions	
Continuous counting	Yes
Counter response parameterizable	Yes
Software gate	Yes
Counting range, parameterizable	Yes
Measuring functions	
Measuring range	
Frequency measurement, min.	Hz
Frequency measurement, max.	800 kHz
Cycle duration measurement, min.	1 µs
Cycle duration measurement, max.	25 s
Velocity measurement, min.	0; (user defined units)
Velocity measurement, max.	2147483; +/- (user defined units)
Accuracy	
Frequency measurement	Up to 100 ppm; depending on measuring interval and signal evaluation. At low frequency external noise may have an effect on accuracy (reference the graph in 2.2.3)
Cycle duration measurement	Up to 100 ppm; depending on measuring interval and signal evaluation. At low frequency external noise may have an effect on accuracy (reference the graph in 2.2.3)
Velocity measurement	Up to 100 ppm; depending on measuring interval and signal evaluation. At low frequency external noise may have an effect on accuracy (reference the graph in 2.2.3)
Potential separation	
Potential separation channels	
between the channels	No; Only one channel is available
between the channels and backplane bus	Yes
Between the channels and load voltage L+	No
between the channels and the power supply of the electronics	No
Isolation	
Isolation tested with	707 V DC (type test)
Degree and class of protection	
IP degree of protection	IP20
Standards, approvals, certificates	
Suitable for safety functions	Yes
Highest safety class achievable in safety mode	
Performance level according to ISO 13849-1	Cat. 4, PL e

	6ES7136-6CB00-0CA0
SIL acc. to IEC 61508	SIL 3
Probability of failure (for service life of 20 years and repair time of 100 hours)	
Low demand mode: PFDavg in accordance with SIL 1	2.00E-03 signal monitoring disabled
Low demand mode: PFDavg in accordance with SIL 3	< 3.00E-05
High demand/continuous mode: PFH in accordance with SIL 1	< 3.00E-08 1/h signal monitoring disabled
High demand/continuous mode: PFH in accordance with SIL 3	< 1.00E-09 1/h
Ambient conditions	
Ambient temperature during operation	
horizontal installation, min.	0 °C
horizontal installation, max.	60 °C
vertical installation, min.	0 °C
vertical installation, max.	50 °C
Altitude during operation relating to sea level	
Ambient air temperature-barometric pressure-altitude	On request: Ambient temperatures lower than 0 °C (without condensation) and/or installation altitudes greater than 2 000 m
Dimensions	
Width	15 mm
Height	73 mm
Depth	58 mm
Weights	
Weight, approx.	42 g

Response times

A

A.1 Maximum response time of the system

Calculating the maximum response time of the system

You can calculate your maximum system response time using the "SIMATIC STEP 7 Safety Advanced: F-Execution Times, F-Runtimes, F-Monitoring and Reaction Times (https://support.industry.siemens.com/cs/ww/en/view/58856512)" Excel file (RT_calculator). Use your configured individual fail-safe module timing parameters and the module characteristic parameters found in this appendix to determine the maximum response time of your system.

Data transport delays included

The T_{cycle} parameter value in the following paragraph includes an allowance for the fail-safe module to acquire and deliver PROFIsafe messages in transactions with the PLC I/O bus. The execution time of the Safety FB in the fail-safe CPU includes the physical transport delay time for PROFIsafe messages moving between the fail-safe module location and the fail-safe CPU. There are no separate transport delay parameters that you must include in your calculations.

A.2 Response times of the F-TM Count module

Maximum response time of the F-module input values

$T_{WCDT\_i} = T_{cycle} * 2$

Where:

T_{cycle} 5 ms	Internal cycle time of the fail-safe module
T_{WCDT_i}	Worst Case Delay Time: Maximum response time from a signal transition at the fail-safe module's counter input to the reliable availability of the safety message frame available for the fail-safe CPU request

Count, status, and event values are reported during each T_{cycle}. In situations where an individual count of a movement is slower than T_{cycle}, the same value can be reported across one or more T_{cycles}.

The response time for counts, status, and event values is essentially a single T_{cycle}. For output image register commands, the response time behavior $T_{cycle} * 2$ applies. The maximum response time is defined as twice the cycle time for simplicity.

Maximum fault response time of the F-module input

$T_{WCDT\_i} = (T_{cycle} * 2) + T_{signal}$ (when moving)

$T_{OFDT\_i} = (T_{cycle} * 2) + T_{diagrep}$ (when not moving or moving slower than a single count per second)

Where:

T_{cycle} 5 ms	Internal cycle time of the fail-safe module
$T_{diagrep}$ 250 ms	Internal diagnostic repetition rate
T_{OFDT_i}	One Fault Delay Time: Maximum response time for the fail-safe module to report a channel as passivated
T_{signal} 20 ms	Maximum transition time of the signal monitoring error output
T_{WCDT_i}	Worst Case Delay Time: Maximum response time from a signal transition at the fail-safe module's counter input to the reliable availability of the safety message frame available for the fail-safe CPU request

Response times that use measured value

Measured values are calculated and updated by the module to the F-CPU at the rate specified by the configured "Update time". Safety reaction times that use measured values in your safety program (for example, SLS) are therefore dependent on the configured update time. Refer to Measured value determination (Page 14) to calculate measure values.

Parameter data record

B

B.1 Parameter defaults and dependencies when configuring with GSD file

When configuring the module with a GSD file, remember that the setting of some parameters are dependent on each other.

F-TM Count module and encoder

The following are F-TM Count module default parameters:

Channel activation	Count/Pos input	Measuring	Signal monitoring
Enabled	Enabled	Enabled	Enabled

The following are encoder default parameters:

Signal type	Invert direction	Pulses per revolution	Signal evaluation	Reaction to N signal
Sin/Cos	Disabled	1024	Quadruple	No reaction

The following are F-TM Count default parameters using STEP 7 or GSD:

	High limit	Start value	Low limit	Counting violation	Reset upon violation	Reaction to Gate start
STEP 7	2147483647	0	-2147483648	Continue	Start value	Set to start
GSD	2147483647 [1]	0 [1]	0 [1],[2]	Continue	Start value	Set to start

[1] Parameter errors result whenever "Low Limit" >= "High Limit", "High Limit" < "Start Value", or "Start Value" < "Low Limit".

[2] Signed values are not supported using FCT V2.0. Negative values must be entered as their equivalent two's compliment values (for example, 2147483648 = - 2147483648 and 4294967295 = -1).

Measured value

The following are measured value default parameters:

Measured value	Update time	Time base (velocity)	Counts/Unit (velocity)
Frequency	100	0	1
Period	100	0	1
Velocity	100	0	1

Safety monitoring

The following are safety monitoring default parameters:

SOS enable	SDI enable	SLS enable
Disabled	Disabled	Disabled [1]

SOS tolerance	SDI tolerance	SLS speed
0	0	0

[1] When SLS is enabled, a measured value other than velocity will result in a parameter error.

PLC data types

C

C.1 PLC data types for F-TM Count

PLC data types for F-TM Count

Fail-Safe compliant PLC user-defined data types (UDTs) for the F-TM-C module are available from SIOS. These PLC data types define and represent the F-TM-C input image register and the F-TM-C output image register. You can import these PLC data types into your TIA Portal project using "External source files" in the project tree.

See also

SIOS (https://support.industry.siemens.com/cs/ww/en/view/109792746)