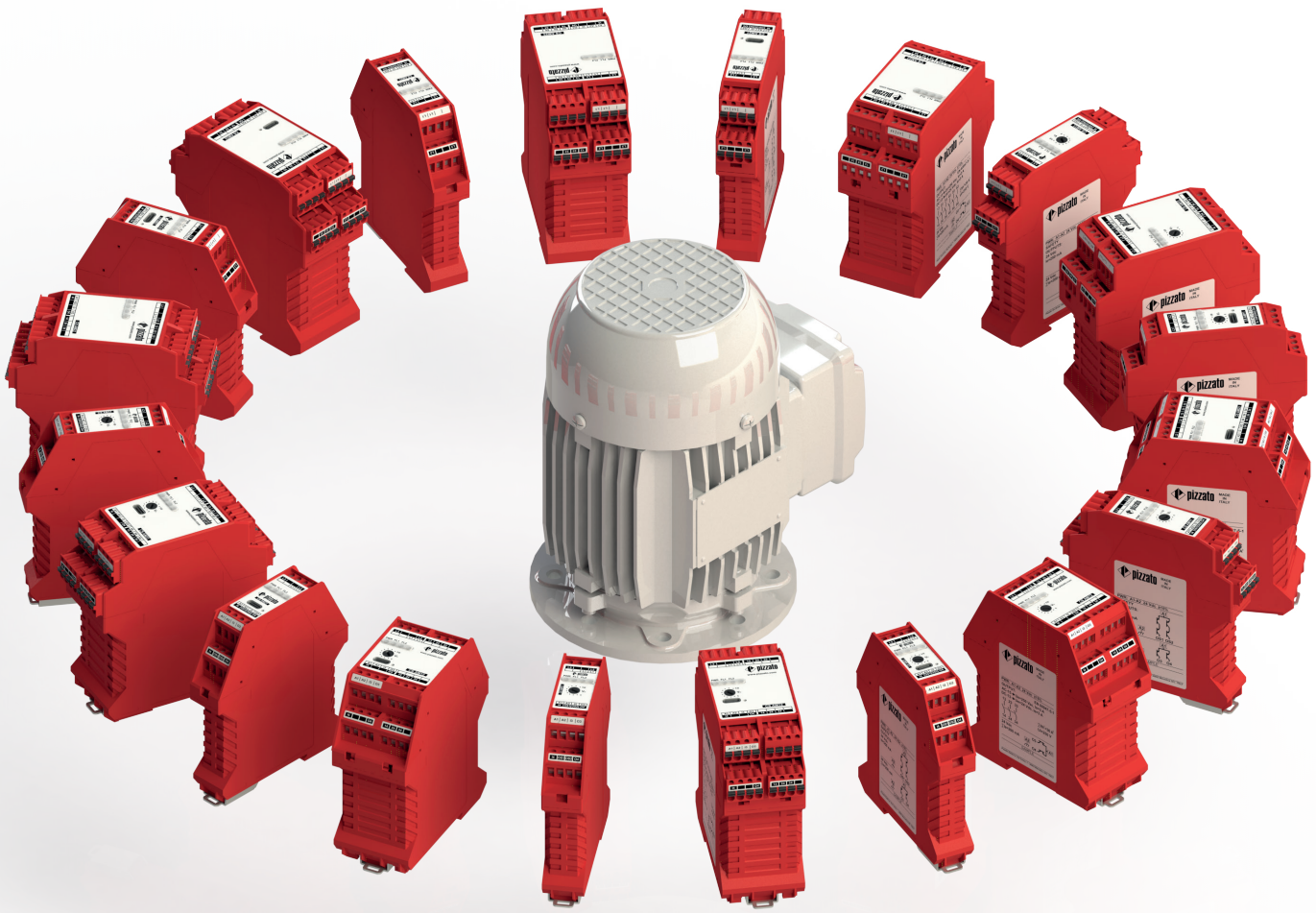
pizzato



Safety modules

CS AM series

Operating instructions

ZE_FOG534A25-ENG

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1 INFORMATION ON THIS DOCUMENT

1.1 Function

These operating instructions provide information on the installation, connection, safe use and configuration of CS AM series modules.

1.2 Target audience

The operations described in this instruction manual must be carried out by qualified personnel only, who are fully capable of understanding them, and with the technical qualifications required for operating the machines and plants in which the safety devices are to be installed.

1.3 Application field

These instructions apply exclusively to the products listed in chapter 5 and their accessories.

1.4 Original instructions

The Italian language version is the original set of instructions for the device. Versions provided in other languages are translations of the original instructions.

2 SYMBOLS USED

This manual uses various symbols, with the following meanings:

This symbol is used to indicate information or instructions that are very important for safety. Failure to observe such instructions may represent a serious risk to personnel.

This symbol indicates the presence of additional information, useful for a better understanding of the content provided.

Text This formatting indicates a button or menu item on the CS AM Configurator software.

Text This formatting indicates a parameter that can be set within the CS AM Configurator software.

3 SAFETY INSTRUCTIONS

3.1 Application limits

The device is designed for use with single- or three-phase AC motors as well as with DC motors.

The module can also be used with motors with inverter control: in this case, the compatibility of the two electronic devices must be checked in advance. The connection between module and inverter must be performed using a shielded cable with which the shield is attached to the motor.

The module detects machine standstill exclusively by measuring the residual voltages in the phases while the motor is at a standstill. Possible disturbances, induced voltages or residual voltages for the drive, which are produced by electronic inverters, could hinder the correct detection of the motor standstill.

When used with DC motors, the module allows only the use of the **SF1** safety function (see chapter 4.2).

Speed monitoring using only frequency measurement on motor phases (without a proximity sensor connected to input I4) cannot be used for monitoring of applications in which movement continues or accelerates when the motor is under STO conditions.

Speed monitoring using only frequency measurement on motor phases (without a proximity sensor connected to input I4) does not permit detection of mechanical locking of the motor or overload conditions.

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⚠ Use of the module with single-phase motors or DC motors does not enable use of the safety function **SF3** (see chapter 4.2).

⚠ When using **SF3** (direction of rotation), a verification and validation of the correct detection must always be performed, keeping in mind that the setting of the value of some parameters (e.g., t_{RB} time) can affect the correct detection of the direction of rotation.

⚠ The use of the CS AM module for monitoring suspended loads in STO condition may not be sufficient, particularly when a freely moving suspended load causes the motor to behave as a generator with a frequency consistent with the value detected by the proximity sensor. For these cases, a consistency check with the STO setting of the inverter and the non-zero speed value detected by the module must be evaluated.

The CS AM Configurator software enables configuration of CS AM1•P, CS AM2•P or CS AM3•P series safety modules which are equipped with a USB type-C port for connection to a PC.

The CS AM1•, CS AM2• or CS AM3• series safety modules are designed to perform safety functions in industrial applications up to "Maximum SIL 3" in accordance with EN IEC 62061, or "PL e" in accordance with EN ISO 13849-1. The achievement of a specific safety level for a given circuit does not depend entirely on the module itself but also on external components connected to it, the adopted circuit architecture, and compliance with additional requirements as set out by the aforementioned standards.

3.2 Required expertise

A range of expertise is required to correctly configure a CS AM series module intended to perform safety functions:

- Knowledge of the module used and its application limits, as set out in this instruction manual, in addition to knowledge of devices connected to it (switches, etc.) and relevant application limits.
- Knowledge of the CS AM Configurator software and the instructions set out in this manual.
- Knowledge of EU Directives applicable to the machinery on which the safety circuit managed by the module will be installed and, consequently, knowledge of the specific standards required to perform risk assessment on the machinery, and standards necessary to select safety measures aimed at preventing or mitigating the risks identified.

Lack of knowledge of the limits of the devices used or failure to observe the specifications of standards may lead to a configuration of modules that is inadequate for the application and therefore dangerous for personnel operating the machinery.

3.3 Intended use

CS AM series safety modules have been developed to perform their functions in industrial applications that comply with standards EN ISO 13849-1 or EN IEC 62061. No other use is permitted.

These products are designed to be electrically connected to devices present on the machinery and, depending on the configured settings, to activate safety outputs. The execution of these functions requires the module to be correctly installed and configured, following the instructions provided in this manual and instructions in the technical manuals of all connected components.

The safe state of CS AM series modules is with safety outputs not active (PNP outputs off or contacts open in the case of modules with relay outputs).

The direct sale of this device to the public is prohibited. Installation and use must be carried out by qualified personnel only.

The use of the device for purposes other than those specified in these operating instructions is prohibited.

Any use other than as expressly specified in these operating instructions shall be considered unintended by the manufacturer.

Also considered unintended use:

- Using the device after having made structural, technical, or electrical modifications to it;
- Using the product in a field of application other than as described in chapter 13.

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3.4 Qualified personnel

The installation of the CS AM module and its configuration using the CS AM Configurator software must be performed by qualified personnel.

The term "qualified personnel" refers to an individual who, based on their education, experience and training in the fields of industrial automation, safety and hazard prevention, has gained the following knowledge and skills:

- Knowledge of the module used and its application limits, as set out in this document, in addition to knowledge of devices connected to it (switches, etc.) and relevant application limits.
- Knowledge of the CS AM Configurator software and the instructions set out in this manual.
- Knowledge of EU Directives applicable to the machinery on which the safety circuit managed by the module will be installed and, consequently, knowledge of the specific standards required to perform risk assessment on the machinery, and standards necessary to select safety measures aimed at preventing or mitigating the risks identified.

3.5 User responsibilities

The programming technician is involved in the configuration of the CS AM module by:

- defining the safety functions performed by the module through configuration of module inputs and outputs
- setting the configuration parameters for each safety function performed by the module.

Pizzato Elettrica's scope of responsibility in the configuration process of modules is to ensure that the configuration created by the user is correctly transferred to the module and to guarantee the reliability of the functions performed by the module.

The user is entirely responsible for the selection and parameterisation of the safety functions performed by the module.

Experienced operators with in-depth knowledge of the machinery may, during risk assessment, decide to exclude certain types of faults. Please note that the responsibility for excluding faults falls entirely upon the machine manufacturer.

The CS AM Configurator software features many different configuration parameters, some of which have predefined values set by Pizzato Elettrica based on typical use by machinery manufacturers. These values include, but are not limited to, simultaneity times, voltage and frequency thresholds, safety-output activation delays, etc. These predefined values may be unsuitable for certain types of machinery and it is the responsibility of the machine manufacturer to check these values and adapt them where necessary.

The programs developed with the CS AM Configurator may detect a significant number of faults in external devices connected to the module (electrical faults, mechanical faults and functional faults). Nevertheless, the possibility of and responsibility for deciding whether to identify these or not falls with the designer configuring the module, since it is not possible to decide beforehand how faults should be handled, nor can functional faults or fault exclusions be assessed in advance, as these must be determined on a case-by-case basis through the risk analysis of each specific piece of machinery.

Pizzato Elettrica licences the CS AM Configurator and other related software for the configuration of CS AM series safety modules. The interface of the CS AM Configurator is mediated and controlled by other software (including, but not limited to, the "Operating System") managing the computer on which the software is installed. Sometimes - potentially without the user's knowledge, as in the case of programs called "viruses" - other software interacts with the interface and memory of the computer on which the CS AM Configurator is installed. This means that Pizzato Elettrica cannot guarantee correct graphic representation on the computer of the information present in the module, nor can it prevent third-party programs from altering the structure of CS AM Configurator data stored on the computer, thus providing incorrect information on the programming being carried out. For this reason, the user must always perform tests with the programmed modules to check that they behave as expected, before commissioning of machinery using them (see also chapter 3.6).

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3.6 Validation and periodic testing

It is good practice and an obligation under applicable standards to perform initial and periodic testing on safety devices for machinery.

It is recommended to perform functional tests on the CS AM module when commissioning the machinery and at least once per year (or after a prolonged shut-down period).

The sequence of functional tests can vary depending on the machine complexity and circuit diagram. This manual contains a sample testing sequence in chapter 9.3, to be considered as minimal and not exhaustive.

All CS AM series modules configured with CS AM Configurator software must be tested and qualified on machinery prior to commissioning. Tests and validation must be repeated following any changes to the safety configuration of the machinery, both in the case of changes to configuration of the module or changes to machinery hardware. Note that many industrial components performing equivalent functions have different electrical parameters (contact bounces, response times, etc.) and safety parameters (PFHd or B10d).

3.7 Applicable directives and standards

Machinery manufacturers intending to install and use a CS AM series safety module for safety functions are responsible for checking compliance with all applicable European Directives prior to commissioning of the machinery.

Below is a non-exhaustive list providing examples of machinery directives:

Machinery Directive 2006/42/EC

Low Voltage Directive 2014/35/EU

EMC Directive 2014/30/EU

For application of CE marking to the machinery, the manufacturer may decide to use the harmonised EN standards appropriate for the machinery in question. As a reminder, some of the main standards employed for risk assessment and design in relation to the safety of machinery are listed below:

Standard	Content
EN ISO 13849-1/2	Safety of machinery - Safety-related parts of control systems
EN ISO 13850	Safety of machinery - Emergency stop function
EN ISO 12100	Safety of machinery - General principles for design
EN IEC 62061	Safety of machinery - Functional safety of safety-related control systems
EN 60204-1	Safety of machinery - Electrical equipment of machines
EN ISO 14119	Safety of machinery - Interlocking devices associated with guards
EN ISO 13851	Safety of machinery - Safety of machinery - Two-hand control devices
EN ISO 13857	Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs
EN ISO 13855	Safety of machinery - Positioning of safeguards with respect to the approach of the human body

3.8 Limits of liability

This manual has been prepared and checked to the best of our knowledge. This does not eliminate the possibility of imprecise information or mistakes or potential improvements to the document. Your suggestions are valued and welcomed. On our website www.pizzato.com, you can check for updated versions of this manual and access feedback tools to submit suggestions or report errors. Registration on the website will also enable us to notify you about software releases with new features, improvements, bug fixes and hardware updates.

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Pizzato Elettrica only supplies this documentation for customers that purchase CS AM series modules. This does not imply that Pizzato Elettrica undertakes to provide further documentation or support for new software tools in addition to the user license of the present version of CS AM Configurator.

Pizzato Elettrica reserves the right to correct and modify this manual and all information contained within it at its full discretion, at any time, and without prior notice.

The information contained in this document does not imply that Pizzato Elettrica assumes any responsibility beyond that set out in the general terms and conditions of sale, contained in the General Catalogue. Any further liability must be confirmed in writing by Pizzato Elettrica.

4 DESCRIPTION

4.1 Device description

The safety device described in this manual is defined according to the Machinery Directive 2006/42/EC as logic component for safety functions.

The safety modules to which these usage instructions refer are devices specifically designed and manufactured for use on industrial machinery.

4.2 Safety functions

The safety functions of the module are defined as follows:

- **SF1 (standstill):** The safety outputs must be deactivated within a set reaction time, when the voltage measured on phases L1-L2-L3, at the module input, is greater than a selectable voltage threshold (available in CS AM1• and CS AM3• modules).
- **SF2 (speed):** The safety outputs must be deactivated within a set reaction time, when the frequency measured on phases L1-L2-L3, at the module input, falls outside the configured range (available in CS AM2• and CS AM3• modules).
- **SF3 (rotation):** The safety outputs must be deactivated within a set reaction time, when the phase shift of input signals (direction of rotation) measured on phases L1-L2-L3, at the module input, is different from the expected one (available in CS AM2• and CS AM3• modules).

The module firmware may combine the above safety functions as specified below:

- **SF2 + SF3 (speed & rotation):** The safety outputs must be deactivated within a set reaction time, when the frequency measured on phases L1-L2-L3, at the module input, falls outside the configured range or the phase shift measured (direction of rotation) does not correspond with the expected value (available in CS AM2• and CS AM3• modules).
- **SF2 + SF3 (dual speed):** The safety outputs must be deactivated within a set reaction time, when the frequency measured on phases L1-L2-L3, at the module input, falls outside the configured range, which may differ based on the phase-shift value (direction of rotation) of L1-L2-L3 (available in CS AM2• and CS AM3• modules).

4.3 Safe state

The safe state of the module is the deactivation state of the safety outputs (safe power off).

The device enters the safe state when the safety function is activated and in the event that the module's diagnostic functions are triggered.

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5 OPERATION

5.1 Device functions

These devices can be used as modules for detection of motor standstill, motor speed and direction of rotation through measurement of residual voltage, frequency and phase shift (without sensors), in safety circuits up to category 4, PL e in accordance with EN ISO 13849-1, and up to "Maximum SIL 3" in accordance with EN IEC 62061:

- Motor standstill monitoring (CS AM1• - CS AM3•)
- Motor rotation speed monitoring (CS AM2• - CS AM3•)
- Motor direction of rotation monitoring (CS AM2• - CS AM3•)

In addition, CS AM modules have the following functionality:

- Ability to perform two safety functions simultaneously and assign them to two different safety outputs (CS AM2• - CS AM3•)
- Configuration via USB-C port (CS AM••P)
- Detection of faults in transmission components through the connection of a single proximity sensor reading the teeth of a tone wheel
- Selectable sensitivity threshold for motor standstill monitoring (CS AM1• - CS AM3•)
- Ability to connect both single phase and three-phase AC motors, as well as DC motors (see chapter 3.1)
- Function for detecting an interrupted measuring circuit (phase loss detection function)
- Galvanic separation between control circuit and measurement circuit
- OSSD electronic safety outputs or relay safety outputs (depending on the model)

The following table lists the different models:

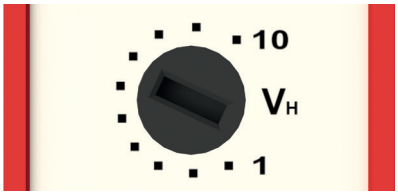
Module	Safety function					Output contacts	Housing dimensions
	SF1	SF2	SF3	SF2+SF3 Speed and rotation	SF2+SF3 Dual speed		
CS AM11•••U	■					2 OSSDs	22.5 x 114 mm
CS AM12•••U	■					3 NO	45 x 114 mm
CS AM21•••U		■	■	■	■	2 OSSDs	22.5 x 114 mm
CS AM22•••U		■	■	■	■	3 NO	45 x 114 mm
CS AM23•••U		■	■	■	■	3 NO + 3NO	45 x 114 mm
CS AM31•••U	■	■	■	■	■	2 OSSDs	22.5 x 114 mm
CS AM33•••U	■	■	■	■	■	3 NO + 3NO	45 x 114 mm

5.2 Trimmer

For use of the safety function **SF1**, two voltage thresholds must be set:

- V_H: Started-motor threshold voltage
- V_L: Motor-standstill threshold voltage

CS AM1• and CS AM3• modules feature a trimmer with 10 positions for adjustment of thresholds V_H and V_L.



To adjust, simply turn the trimmer pointer to the desired position using a screwdriver.

For the programmable modules CS AM1•P and CS AM3•P, it is possible to enable or disable the external trimmer via the CS AM Configurator software. With the trimmer disabled, voltage thresholds are set via the configuration software. For modules with motor standstill monitoring that are not programmable, the trimmer is always enabled.

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5.2.1 Trimmer enabled

Based on the position of the trimmer, it is possible to select the started-motor threshold V_H within one of the following two sensitivity ranges:

Sensitivity 40 mV - 500 mV		Sensitivity 200 mV - 2 V	
Position	**V_H**	**Position**	**V_H**
1	40 mV	1	200 mV
2	100 mV	2	400 mV
3	150 mV	3	600 mV
4	200 mV	4	800 mV
5	250 mV	5	1 V
6	300 mV	6	1.2 V
7	350 mV	7	1.4 V
8	400 mV	8	1.6 V
9	450 mV	9	1.8 V
10	500 mV	10	2 V

Using the CS AM Configurator software, it is possible to select the sensitivity in use and motor-standstill threshold voltage V_L can be configured from 20 mV up to 99% of V_H.

For non-programmable models, the V_L and sensitivity values are fixed: V_L = 50% and the sensitivity range in use depends on the article code of the specific module.

5.2.2 Trimmer disabled

With the trimmer disabled, the started-motor threshold voltage V_H can be configured using the CS AM Configurator software within a broad range, with a minimum value of 40 mV, and a maximum value of 2 V.

The motor-standstill threshold voltage V_L can be configured from 20 mV up to 99% of V_H.

A specific LED event (see chapter 6.2) occurs if the operator attempts to turn the trimmer while it is disabled.

5.3 Self-test on module start-up

The module enters initial self-test state on start-up. During the initial test phase, the module must detect voltage on motor power-supply phases ($V_{13,23}$) below the motor-standstill threshold (V_L for CS AM1•, 1 V for CS AM2•, V_L for CS AM3• if at least one safety output is configured as "standstill", otherwise it is 1 V). Therefore, the motor must be at a standstill and connection with phases must be intact.

If the no-voltage condition during the initial self-test is not met, or if the self-test is not successfully completed, the module switches to the error state. A self-test error is signalled by a specific sequence of LED flashes (see chapter 6.2).

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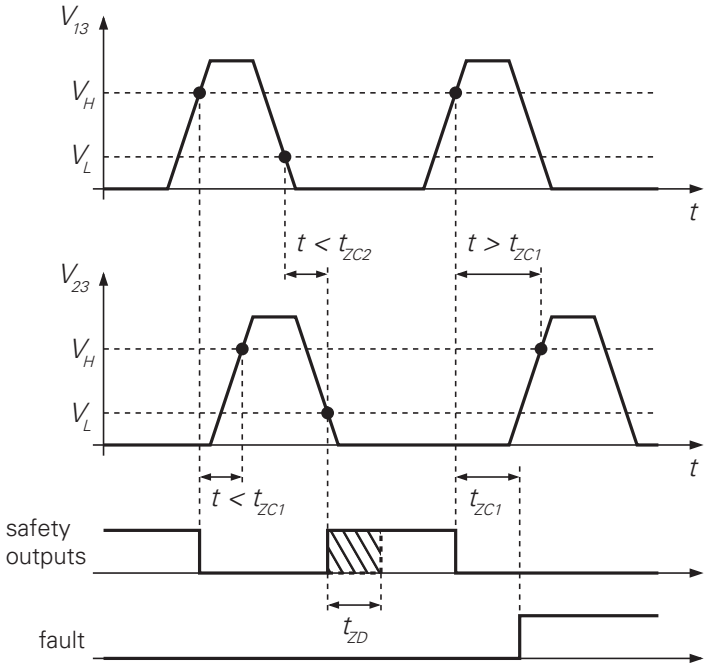
5.4 "Standstill" function

5.4.1 Detection of motor standstill (CS AM1• - CS AM3•)

Once the initial self-test has been passed and in case of absence of phase voltage, the module enters no-voltage state, activating the safety outputs.

When a voltage above the threshold V_H is detected by at least one measurement circuit, the module enters voltage-present state, deactivating the safety outputs. The two channels must both detect a residual voltage value above the upper threshold V_H within the maximum simultaneity time, for motor start-up (t_{ZC1}), where set, otherwise the module enters error state.

Following detection of a voltage below the threshold V_L by both channels, the module returns to no-voltage state, activating the safety outputs after the maximum simultaneity time, for motor shutdown (t_{ZC2}), where set; if the maximum simultaneity time is exceeded the module enters error state.



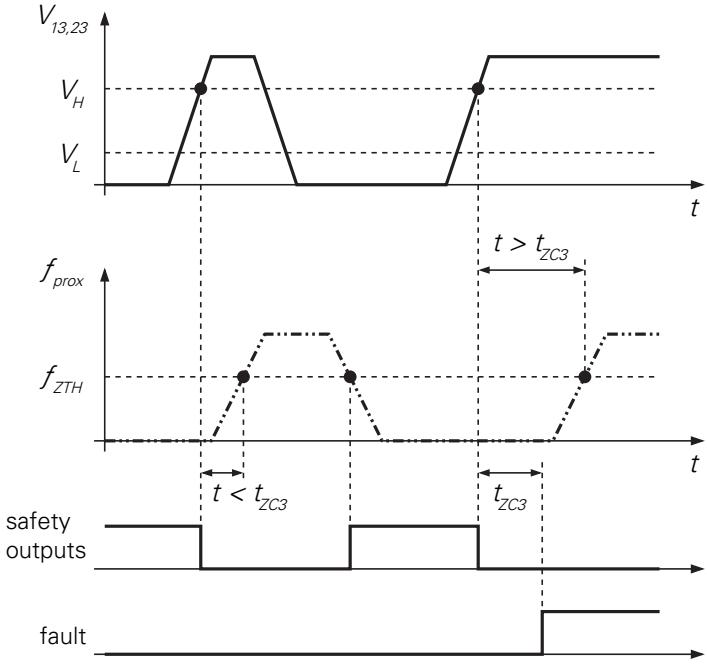
In error state, the module sets outputs to safe state (OSSDs off or relay contacts open). Safe state is maintained until reset or re-start of the module. The error state is signalled by a specific sequence of LED flashes (see chapter 6.2).

See chapter 5.2 for the definition of thresholds V_L and V_H.

Using the CS AM Configurator software, it is possible to configure the times t_{ZC1}, t_{ZC2} and t_{ZD}, the voltage thresholds V_L and V_H, and use of the trimmer.

5.4.2 Checking the "integrity of the kinematic chain" for the "Standstill" function (CS AM1• - CS AM3•)

For CS AM modules with motor standstill monitoring, a proximity sensor can be connected to input I4, setting up the safety function **SF1** with an additional diagnostics function on mechanical transmission components. The proximity sensor must be positioned to detect the teeth of a tone wheel that is integral with the shaft driven by the mechanical transmission components. The diagnostics function is set up as follows:



- In the no-voltage state described in the previous chapter, if the frequency read by the proximity sensor f_{prox} is greater than the value f_{ZTH}, the safety outputs associated with **SF1** remain disabled (safe state). This makes it possible to verify that the shaft is correctly at a standstill even downstream of any belts or transmission components, thus verifying their integrity.
- In the presence of voltages on the phases greater than V_H, it is verified that the frequency measured by the proximity sensor exceeds the f_{ZTH} value within a t_{ZC3} time. If this condition is not met, the module enters error state, signalling the event with a specific sequence of LED flashes (see chapter 6.2).
- The f_{ZTH} parameter must be configured using the CS AM Configurator software based on the application. The t_{ZC3} parameter is fixed at 10 seconds.

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5.5 "Speed" function

5.5.1 Monitoring of motor rotation speed ("Speed") with Automatic Start (CS AM2• - CS AM3•)

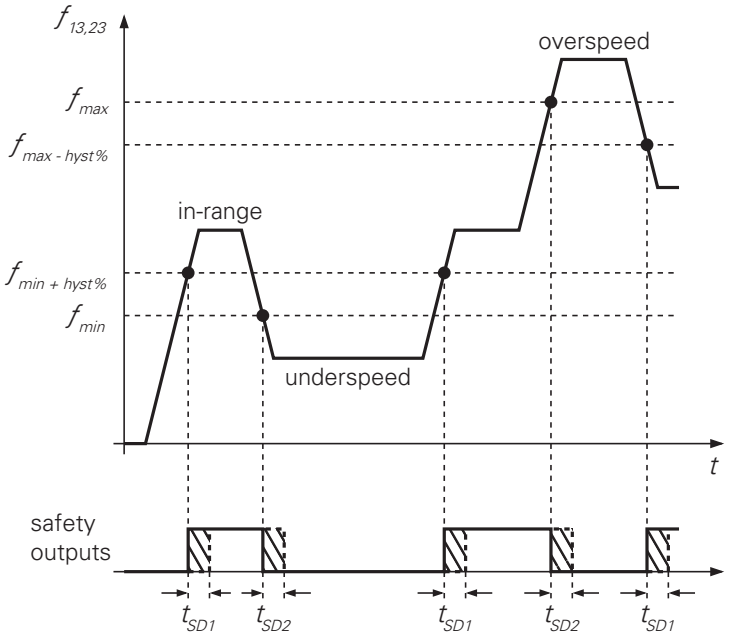
(Can only be used with single-phase or three-phase AC motors)

The motor rotation speed is monitored by measuring the frequency of the rotating magnetic field of the electric motor.

Once the initial self-test has been passed, the module starts evaluating the rotation frequency of the motor $f_{13,23}$, by comparing it to the maximum limits f_{max}, $f_{max\text{-}hyst\%}$ and the minimum limits f_{min}, $f_{min+hyst\%}$ allowed.

If the frequency detected on both phases L1-L3 (f_{13}) and L2-L3 (f_{23}) is within the permissible range, the motor speed is considered to be "IN-RANGE" and the safety outputs are activated.

If the frequency detected for one of the phases exceeds the maximum limit ("OVER" state) or falls below the minimum ("UNDER" state) the safety outputs are deactivated.



The frequency value detected can be filtered by setting the parameters n_S and f_S with which it is possible to define the number of measurements necessary (n_S) above a certain frequency value (f_S) to enable a change in state (below this frequency, the number of measurements is one).

The change in state of the safety outputs can be delayed both for activation and deactivation. By setting the value t_{SD1}, it is possible to set the activation delay of safety outputs, while by setting t_{SD2}, it is possible to set the deactivation delay of safety outputs. The count of these delays is signalled by a specific sequence of LED flashes (see chapter 6.2).

By setting the f_{min} parameter to 0 Hz, it is possible to deactivate motor minimum speed monitoring.

It is possible to activate verification of the coherence of detected frequencies f_{13} and f_{23}. If the frequencies differ by more than a certain percentage *Max deviation* for a time longer than t_{SC}, the module enters error state.

In error state, the module sets outputs to safe state (OSSDs off or relay contacts open). This is maintained until reset or re-start of the module. The error state is signalled by a specific sequence of LED flashes.

Using the CS AM Configurator software, it is possible to set parameters f_{max}, f_{min}, *hyst%*, n_S, f_S, t_{SD1}, t_{SD2}, *Max deviation* and t_{SC}.

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5.5.2 Monitoring of motor rotation speed ("Speed") with Monitored Start (CS AM2• - CS AM3•)

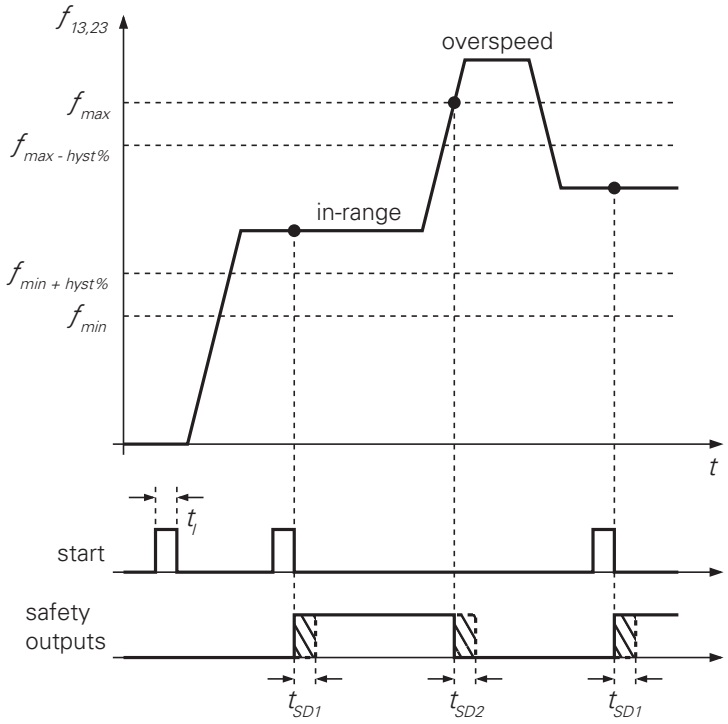
(Can only be used with single-phase or three-phase AC motors)

In the actuation mode with Monitored Start, activation of safety outputs occurs only if the motor speed is "IN-RANGE" and an impulse is detected of +24 V lasting t_I at the input configured as Start.

If an activation delay is set for safety outputs, t_{SD1}, the count begins upon detection of the impulse at the Start input.

Once the "IN-RANGE" state has been reached for speed, a specific sequence of LED flashes (see chapter 6.2) indicates that the device is awaiting the Start command.

Using the CS AM Configurator software, it is possible to select the Start Speed input (I3 or I4).



5.5.3 Monitoring of motor rotation speed ("Speed") and Start-up Monitoring with Automatic Start (CS AM2• - CS AM3•)

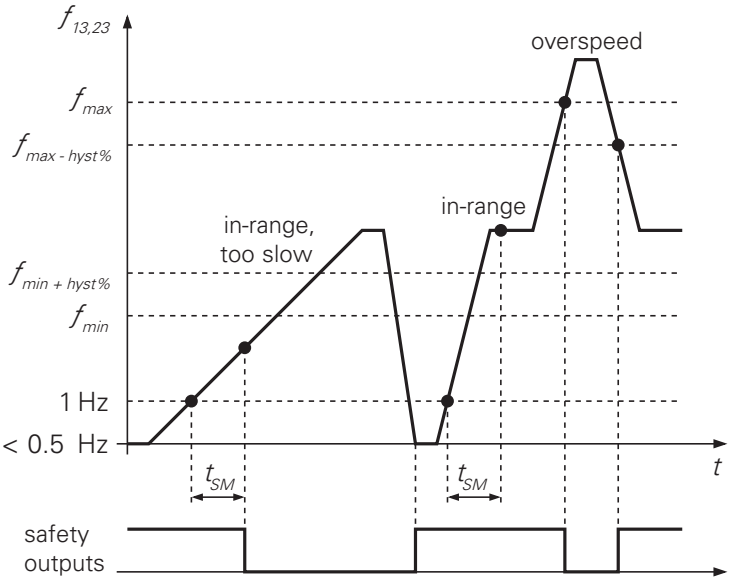
(Can only be used with single-phase or three-phase AC motors)

The function is as described in the paragraph for the "Speed" function with Automatic Start. In addition to the standard function, it is verified that the "IN-RANGE" speed condition is met within the maximum time period t_{SM}.

On module start-up and in zero-speed motor state ($f_{13,23}$ < 0.5 Hz) the safety outputs are active.

As soon as the frequency detected for the phases $f_{13,23}$ exceeds the value of 1 Hz, the module begins counting the time t_{SM}, signalling the start of the count with a specific sequence of LED flashes (see chapter 6.2).

If the motor speed reaches "IN-RANGE" state within the time period t_{SM}, the safety outputs remain active and functioning continues as described in the paragraph on the "Speed" function with Automatic Start.



If the motor speed cannot reach the "IN-RANGE" state within time period t_{SM} the safety outputs are deactivated and it will be necessary to return to the zero-speed state to reset monitoring and reactivate the safety outputs.

Using the CS AM Configurator software, it is possible to set the t_{SM} parameter.

For this functionality, it is not possible to set f_{min} = 0 Hz.

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5.5.4 Monitoring of motor rotation speed ("Speed") and Start-up Monitoring with Monitored Start (CS AM2• - CS AM3•)

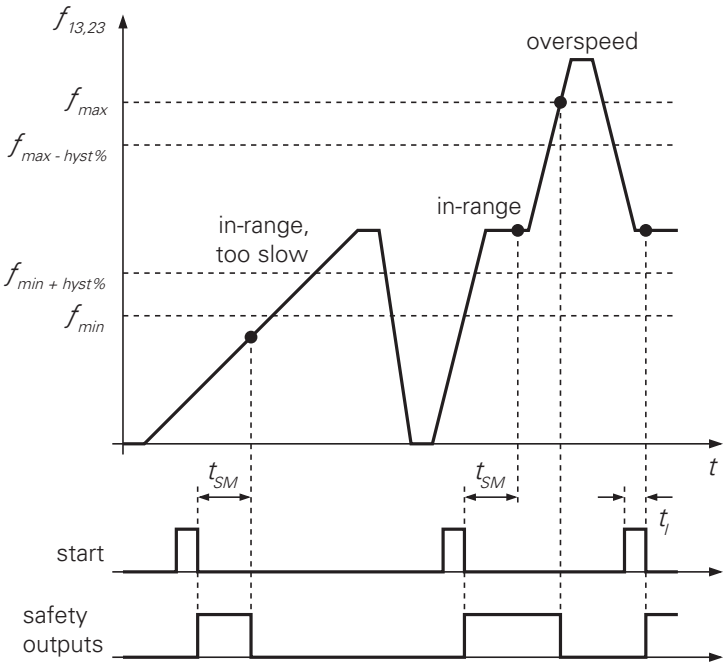
(Can only be used with single-phase or three-phase AC motors)

The function is as described in the paragraph for the function "Speed" with Monitored Start. In addition to the standard function, it is verified that the "IN-RANGE" speed condition is met within the maximum time period t_{SM}. On module start-up and in zero-speed motor state or "UNDER" state ($f_{13,23} < f_{min}$) a Start signal with a duration of t_I is required to activate the safety outputs.

As soon as the safety outputs are activated, the module begins counting the time t_{SM}, signalling the start of the count with a specific sequence of LED flashes.

If the motor speed cannot reach the "IN-RANGE" state within time period t_{SM}, the safety outputs are deactivated.

Once the start-up phase is complete, the function is as described in the paragraph for the function "Speed" with Monitored Start.



Using the CS AM Configurator software, it is possible to set the t_{SM} parameter and select the Start Speed input to be used (I3 or I4).

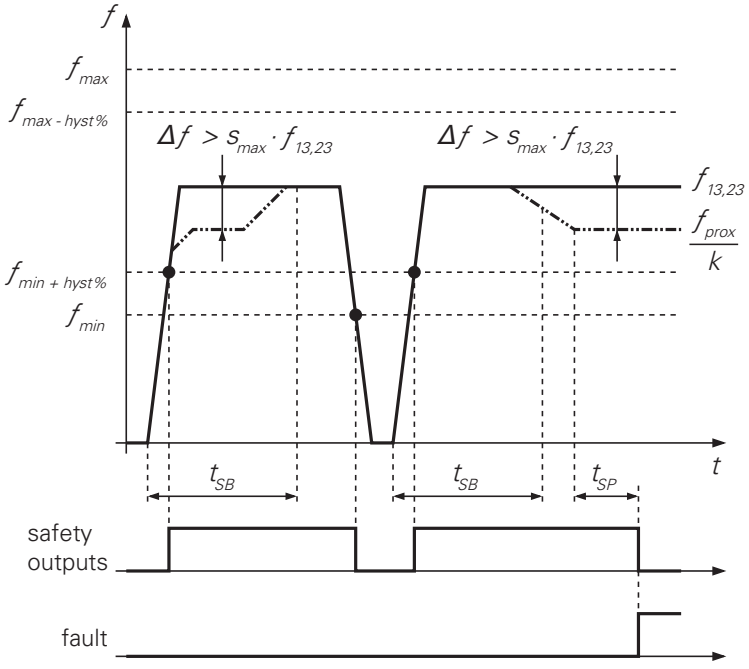
5.5.5 Diagnostics of "motor overload" or "belt slippage" for the "Speed" function (CS AM2• - CS AM3•)

(Can only be used with single-phase or three-phase AC motors)

For CS AM modules with monitoring of motor rotation speed, it is possible to connect a single proximity sensor to input I4 and activate the diagnostics function "motor overload" or "belt slippage", in addition to the safety function.

For the correct operation of this diagnostics function, it is necessary to define the conversion factor K between the frequency detected by the proximity sensor and the actual rotation frequency of the motor, taking into account possible reduction ratios and gears.

Comparing the frequency on the phases $f_{13,23}$ with the frequency detected by the proximity sensor f_{prox}, it is possible to detect any motor-overload or belt-slippage conditions. If the values $f_{13,23}$ and $\frac{f_{prox}}{K}$ differ by a value greater than a certain percentage s_{max} for longer than a certain period of time t_{SP}, the module enters error state, signalling the event with a specific sequence of LED flashes (see chapter 6.2).



During the motor start-up phase, this functionality may be inhibited for a configurable time period t_{SB}.

Using the CS AM Configurator software, it is possible to set the following parameters: K, s_{max}, t_{SP} and t_{SB}.

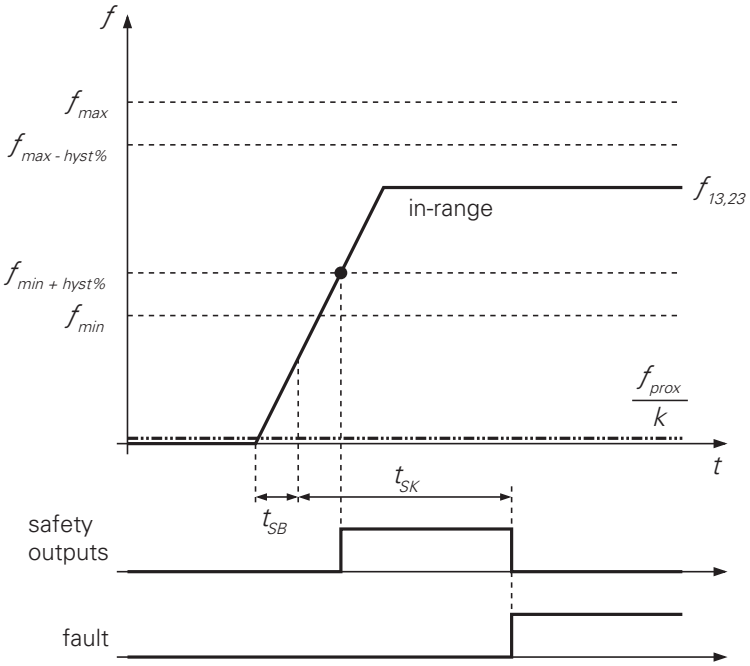
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5.5.6 Diagnostics of “blocked motor” or “belt breakage” for the “Speed” function (CS AM2• - CS AM3•)

(Can only be used with single-phase or three-phase AC motors)

For CS AM modules with monitoring of motor rotation speed, it is possible to connect a single proximity sensor to input I4 and activate the diagnostics function “blocked motor” or “belt breakage”, in addition to the safety function.

For the correct operation of this diagnostics function, it is necessary to define the conversion factor “K” between the frequency detected by the proximity sensor and the actual rotation frequency of the motor, taking into account possible reduction ratios and gears.



By comparing the frequency on the phases $f_{13,23}$ with the frequency detected by the proximity sensor f_{prox}, it is possible to detect any blocked-motor or belt-breakage conditions. If the condition $f_{13,23} > 0$ Hz and $f_{prox} = 0$ Hz persists for longer than a certain period of time t_{SK}, the module enters error state, signalling the event with a specific sequence of LED flashes (see chapter 6.2).

During the motor start-up phase, this functionality may be inhibited for a configurable time period t_{SB}.

Using the CS AM Configurator software, it is possible to set the following parameters: K, t_{SK}, t_{SB}.

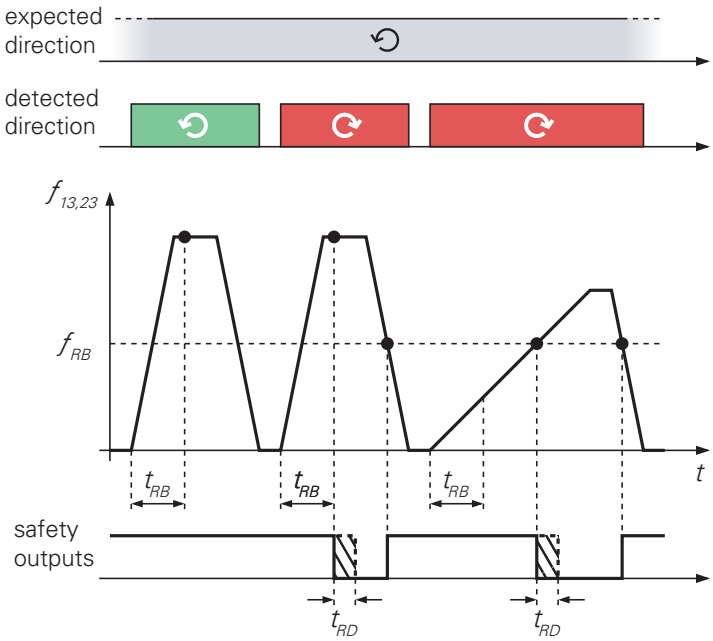
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5.6 "Rotation" function

Definition of a direction of rotation is strictly tied to the wiring of phases L1, L2 and L3. Inversion of the wiring causes reading of an inverted direction of rotation.

5.6.1 Monitoring motor direction of rotation ("Rotation") with Automatic Start (CS AM2• - CS AM3•)

(Can only be used with three-phase AC motors)



Once the initial self-test has been passed, the module activates the safety outputs.

If $f_{13,23}$ is below the value f_{RB} the safety outputs associated with the "Rotation" function are active.

As soon as the frequency in the motor phases $f_{13,23}$ exceeds the value f_{RB} and the time period t_{RB} has passed since motor start-up ($f_{13,23}$ > 0 Hz), the module starts evaluating the detected direction of rotation.

The direction of rotation detection phase occurs up to a frequency value of 100 Hz. Once this frequency value is exceeded, the direction of rotation is kept constant. It is therefore important, to ensure that the rotation direction is detected at a frequency below 100 Hz, to correctly set the t_{RB}, t_{RD}, and f_{RB} parameters according to the acceleration expected in the application. For example, if at the end of the t_{RB} time the frequency value on the phases is greater than 100 Hz, the direction of rotation is not detectable and remains set to the expected value.

If the detected direction of rotation does not correspond to the direction expected, the safety outputs are deactivated.

Detection of a change in direction of rotation can be filtered by setting a time delay t_{RD} before confirmation of the new direction of rotation. The time delay can be useful above all in applications with very rapid phases of acceleration and deceleration.

During normal operation, the colour of the PWR LED indicates the direction of rotation (see chapter 6.2).

Using the CS AM Configurator software, it is possible to define the expected direction and the parameters f_{RB}, t_{RB} and t_{RD}.

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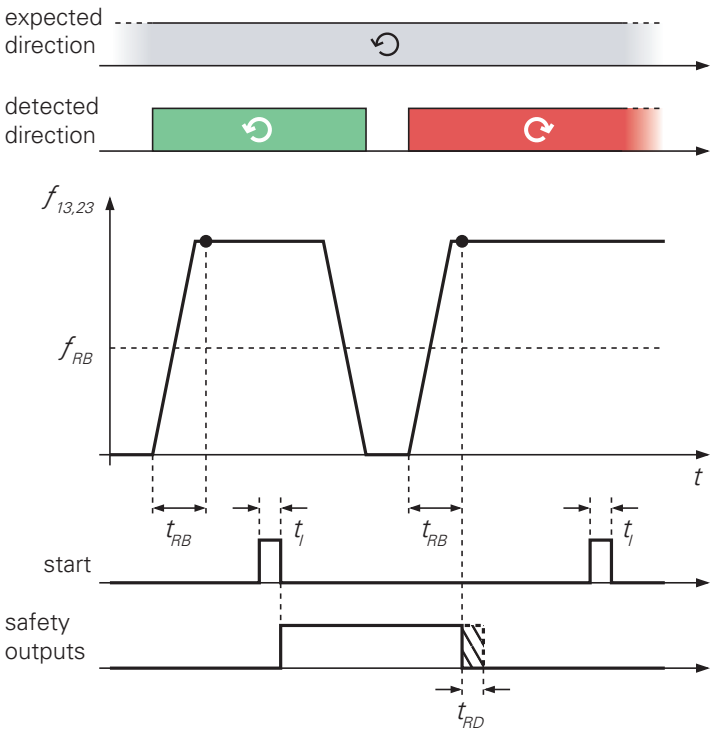
5.6.2 Monitoring motor direction of rotation ("Rotation") with Monitored Start (CS AM2• - CS AM3•)

(Can only be used with three-phase AC motors)

In the actuation mode with Monitored Start, activation of safety outputs occurs only if the motor direction of rotation is as expected and an impulse is detected of +24 V lasting t_I at the Start input.

A specific sequence of LED flashes (see chapter 6.2) indicates that the device is awaiting the Start command.

Using the CS AM Configurator software, it is possible to select the Start Rotation input to be used (I3 or I4) and define the parameters f_{RB}, t_{RB} and t_{RD}.



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5.7 "Speed & Rotation" function

Definition of a direction of rotation is strictly tied to the wiring of phases L1, L2 and L3. Inversion of the wiring causes reading of an inverted direction of rotation.

5.7.1 Monitoring motor speed and direction of rotation ("Speed & Rotation") (CS AM2• - CS AM3•)

(Can only be used with three-phase AC motors)

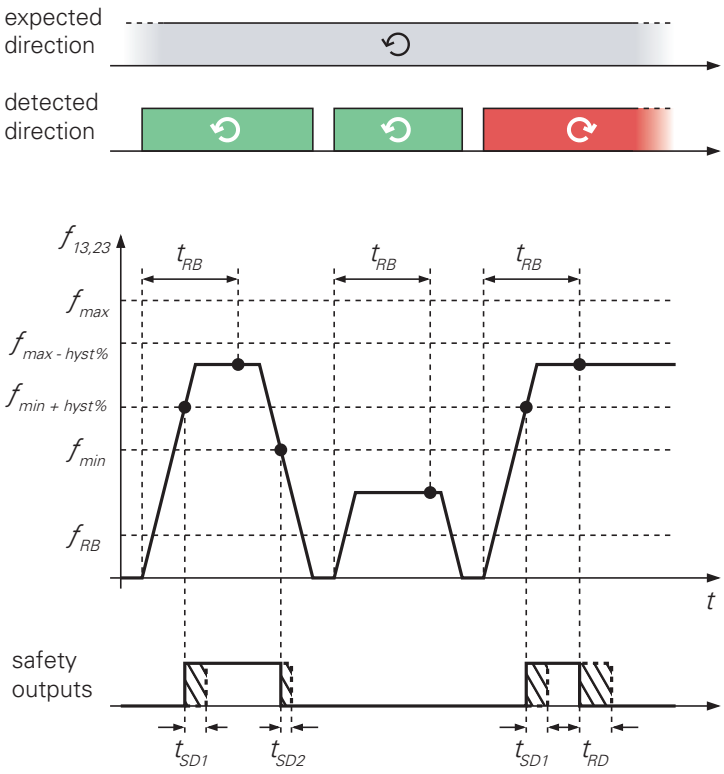
The "Speed & Rotation" safety function corresponds to an "AND" logic between the "Speed" and "Rotation" functions described above. The motor must operate within the required speed limits and rotate in the expected direction of rotation to activate the safety outputs.

The overall reaction times must consider both safety functions.

If an unexpected direction of rotation is detected during the counting of the t_{SD1}, t_{SD2} and t_{SM} timings (where set) the count returns to zero and begins again when the direction of rotation corresponds to that expected.

Monitored Start can always be activated by setting I3 or I4 as Start Speed signal.

Using the CS AM Configurator software, it is necessary to define all parameters regarding the "Speed" and "Rotation" functions.



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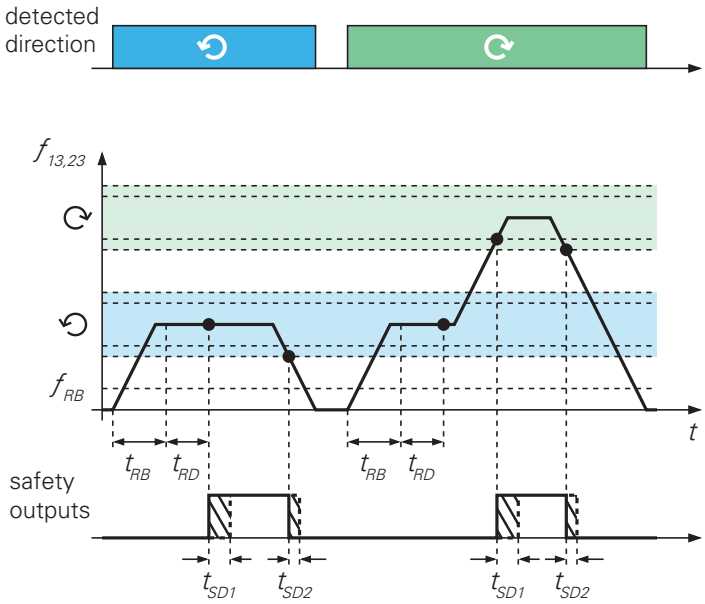
5.8 "Dual Speed" function

Definition of a direction of rotation is strictly tied to the wiring of phases L1, L2 and L3. Inversion of the wiring causes reading of an inverted direction of rotation.

5.8.1 Monitoring of motor rotation speed based on the direction of rotation of the motor ("Dual Speed") (CS AM2• - CS AM3•)

(Can only be used with three-phase AC motors)

The "Dual Speed" safety function combines the "Speed" function with the direction of rotation of the motor, making it possible to set different speed limits depending on whether the motor turns clockwise or anticlockwise. The safety outputs are activated once the correct direction of rotation has been identified and the speed falls within the limits set for that direction.



The direction of rotation of the motor is evaluated after f_{RB} and t_{RB}, where applicable, as described in the chapter dedicated to the "Rotation" function. Similarly, the parameter t_{RD} is applied to filter detection of a change in the direction of rotation.

The direction of rotation detected is signalled by the PWR LED being lit with a specific colour. This enables visual identification of the speed limits currently set.

On start-up and as long as the direction of rotation has not been evaluated and/or does not have a valid value (direction "UNKNOWN") the safety outputs are deactivated.

If f_{min} = 0 Hz is set for both directions of rotation and as long as it has not been possible to identify the current direction of rotation, if $f_{13,23}$ is lower than both $f_{(max\text{-}hyst\%)}$ values set, the safety outputs are activated. This is a special case in which it is not necessary to monitor the minimum speed of the motor for either of the two directions of rotation.

The overall reaction times must consider both safety functions applied: the function detecting the direction of rotation and the "Speed" function.

Monitored Start can always be activated by setting I3 or I4 as Start Speed signal.

This function involves all of the configuration parameters required in the previous chapters for the "Speed" and "Rotation" functions, with the exception of Startup Monitoring, which is not available.

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6 OPERATING STATES AND LED SIGNALLING

6.1 Operating states

CS AM modules have four operating states:

State	Description
POWER-ON	State of module during start-up phase
SET	State of module during configuration phase
RUN	State of normal operation of module. The safety functions are evaluated and the corresponding safety outputs are activated only in this state.
ERROR	Error state of the module

Changes of state are managed by the module and can be requested via the CS AM Configurator software during the configuration phase.

The ERROR state is a safe state that requires operator intervention. In this case, the state can only change by restarting the module (disconnecting power supply) or resetting it using a Reset input (if configured).

The reset signal required is a +24 V impulse with duration t_{RESET}.

Internal errors and those related to temperature and supply voltage conditions of the module cannot be cleared with the Reset function.

Restarting or resetting using the Reset signal means that the module will repeat the initial self-test.

6.2 Signalling LEDs

To display the operating state and indicate detected events, CS AM modules are equipped with three RGB LEDs: PWR LED, FL1 LED and FL2 LED.

The PWR LED has the purpose of indicating the state and system signalling, while FL1 LED and FL2 LED have the purpose of providing specific information on the state of the two safety outputs OS1 and OS2 (or the two pairs of relay outputs) and on the functions associated with them.

In the RUN state and in the absence of specific events, the LEDs behave as indicated in the table below:

RUN state (with absence of events)	PWR LED	FL1 LED	FL2 LED
Module in RUN state The module is functioning correctly. If a function linked to rotation is active, so the module is functioning correctly, and it is detected that the motor is turning clockwise.	(*)	Safety output 1 active	Safety output 2 active
		Safety output 1 inactive	Safety output 2 inactive
Module in RUN state (anticlockwise rotation) If a function linked to rotation is active, so the module is functioning correctly, and it is detected that the motor is turning anticlockwise.	(*)	Safety output 1 active	Safety output 2 active
		Safety output 1 inactive	Safety output 2 inactive
Module in RUN state (unknown rotation) If a function linked to rotation is active, so the module is functioning correctly, but it is not possible to detect the direction of rotation of the motor.	(*)	Safety output 1 active	Safety output 2 active
		Safety output 1 inactive	Safety output 2 inactive

(*) The colours of the PWR LED in RUN state are referred to as "Background" colours, because they represent the background colours of the RUN state event signals (see table below).

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In all other cases, and in particular in the case of errors, events are as indicated in the table below. When multiple events of the same type occur simultaneously, the signalling priority for the event is also indicated (priority 1 is the lowest).

State	Type	Priority	Description	PWR LED	FLx LED
POWER-ON	-	-	**Initial self-test** The module is performing self-testing on start-up.		
		-	**Self-test error** Self-testing was not successfully completed. The voltage in phases during start-up exceeded the motor-standstill threshold: verify that the motor is not supplied with power during module start-up, and verify the motor-standstill threshold set and the wiring of phases. Restart or reset the module.		
SET	-	-	**Module not configured** Load the configuration into the module.		
		-	**Module in configuration mode** The module has entered configuration state.		
RUN	SPEED SIGNALLING (CS AM2• and CS AM3•)	2	**OSx SPEED:** **Signalling of OSx activation/deactivation delay** The module is waiting before changing the state of the Speed output to meet the delay set on the configuration software.	n/a	
		1	**OSx SPEED:** **Waiting for Monitored START signal** Based on the current state of the motor, the module is ready to activate the Speed output but needs (due to configuration) an external START signal to proceed.	n/a	
RUN	SYSTEM WARNING	3	**Warning - Trimmer rotation disabled** The program loaded on the module disables the trimmer for selection of the motor-standstill threshold: any attempt to modify the threshold by turning the trimmer is ignored. If use of the trimmer is required, check the uploaded configuration parameters.		n/a
		2	**Warning - Temperature** Operating temperature of the module close to maximum permissible limits.		n/a
		1	**Warning - Voltage** Supply voltage of the module close to maximum permissible limits.		n/a

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State	Type	Priority	Description	PWR LED	FLx LED
ERROR	SYSTEM ERRORS	7	**Internal error** Restart the module. If the error persists, contact technical assistance.		
		6	**Temperature error** Operating temperature of the module above maximum permissible limits. Check the temperature and restart the module.		
		5	**Voltage error** Supply voltage of module above maximum permissible limit. Check the supply voltage and restart the module.		
		4	**Software configuration error** Check the module parameters with errors reported by the software and reprogramme the module.		
		3	**Trimmer position error** The trimmer pointer is between two values. Check the position of the pointer. Restart or reset the module.		
		2	**OSx OSSD short-circuit error** Check connection of the OSx OSSD output, ensuring in particular that it is not short-circuited at 0 V, 24 V or with the other safety output. Restart or reset the module.		
		1	**OSx EDM error** Check that the EDM function has been correctly set-up and check correct connection of the input programmed as OSx EDM. The same signalling is used in the case of an error with "Legacy Y1-Y2" functionality: check the circuit is correctly set-up. Restart or reset the module.		

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State	Type	Priority	Description	PWR LED	FLx LED
ERROR	STANDSTILL ERRORS (CS AM1• and CS AM3•)	4	**OSx STANDSTILL:** **Phase simultaneity error during start-up** Check the wiring of the motor phases. Depending on the application and characteristics of the motor or inverter connected, it may be necessary to increase the simultaneity time by adjusting the corresponding parameter or disabling this function. Restart or reset the module.		
		3	**OSx STANDSTILL:** **Phase simultaneity error on stop** Check the wiring of the motor phases. Depending on the application and characteristics of the motor or inverter connected, it may be necessary to increase the simultaneity time by adjusting the corresponding parameter or disabling this function. Restart or reset the module.		
		2	**OSx STANDSTILL with PROXIMITY SENSOR:** **Proximity sensor frequency error - out of module measurement range** The frequency detected by the sensor exceeds the maximum value that can be measured. Check the input signal of the proximity sensor. Restart or reset the module.		
		1	**OSx STANDSTILL with PROXIMITY SENSOR:** **Proximity sensor detection error** Check the wiring, correct functioning and positioning of the proximity sensor. This error can only occur with configuration of the proximity sensor as an additional input signal (in addition to phase voltage) to monitor the motor-standstill state. Restart or reset the module.		

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State	Type	Priority	Description	PWR LED	FLx LED
ERROR	SPEED ERRORS (CS AM2• and CS AM3•)	3	**OSx SPEED with/without PROXIMITY SENSOR:** **Phase (or proximity sensor) frequency error - out of module measurement range** The frequency detected by the module or sensor exceeds the maximum value that can be measured. Check the input signal of the phases or of the proximity sensor (if used). Restart or reset the module.		
		2	**OSx SPEED:** **Error for incoherence of phase frequencies** The frequency detected for phase L1-L3 of the motor differs from that for phase L2-L3 by more than the maximum permissible amount. Check the phase wiring. Based on the application and the type of motor, it could be necessary to adjust the frequency-incoherence parameter by increasing the tolerance and the delay, or disabling the function in certain cases where it is not required. Restart or reset the module.		
		1	**OSx SPEED with PROXIMITY SENSOR:** **"Blocked Motor", "Belt Breakage" or "Motor Overload", "Belt Slippage" error** An excessive motor overload or slippage/breakage of the belt has been detected. Check the condition of the motor and belt. Check the wiring, correct functioning and positioning of the proximity sensor. This error can only occur with configuration of the proximity sensor as a signal to monitor the state of the belt or other transmission components. If necessary, adjust configuration parameters regarding these functions. Restart or reset the module.		

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7 ELECTRICAL CONNECTIONS OF THE DEVICE

Attention: The safety modules CS AM•1 are fitted with OSSD-type solid state electronic outputs. These outputs behave differently from electromechanical contacts. Use and installation of a safety module with solid state outputs is only permitted if all properties of this particular type of outputs are known in detail.

7.1 Electrical connections

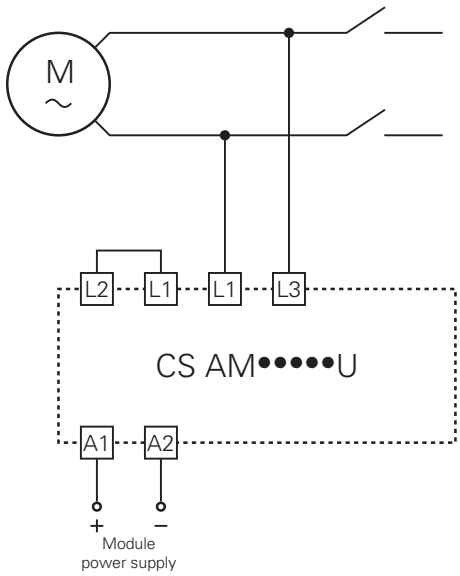
Connection		CS AM•1	CS AM•2	CS AM•3
A1	Power supply input +24 Vdc	■	■	■
A2	Power supply input 0 V	■	■	■
I3	Configurable inputs	■	■	■
I4		■	■	■
O3	Configurable outputs	■	■	■
O4		■	■	■
L1	Motor phase 1	■	■	■
L2	Motor phase 2	■	■	■
L3	Motor phase 3	■	■	■
OS1	OSSD safety outputs	■		
OS2		■		
13-14	NO safety contacts		■	■
23-24			■	■
33-34			■	■
43-44				■
53-54				■
63-64				■

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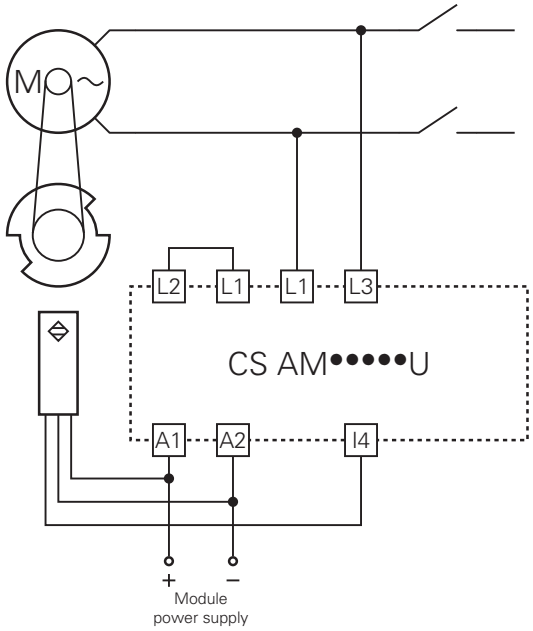
7.2 Wiring diagrams

SINGLE-PHASE OR DC MOTOR

WITHOUT PROXIMITY SENSOR

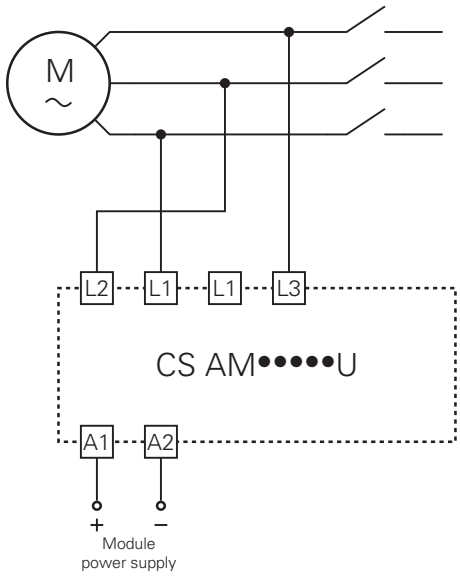


WITH PROXIMITY SENSOR

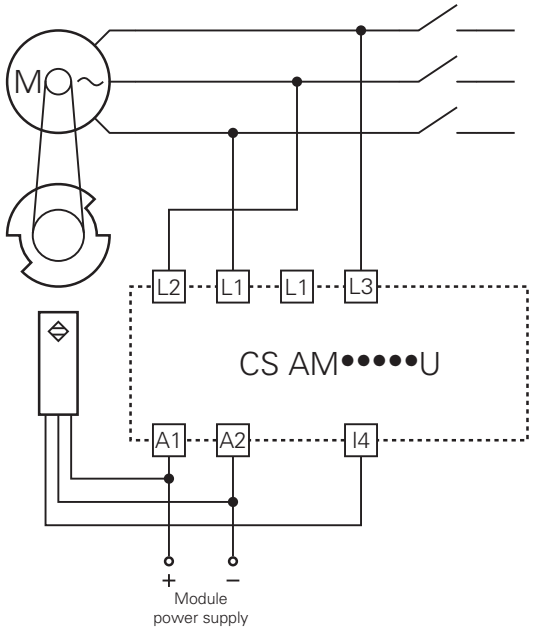


THREE-PHASE MOTOR

WITHOUT PROXIMITY SENSOR



WITH PROXIMITY SENSOR



Notes: In case of star/delta starting, connect the module to the ends of a single winding.

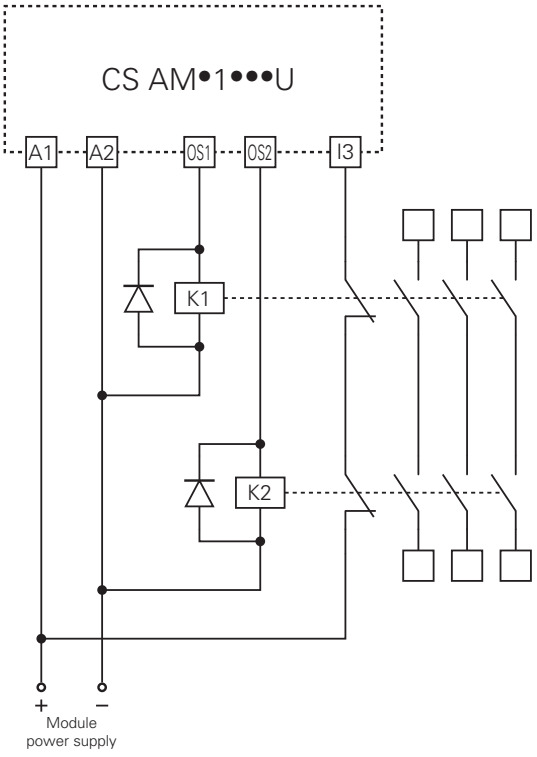
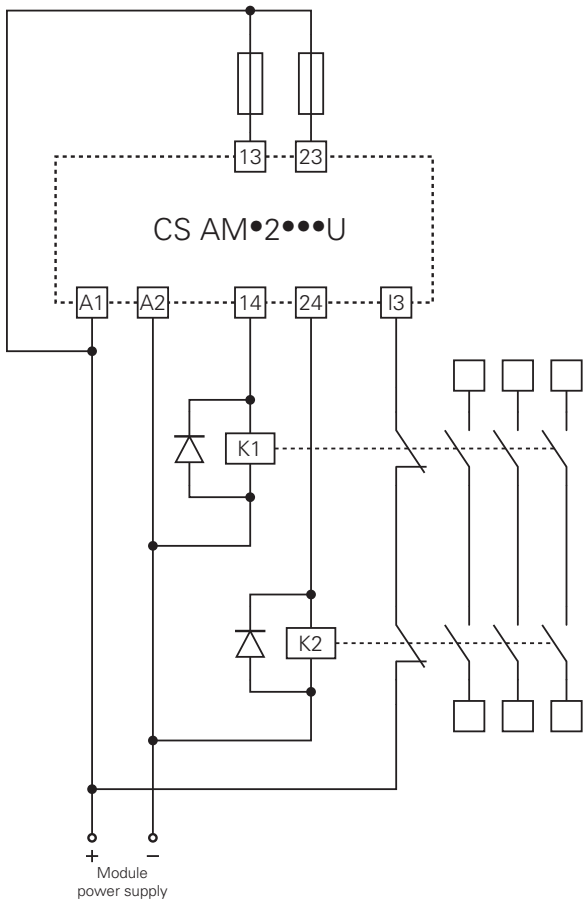
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7.3 External device monitoring (EDM)

If appropriately configured, the CS AM safety module enables checking of the NC contacts of contactors or forcibly guided relays controlled by the safety outputs of the module itself. This check is carried out by the module by monitoring the EDM (External Device Monitoring) input. When the safety outputs are activated, the device checks that the EDM input deactivates within the time t_{EDM}. When the safety outputs are deactivated, the device checks that the EDM signal reactivates within the time t_{EDM}.

If the maximum time t_{EDM} is exceeded, the system enters ERROR state, deactivating (where active) the safety outputs, and indicating the error via the corresponding LED sequence (see chapter 6.2).

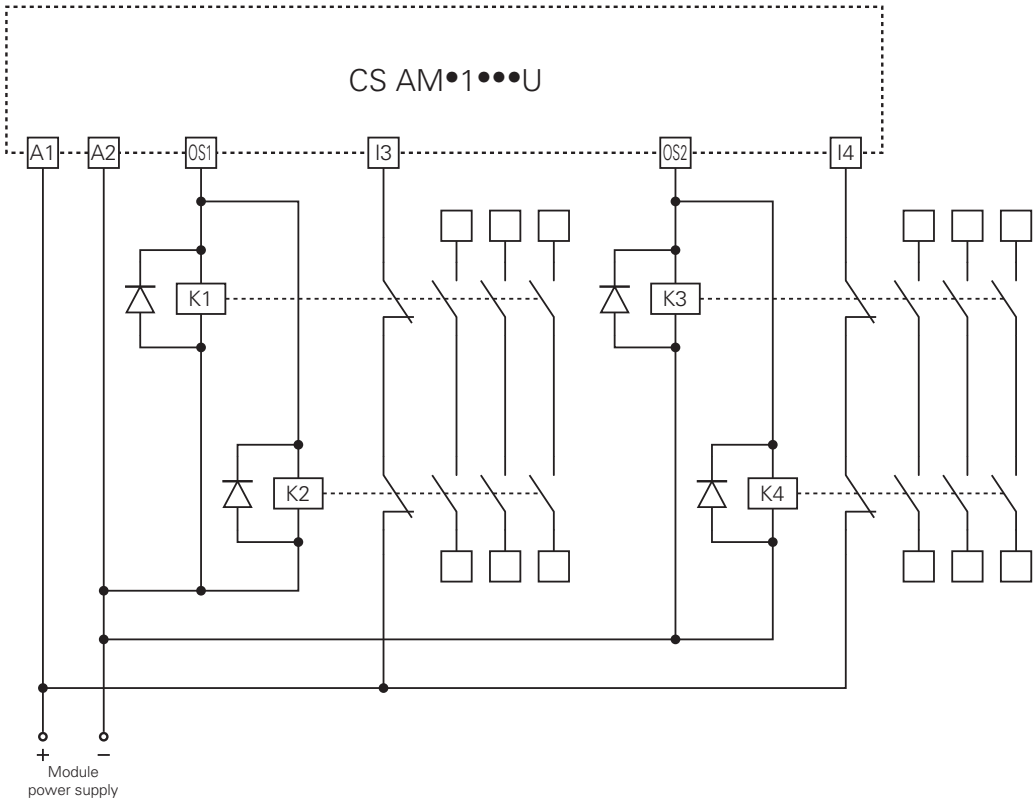
EDM for CS AM with single safety function

CS AM•1	CS AM•2 and CS AM•3
	

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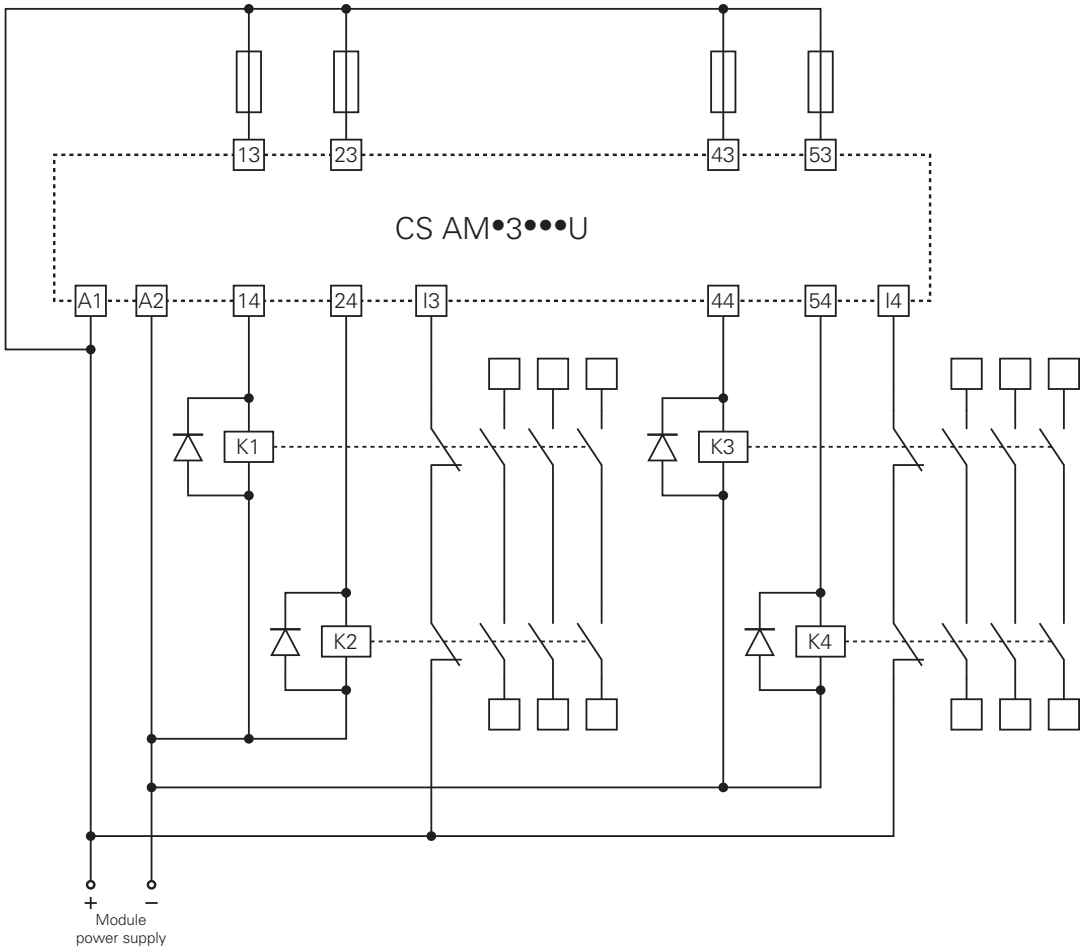
EDM for CS AM with dual safety function

CS AM•1*



* The same OSSD output from the CS AM module may be connected to the coils of two force-guided contactors with series-wired contacts, provided that they are installed within the same electrical cabinet (fault exclusion principle applies). For reference, see EN ISO 13849-2, Table D.4, Clause D.2.4.

CS AM•2 and CS AM•3



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7.4 Backwards compatibility with model CS AM-0

Models CS AM1• and CS AM3• can be used in place of the various versions of the Pizzato CS AM-0 motor standstill monitoring module.

In case of replacement of a CS AM-0 module, it is also possible to replicate (if necessary) contact expansion functionality which involved feedback terminals Y1-Y2.

The wiring diagram for expansion of contacts is that provided in chapter 7.3. Unlike CS AM-0, for which two feedback terminals were required, a single input is sufficient.

To replicate the functioning of terminals Y1-Y2 of CS AM-0, input I3 (or I4) used as feedback of the NC contacts, must be configured using the CS AM Configurator software as "Legacy Y1-Y2".

As for CS AM-0, absence of a +24 V signal at the feedback input when the output relays are switched on triggers the module to enter ERROR state, signalling the error as EDM error, as indicated in chapter 6.2.

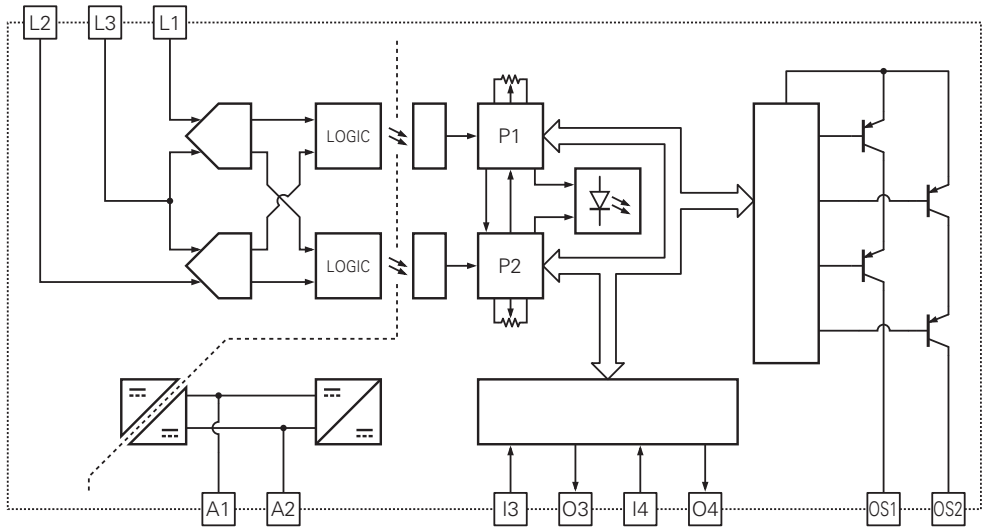
To electrically disable this functionality, input I3 (or I4) configured as "Legacy Y1-Y2" should be connected directly at +24 V unlike the CS AM-0 module where, to disable the function, it was necessary to bridge Y1 and Y2.

⚠ Attention: this function does not guarantee monitoring of changes to the state of external contacts equivalent to the standard EDM function. It only verifies that the NC contact is in the expected logic state when the relay is switched on. To monitor the correct change of state of the external device, use of the standard EDM function is recommended.

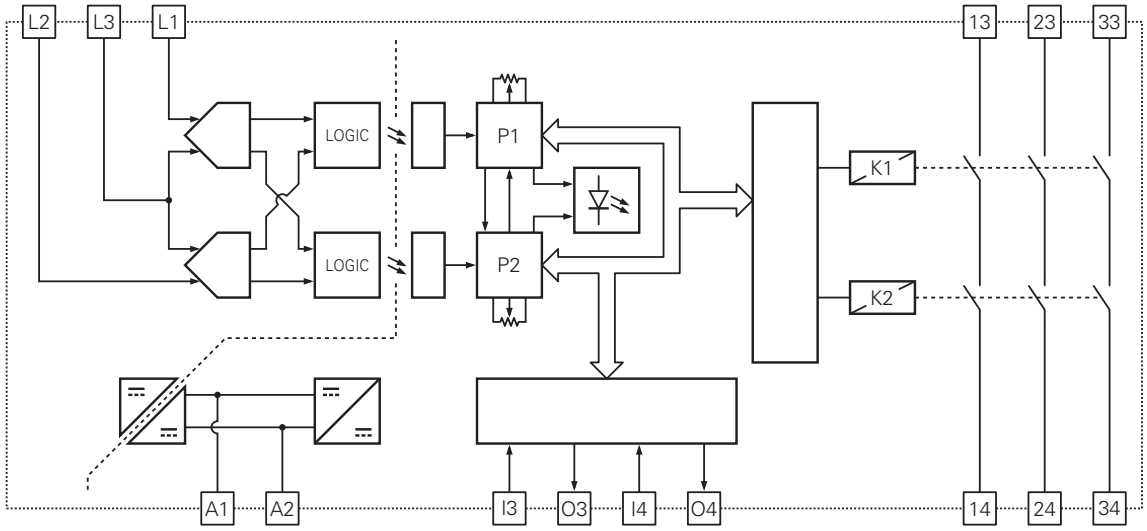
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8 INTERNAL WIRING DIAGRAM

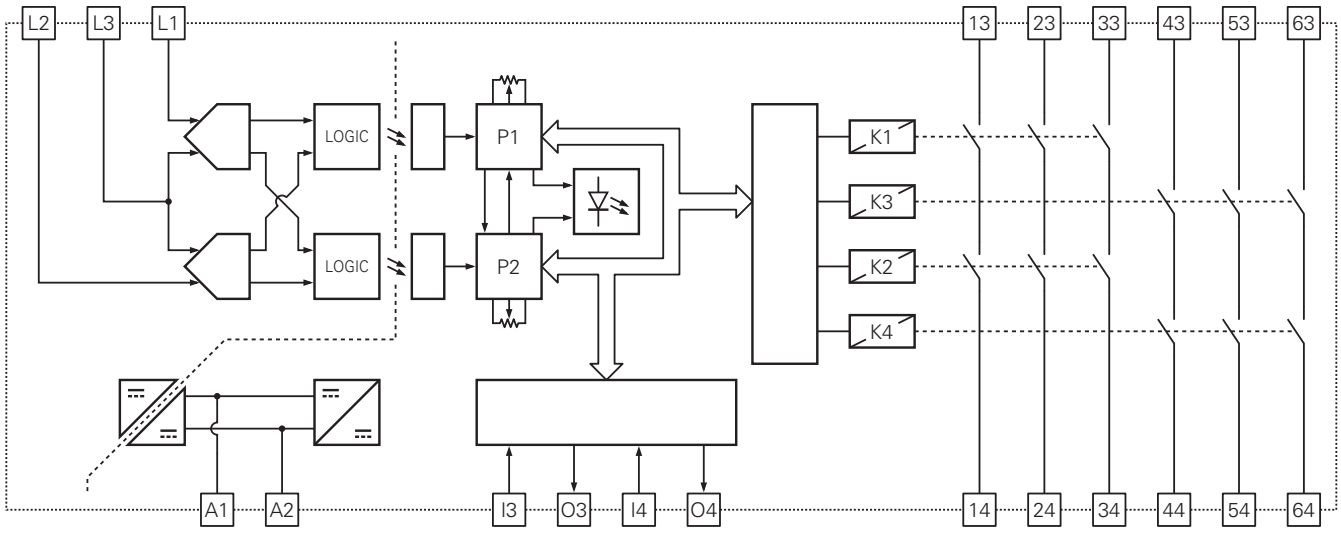
CS AM•1



CS AM•2



CS AM•3



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9 INSTRUCTIONS FOR PROPER USE

9.1 Installation

Do not exceed the tightening torque of the terminal screws specified in the present operating instructions.

Observe the wiring of the terminals: incorrect wiring can damage the device which may result in loss of the safety function.

The device may only be installed and used if these technical requirements and all safety standards relevant to use have been evaluated and implemented.

Install only inside a cabinet with protection degree not less than IP54 according to EN 60529.

Always affix the device with the specific DIN rail adaptor acc. to EN 60715.

Do not stress the device with bending or torsion.

Do not modify or open the device for any reason.

The device carries out an operator protection function. Any inadequate installation or tampering can cause serious injuries and even death, property damage, and economic losses.

These devices must not be bypassed, removed or disabled in any other way.

If the machine where the device is installed is used for a purpose other than that specified, the device may not provide the operator with efficient protection.

The safety category of the system (according to EN ISO 13849-1), including the safety device, also depends on the external components connected to it and their type.

Before installation, make sure the device is not damaged in any part.

Before commissioning, check the correct functioning of the module according to the instructions of the operating diagrams (see chapter 5).

Avoid excessive bending of connection cables in order to prevent any short circuits or power failures.

Do not paint or varnish the device.

Do not drill the device.

Do not use the device as a support or rest for other structures, such as raceways, sliding guides or similar.

Before commissioning, make sure that the entire machine (or system) complies with all applicable standards and EMC Directive requirements.

The documentation required for correct installation and maintenance is available online in various languages on the Pizzato Elettrica website.

Should the installer be unable to fully understand the documents, the product must not be installed and the necessary assistance may be requested from the manufacturer (see chapter 16).

Always attach the following instructions to the manual of the machine in which the device is installed.

These operating instructions must be kept available for consultation at any time and for the whole period of use of the device.

9.2 Do not use in following environments

In environments where continuous temperature fluctuations cause the formation of condensation inside the device.

In environments where the application causes the device to be subjected to strong impacts or vibrations.

In environments with the presence of explosive or flammable gases or dusts.

In environments containing strongly aggressive chemicals, where the products used coming into contact with the device may impair its physical or functional integrity.

Prior to installation, the installer must ensure that the device is suitable for use under the ambient conditions on site.

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9.3 Maintenance and functional tests

Attention: Do not disassemble or try to repair the device. In case of any malfunction or failure, replace the entire device.

The device installer is responsible for establishing the sequence of functional tests to which the device is to be subjected before the machine is started up and during maintenance work.

The sequence of the functional tests can vary depending on the machine complexity and circuit diagram; therefore the functional test sequence detailed below is to be considered as minimal and not exhaustive.

Perform the following sequence of checks before the machine is commissioned and at least once a year (or after a prolonged shutdown):

1) Check that the safety module housing is undamaged and in good condition. If the housing is damaged, replace the entire device.
2) Check that all signalling LEDs are working.
3) Check that the electrical cables are firmly lodged inside the terminals and connectors.
4) Check that during operation the module behaves according to the operating diagrams provided in chapter 5.

The device has been created for applications in dangerous environments, therefore it has a limited service life. Although still functioning, after 20 years from the date of manufacture the device must be replaced completely. The date of manufacture is placed next to the product code (see chapter 12).

9.4 Wiring

Attention: Do not install the safety module if voltage is present. Power the device only when the electrical circuits have been completely realized according to the specifications indicated in chapter 5.

The first time you start the machine ensure that there are no people close to hazardous areas.

Check that the supply voltage is correct before powering the device.

Keep the charge within the values specified in the electrical operation categories.

Only connect and disconnect the device when the power is off.

When using plug-in-type terminal blocks, they may only be plugged in or unplugged if no supply voltage is present.

Discharge static electricity before handling the product by touching a metal mass connected to earth. Any strong electrostatic discharge could damage the device.

Supply the semiconductor signalling outputs from a single SELV/PELV voltage source according to applicable standards.

We recommend keeping the power supply of the safety module galvanically separated from the power section of the machine and keeping the connection cables of the module separated from the power cables.

Always connect the protection fuse (or equivalent device) in series with the power supply for each device.

Always connect the protection fuse (or equivalent device) in series to the safety electrical contacts (CS AM•2 and CS AM•3).

During and after the installation do not pull the electrical cables connected to the device. If excessive tension is applied to the cables, the device may be damaged.

9.5 Additional requirements for safety applications with operator protection functions

Provided that all previous requirements for the devices are fulfilled, for installations with operator protection function additional requirements must be observed:

- Utilization implies knowledge of and compliance with following standards: EN ISO 13849-1, EN IEC 62061, EN 60204-1, EN ISO 12100.
- If expansion modules or external contactors are used, make sure that they have forcibly guided contacts.

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9.6 Limits of use

Use the device following the instructions, complying with its operation limits and the applicable safety regulations.

The devices have specific application limits (min. and max. ambient temperature, maximum currents, IP protection degree, etc.). These limitations are met by the device only if considered individually and not as combined with each other.

According to EU directives, this device is not intended for private use.

The manufacturer's liability is to be excluded in the following cases:

1) Use not conforming to the intended purpose.
2) Failure to adhere to these instructions or regulations in force.
3) Mounting not performed by qualified and authorised personnel.
4) Omission of functional tests.

For the cases listed below, before proceeding with the installation contact our assistance service (see chapter 16):

1) In nuclear power stations, trains, airplanes, cars, incinerators, medical devices or any application where the safety of two or more persons depend on the correct operation of the device.
2) Applications not contemplated in this instruction manual.

10 CS AM CONFIGURATOR

10.1 Introduction

The CS AM Configurator program is a software application for the configuration of CS AM series modules. This software is licensed to users wishing to configure these modules following registration at www.pizzato.com. User registration is necessary to enable notifications about updates and notifications regarding the products used.

10.2 Minimum operating requirements for CS AM Configurator

The CS AM Configurator program was developed to operate on personal computers with the following minimum features:

Operating system: Microsoft Windows 10, Microsoft Windows 11, on which .NET 4.6.1 framework or higher and the Microsoft Report Viewer component must be installed. The .NET framework and the Microsoft Report Viewer component, if not present, are automatically installed during installation of CS AM Configurator.

RAM memory: 256 MB

Disk space: 150 MB

USB connection: 1.0

Display with minimum resolution of: 1280 x 800 pixel.

10.3 Software version

The software version currently installed can be viewed in the menu ? ➔ Info.

10.4 Software installation

The CS AM Configurator software is available for download on the website www.pizzato.com, in the DOWNLOAD section.

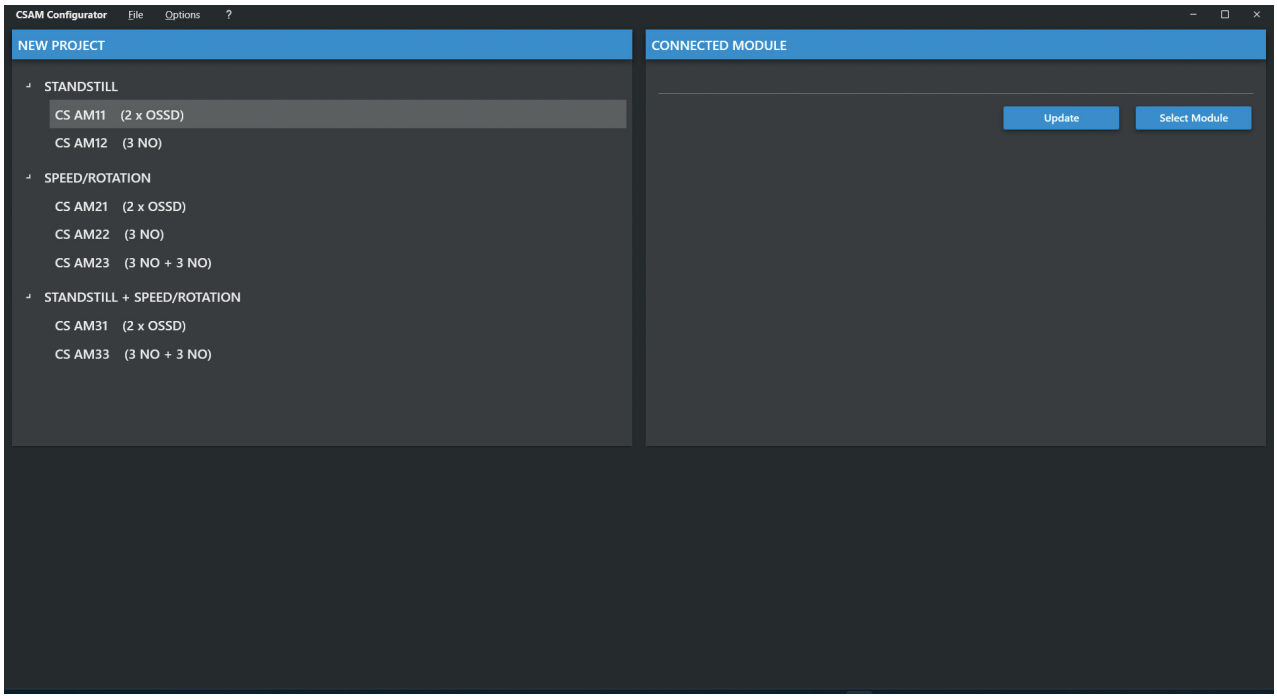
After downloading the installation file, run it and follow the instructions in the installation wizard.

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10.5 User interface

10.5.1 Home screen

The following screen appears when the CS AM Configurator software is launched:



On the left side of the screen, the user can select the module type to work on when creating a new project. The new project will contain the default configuration parameters.

On the right is a list of any modules connected to the computer. Users can select one of the modules and click on Select Module to connect to the module.

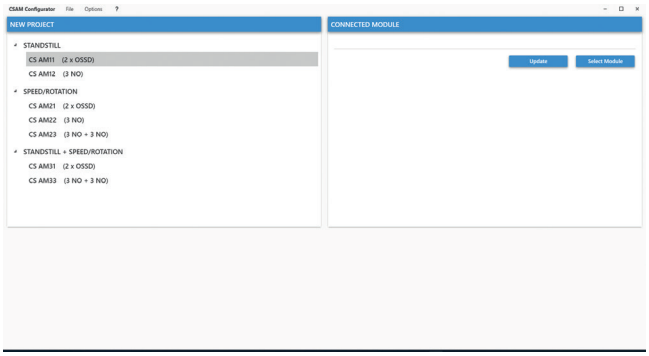
If the module does not appear in the list, the list can be updated by clicking on the Update button.

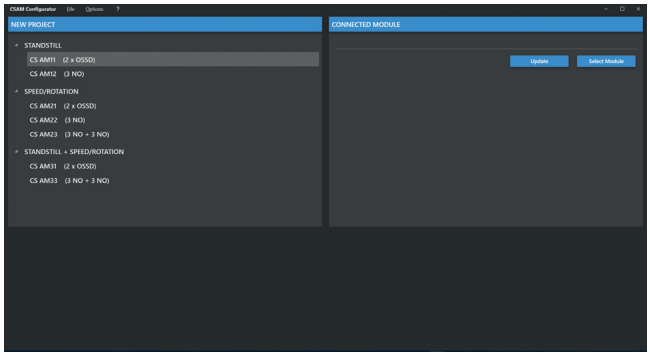
10.5.2 File menu

The File menu contains the main functions for management of the project files, with options New, Open, Save and Save as. The file extension for project files is "*.pzzam".

10.5.3 Options menu

The Options menu allows users to customise the appearance of the software window. In particular, two display modes are available, light or dark, which can be selected by clicking on Options ➔ Switch Theme.





Within the Options menu, the user can also change the main colour of the theme by clicking on Change colour.

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10.6 Creating a new project

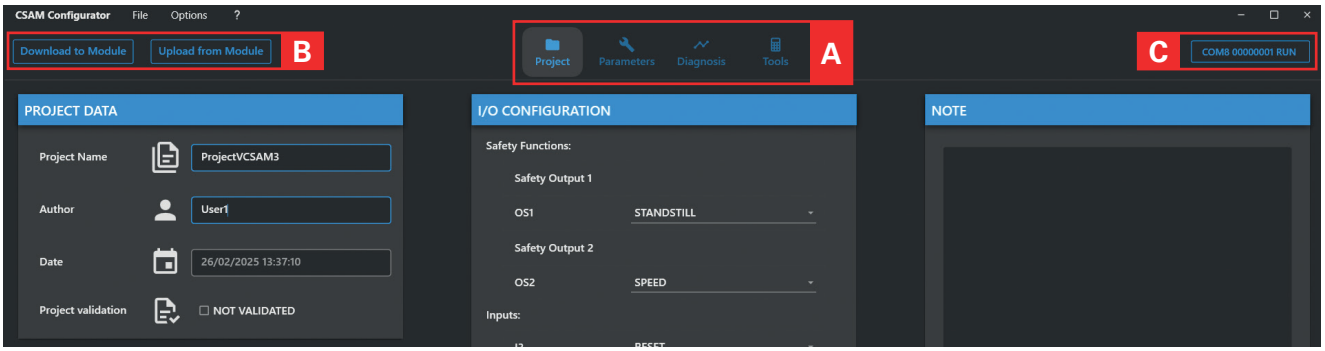
Within the CS AM Configurator software, projects consist of a set of parameters required for configuration of CS AM series modules. These parameters mainly include:

- General project information
- Configuration parameters for safety functions performed by the module
- Password management

When the CS AM Configurator software is launched, users can choose whether to create a new project starting from the configuration of the module connected to the USB port or to create a new project by selecting the type of CS AM module to configure (see chapter 10.5.1).

10.6.1 Project screen

The project screen mainly consists of four main tabs, each of which can be accessed by selecting the corresponding icon at the top of the window (A). The four tabs are: "Project", "Parameters", "Diagnosis" and "Tools".

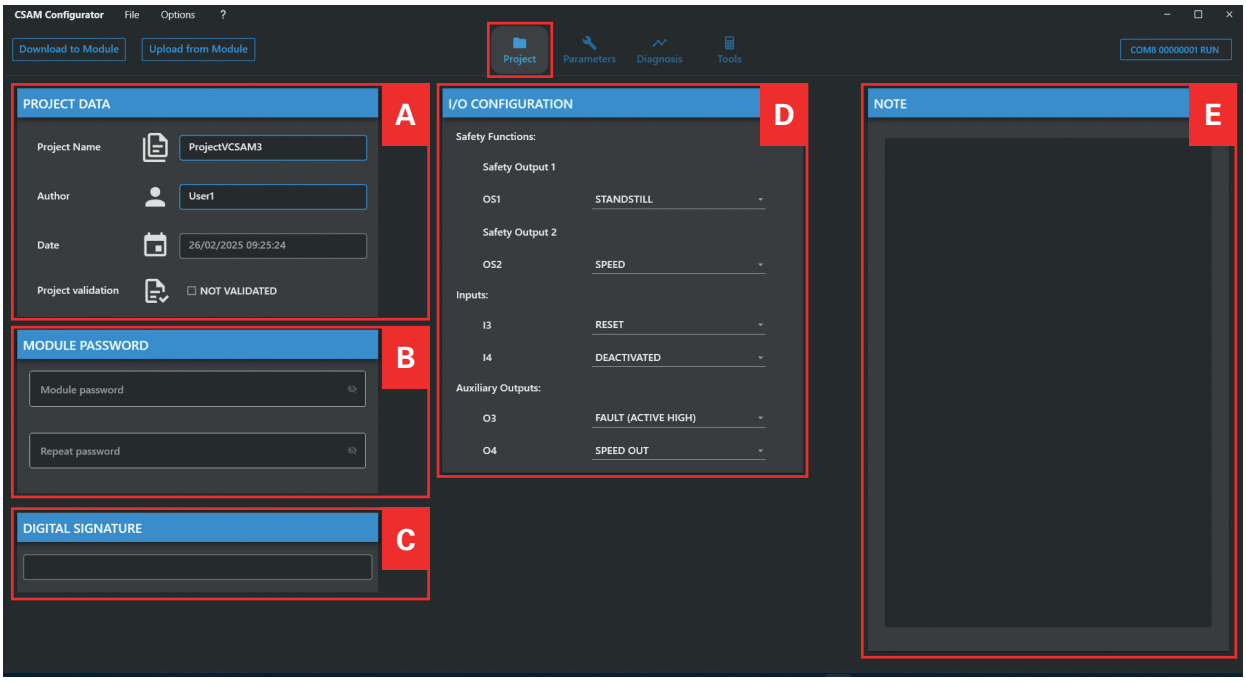


If a CS AM module is connected to the software, the project screen will also display buttons (B) that allow users to perform key operations in case of a CS AM series module connected via USB port, including configuration of the module "Download to Module" and reading of module parameters "Upload from Module" (see chapter 10.7).

In the top right of the screen there is a field indicating the state of the connected module and its serial number (C). If the module is in error state, error details can be viewed by using the mouse to click on this field.

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10.6.2 “Project” tab



A) PROJECT DATA
This section displays the main project details. The project name and author can be changed here. The other fields cannot be edited by the user.

B) MODULE PASSWORD
A password can be entered in this field to protect the module from further changes. The password is applied to the module when it is configured with this project (see chapter 10.8).

C) DIGITAL SIGNATURE
The set of data required for module configuration undergoes a mathematical calculation that generates an identification code referred to as a “Digital Signature”. This is a string of eight characters serving as a unique identifier for the configuration project.

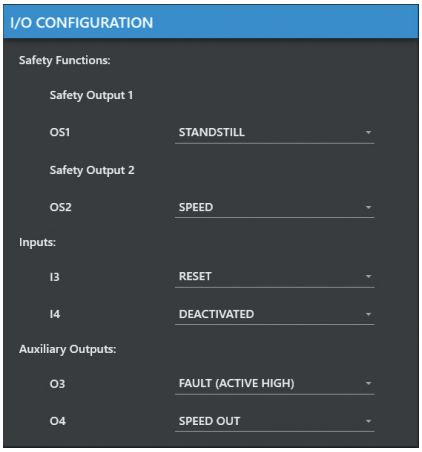
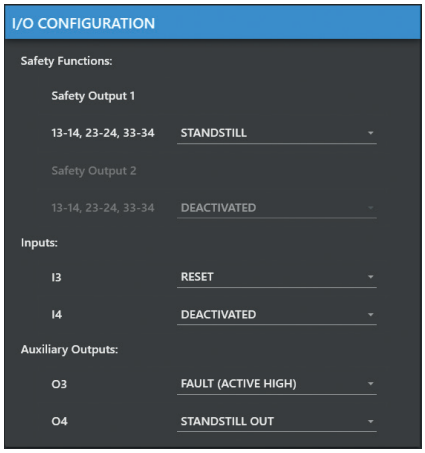
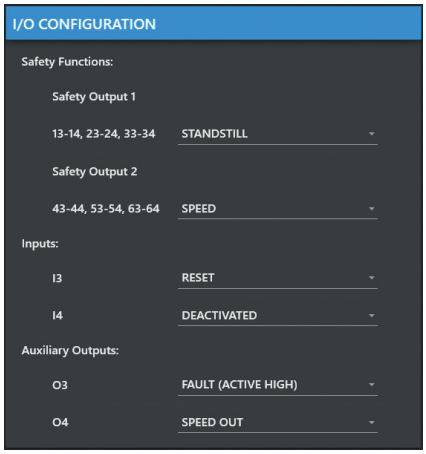
D) I/O CONFIGURATION
In this section, users can configure the input and output interface of the module by selecting the safety function to be assigned to the safety outputs, the functions of inputs I3 and I4, and the behaviour of signalling outputs O3 and O4.

E) NOTES
This section includes an user-editable text field to add notes and comments related to the project. The content of this text field remains within the project file on the computer and is not transferred to the CS AM module.

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10.6.2.1 I/O configuration

Configuration of module inputs and outputs can be performed by selecting the function to be assigned to each input or output from the corresponding drop-down menu. The structure of this section varies depending on the type of module selected:

CS AM•1 - Modules with OS1 and OS2 solid-state safety outputs	CS AM•2 - Modules with safety relay outputs (3NO)	CS AM•3 - Modules with safety relay outputs (3NO+3NO)
		

It is recommended to select parameters from top to bottom, following the order in which the software lists the different fields. This enables the CS AM Configurator software to apply a set of rules on selection of each parameter and to filter the options for subsequent parameters in order to avoid incorrect or unfeasible I/O configurations.

- Safety outputs

Set-up of the function assigned to the module safety outputs depends on the type of module:

Module	Available functions for safety outputs
CS AM1•	STANDSTILL DEACTIVATED
CS AM2•	ROTATION SPEED SPEED & ROTATION DUAL SPEED RANGE DEACTIVATED
CS AM3•	STANDSTILL ROTATION SPEED SPEED & ROTATION DUAL SPEED RANGE DEACTIVATED

Assigning a safety output to a specific safety function automatically enables that function.

- Inputs

Digital inputs I3 and I4 can be configured with the following values:

Module	Available functions for input I3	Available functions for input I4
CS AM1•	SAFETY OUTPUT 1 EDM* LEGACY Y1-Y2 RESET DEACTIVATED	PROXIMITY SENSOR SAFETY OUTPUT 1 EDM* LEGACY Y1-Y2 RESET DEACTIVATED
CS AM2• CS AM3•	SPEED START ROTATION START SAFETY OUTPUT 1 EDM* SAFETY OUTPUT 2 EDM* LEGACY Y1-Y2 (only CS AM3•) RESET DEACTIVATED	PROXIMITY SENSOR SPEED START ROTATION START SAFETY OUTPUT 1 EDM* SAFETY OUTPUT 2 EDM* LEGACY Y1-Y2 (only CS AM3•) RESET DEACTIVATED

*if the module has 3NO relay outputs (CS AM•2 modules), there will be a single item for EDM called SAFETY OUTPUT EDM.

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The list of available functions depends on the safety functions assigned to the safety outputs. Assignment of a certain function implies that it will be enabled (e.g. setting I3 as "Speed Start" implies that the Speed safety function requires a Monitored Start signal on I3, as described in chapter 5.5.2). The exact function performed by the module thus depends both on configuration of the safety outputs and the inputs.

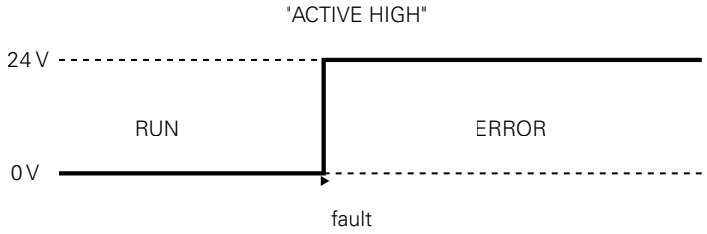
- Signalling outputs

Signalling outputs O3 and O4 can be configured with the following values:

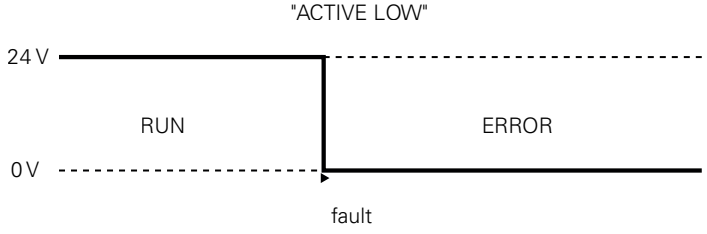
Module	Available functions for signalling outputs
CS AM1•	STANDSTILL OUT FAULT (ACTIVE HIGH) FAULT (ACTIVE LOW) DEACTIVATED
CS AM2•	SPEED OUT ROTATION OUT FAULT (ACTIVE HIGH) FAULT (ACTIVE LOW) DEACTIVATED
CS AM3•	STANDSTILL OUT SPEED OUT ROTATION OUT FAULT (ACTIVE HIGH) FAULT (ACTIVE LOW) DEACTIVATED

The list of values that can be selected depends on the safety functions assigned to the safety outputs. E.g., if a CS AM3• module is configured with OS1 assigned to the STANDSTILL function and OS2 assigned to the SPEED function, the options available for selecting the signalling outputs will not include ROTATION OUT, because the ROTATION safety function is not selected. Similarly, inclusion of the SPEED OUT option depends on selection of the SPEED, SPEED & ROTATION or DUAL SPEED function.

By setting the "FAULT (ACTIVE HIGH)" value, the signalling output will be deactivated when the module is in RUN or SET state and will be activated when the module enters ERROR state.



By setting the "FAULT (ACTIVE LOW)" value, the signalling output will be active when the module is in RUN or SET state and will be deactivated when the module enters ERROR state.

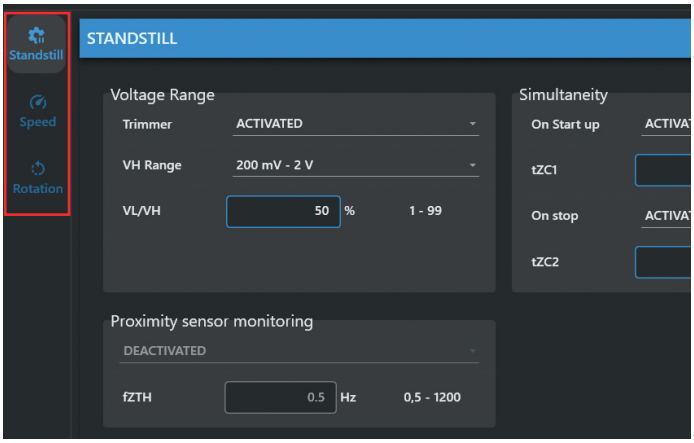


In POWER-ON state, the signal outputs O3 and O4 are always deactivated.

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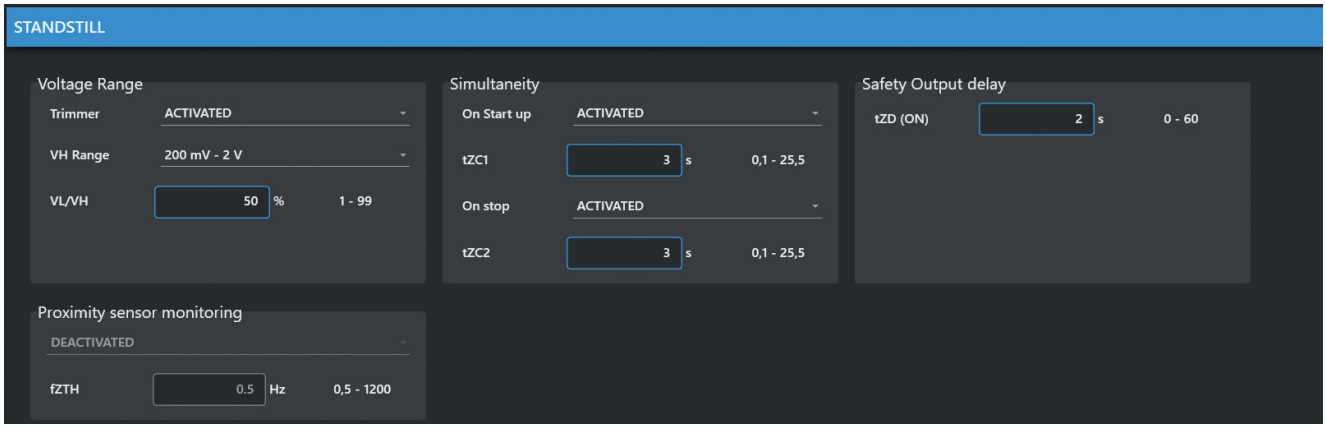
10.6.3 "Parameters" tab

To the left of the "Parameters" tab are three controls to access specific parameters for the Standstill, Speed and Rotation functions.



10.6.3.1 Standstill

The "Standstill" section features all parameters for configuration of the safety function for motor standstill monitoring **SF1**:



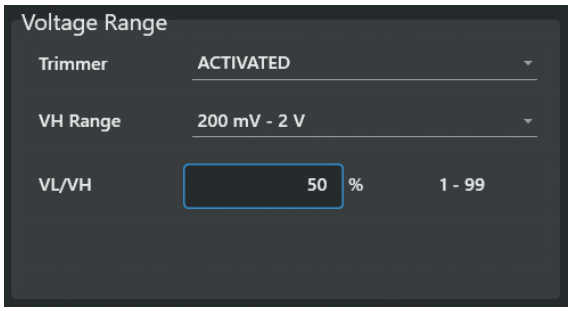
- Voltage Range

The "Voltage Range" field contains settings regarding the residual voltage threshold for the motor standstill monitoring function. First of all, it is possible to enable and disable the trimmer on the front panel of the module.

The voltage-range parameters are V_L and V_H, which refer to:

- V_L the lower voltage threshold, below which the module considers the motor to be at a standstill
- V_H the upper voltage threshold, above which the module considers the motor to be turning.

If the trimmer is enabled ("ACTIVATED"), it will be possible to set the range for the threshold value V_H using the parameter "VH Range".



The exact V_H threshold value can be selected using the trimmer, in 10 steps, as described in chapter 5.2.

The threshold value V_L can be set indirectly by entering a percentage in relation to the value V_H, ranging from 1% to 99% (V_L/V_H). The minimum value for the parameter V_L is 20 mV. The software checks that

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this condition is met and adjusts the ratio, if required, to reach a correct combination of parameters.

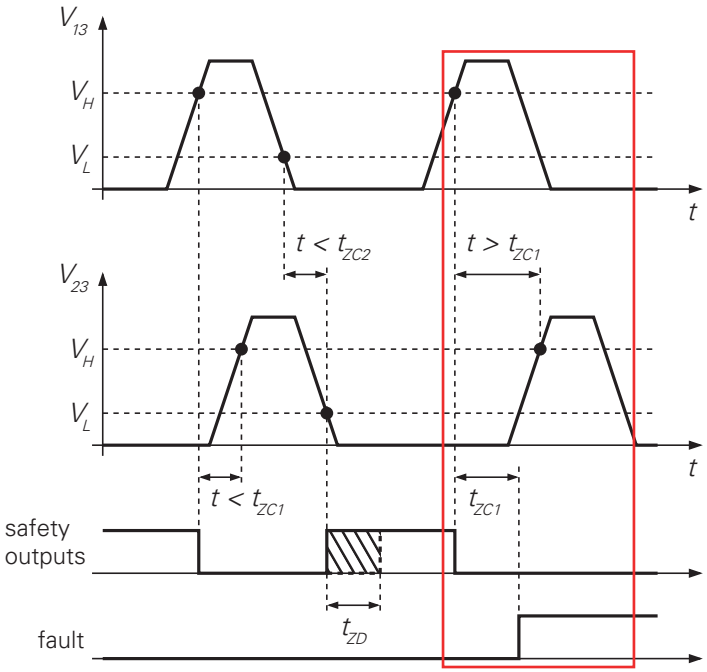
Here are some examples of threshold settings:

V_H (trimmer)	V_L / V_H	V_L calculated
200 mV	50%	100 mV
150 mV	75%	112.5 mV
75 mV	40%	30 mV

The firmware of CS AM modules manages values expressed in mV, therefore decimals will be rounded to the nearest whole number.

- Simultaneity





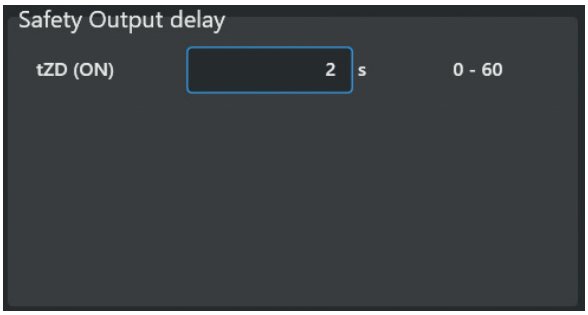
The detection of the motor standstill is achieved by measuring the residual voltage generated by the rotating motor on two windings. The module is capable of detecting the simultaneity of the phase crossings through one of the two thresholds. The parameters to configure the simultaneity controls are presented within the "Simultaneity" section, at motor start-up ("On Start Up") or motor stop ("On Stop"):

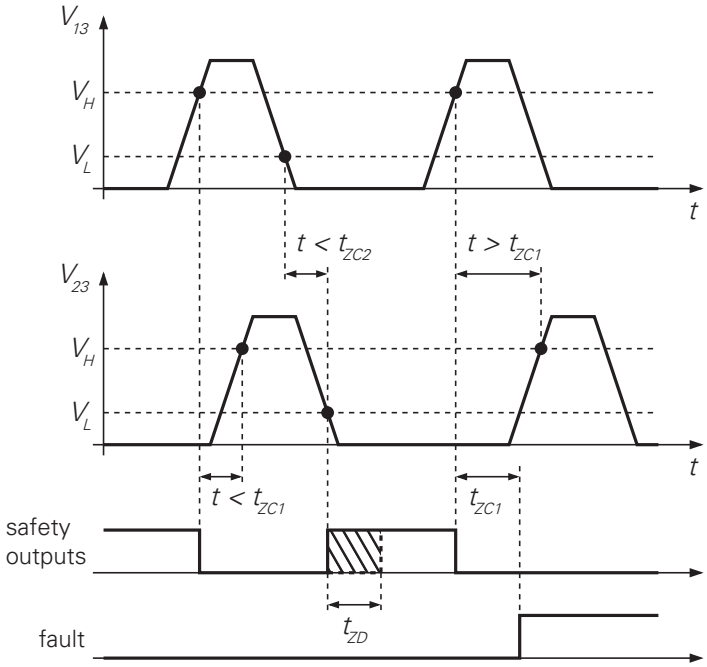
- During start-up of the motor ("On Start up"), it will check that the two phases exceed the threshold V_H within a set time period t_{ZC1}
- During motor stop ("On stop"), it will check that the two phases fall below the threshold V_L within a set time period t_{ZC2}

The simultaneity times can be set. The maximum achievable safety levels indicated in chapter 13.2 are to be considered with these diagnostics active.

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- Safety Output delay



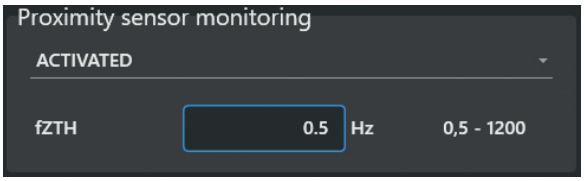


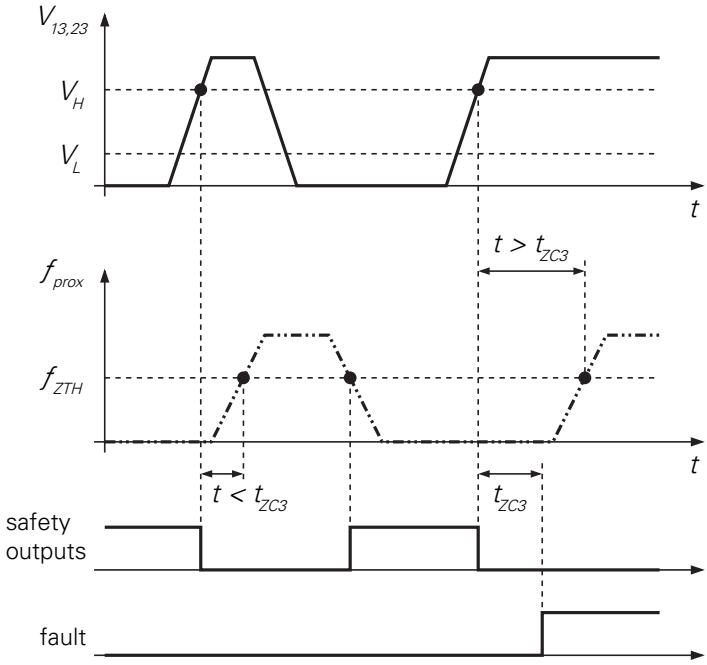
Activation of Standstill safety outputs can be delayed using the parameter t_{ZD}, which represents the activation delay time (which can be set between 0 and 60 seconds).

This delay is useful to filter switching of safety outputs when the voltage values measured are not very stable due, for example, to electromagnetic disturbances. During the motor stopping phase, if the voltage value falls below the threshold V_L for a period shorter than t_{ZD}, the safety outputs will remain deactivated. To activate the safety outputs, the voltage value measured must remain below the threshold V_L for a period longer than t_{ZD}. For calculation of the overall reaction time, refer to chapter 13.4.

Motor standstill monitoring is performed by measuring, on two windings, the residual voltage generated by the rotating motor. It is possible to increase fault diagnostics for this safety function, by enabling phase simultaneity checking, on start-up of the motor ("On Start Up") or when the motor is stopped ("On Stop"). The numerical parameter represents time.

- Proximity sensor monitoring





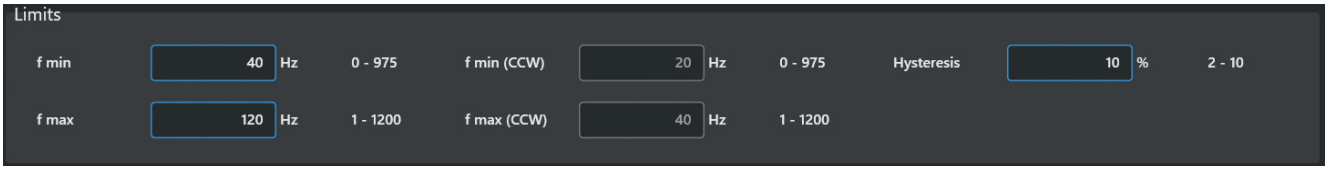
If the proximity sensor has been enabled on input I4 (see chapter 10.6.2.1), the section "Proximity sensor monitoring" will be editable and the diagnostics function described in chapter 5.4.2 can be activated and the parameter f_{ZTH} set.

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10.6.3.2 Speed

The "Speed" section features all parameters for configuration of the safety function **SF2** for motor rotation-speed detection:

- Limits

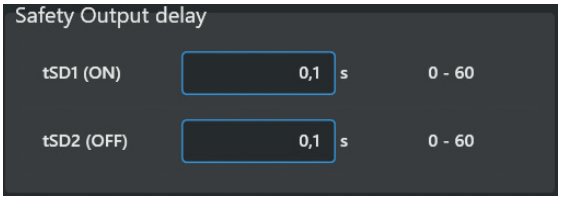


In the "Limits" section, the user can enter frequency values for the speed-check thresholds, and the hysteresis value as a percentage.

In particular:

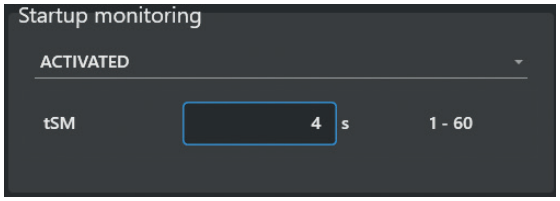
- f min is the minimum frequency value of the range. If the DUAL SPEED safety function is enabled, this value refers to clockwise rotation.
- f max is the maximum frequency value of the range. If the DUAL SPEED safety function is enabled, this value refers to clockwise rotation.
- f min (CCW) is enabled only in case of use of the DUAL SPEED safety function. This is the minimum frequency value with reference to anti-clockwise rotation.
- f max (CCW) is enabled only in case of use of the DUAL SPEED safety function. This is the maximum frequency value with reference to anti-clockwise rotation.
- Hysteresis is the parameter that sets the value of hysteresis on the frequency limits set, expressed as a percentage between 2% and 10%.

- Safety Output delay



In this section, it is possible to set the delay for activation of the safety outputs t_{SD1} as well as the delay for deactivation of the safety outputs t_{SD2}. These parameters refer to the delays applied to the safety outputs associated with SPEED, SPEED & ROTATION and DUAL SPEED functions.

- Startup monitoring

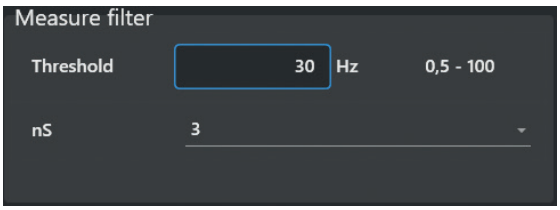


In this section, the user can activate the "Speed Startup monitoring" function and set the corresponding parameter t_{SM}.

If an input has been assigned to the Start function, the active function is "Speed Startup monitoring with Monitored Start", otherwise the active function is "Speed Startup monitoring with Automatic Start".

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- Measure filter



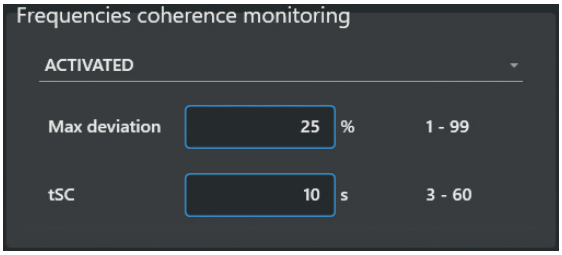
The measure filter allows users to set the frequency value f_S, above which n_S frequency measurement cycles will be required to confirm a change of state of the Speed function (e.g. passage from "IN-RANGE" to "UNDER" or "OVER" speed).

The filter enhances immunity to potential disturbances, thereby increasing the measurement robustness.

The parameter n_S can be set to values between 1 and 5. This value affects the reaction time of the module. Specifically:

- the lower the value n_S, the lower the reaction time of the module, and measurement will be more sensitive to external factors
- the higher the value n_S, the higher the reaction time of the module, and measurement will be more robust and less susceptible to external factors.

- Frequencies coherence monitoring



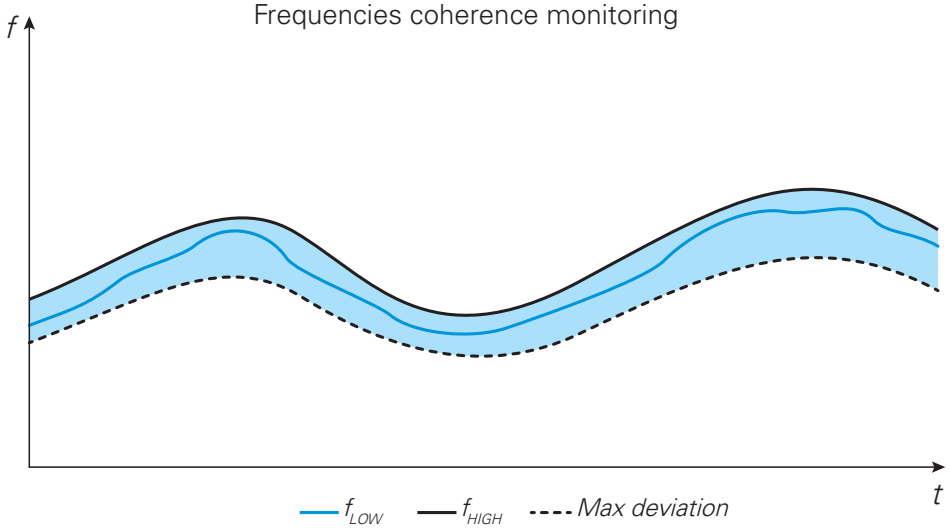
This monitoring function allows users to evaluate the coherence of the two frequency values measured between L1-L3 and between L2-L3, respectively.

The "Max deviation" parameter is expressed as a percentage and represents the maximum difference permissible between the two values measured. It is calculated as follows:

the module identifies the greater of the two frequency values measured for the two channels f_{HIGH} and compares it with the lower value f_{LOW}, so that:

$$f_{LOW} < f_{HIGH} - (f_{HIGH} * Max\ deviation)$$

Frequencies coherence monitoring

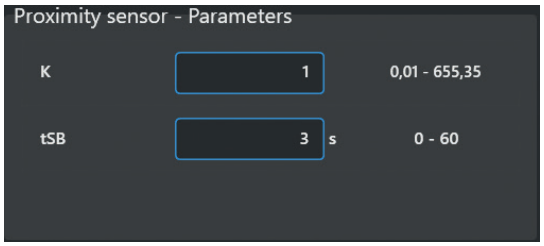


The parameter t_{SC} defines the maximum acceptable time for incoherence.

If the two frequency values measured differ by more than the "Max deviation" for a period longer than t_{SC} the module enters ERROR state triggering the corresponding LED signalling.

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- Proximity sensor - Parameters



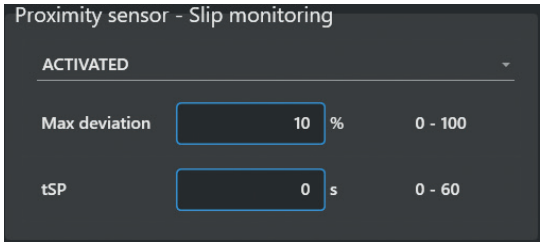
Enabling input I4 of the module for connection of a proximity sensor makes it possible to monitor the frequency generated by the sensor positioned on a tone wheel downstream of a kinematic chain (e.g. a belt or chain).

Parameter "K" represents the conversion factor between the frequency detected by the proximity sensor and the real rotation frequency of the motor, taking into account any speed-reducing ratios and gears:

$$f_{prox} = K * f_{13,23}$$

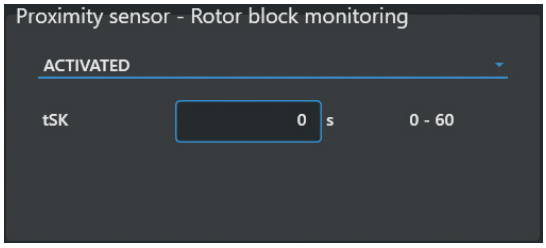
Parameter t_{SB} represents the time that passes between the moment of detection of the condition $f_{prox} \neq 0$ and the moment in which the module begins to evaluate the value of f_{prox} and compare it with $f_{13,23}$ appropriately corrected with factor K.

- Proximity sensor - Slip monitoring



Through this check, it is possible to enable the function described in chapter 5.5.5 and define the corresponding parameters t_{SP} and "Max deviation" (S_{max}).

- Proximity sensor - Rotor block monitoring



Through this check, it is possible to enable the function described in chapter 5.5.6 and define the corresponding parameter t_{SK}.

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- Determination of factor K

In the case of belt transmission, for example, the transmission ratio is referred to as:

$$i = \frac{r''}{r'}$$

where *r'* and *r"* are the radii of the driving pulley and the driven pulley, respectively.

The rotation speed (rpm) of the motor M connected to the driving pulley is equal to:

$$v' = 60 * \frac{f_{13,23}}{p}$$

where p is the number of pole pairs of the motor.

The rotation speed (rpm) of shaft A connected to the driven pulley is equal to:

$$v'' = i * v'$$

Considering N as the number of teeth/holes in the tone wheel, the frequency measured by the proximity sensor is equal to:

$$f_{prox} = \frac{v'' * N}{60}$$

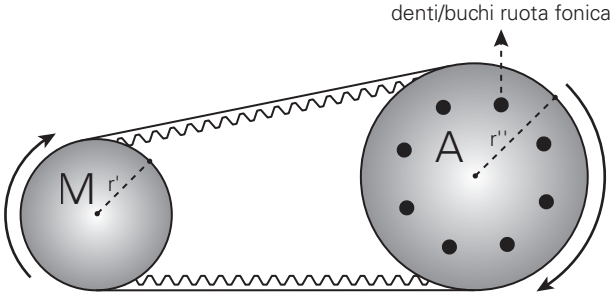
Therefore, the relationship between the frequencies is:

$$f_{prox} = i * \cancel{60} * \frac{f_{13,23}}{p} * \frac{N}{\cancel{60}} = \frac{i * N}{p} * f_{13,23}$$

therefore, factor K is equal to:

$$K = \frac{i * N}{p}$$

Below is an example of the calculation of factor K:



Data
r' = 20 cm
r'' = 30 cm
i = 30⁄20 = 1.5
p = 2
N = 8
v' = 1200 rpm

Calculation of factor K

$$K = \frac{i * N}{p} = \frac{1{,}5 * 8}{2} = 6$$

$$f_{13,23} = \frac{v' * p}{60} = \frac{1200 * 2}{60} = 40\ Hz$$

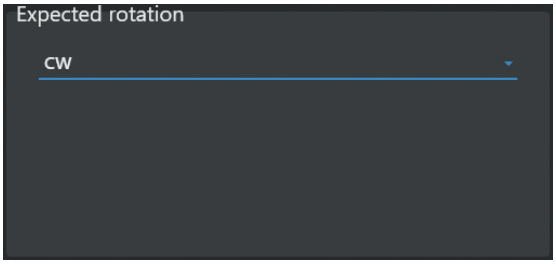
$$f_{prox} = K * f_{13,23} = 6 * 40 = 240\ Hz$$

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10.6.3.3 Rotation

If one of the functions including determination of the direction of rotation (ROTATION, SPEED & ROTATION or DUAL SPEED) has been enabled in the section I/O CONFIGURATION, it will be possible to modify the parameters in the ROTATION section.

- Expected rotation



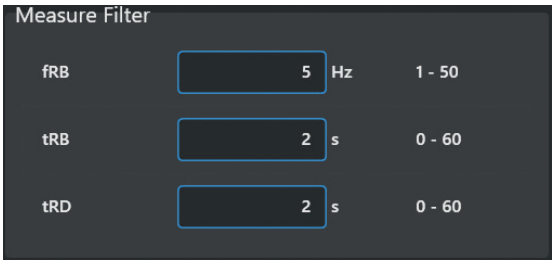
With the parameter "Expected rotation", the user can set the expected direction of rotation.

With the ROTATION safety function, if the motor rotates in the expected direction of rotation, the safety outputs will be activated.

With the SPEED & ROTATION safety function, if the motor rotates in the expected direction of rotation and the rotation speed is within the set range, the safety outputs will be activated.

With the DUAL SPEED safety function, the parameter does not need to be set because it is not used.

- Measure Filter



With the measure filter in the Rotation section, the user can optimise detection of the direction of rotation.

During motor start-up, the parameters f_{RB} and t_{RB} represent, respectively, the frequency value and time period below which the direction of rotation is not evaluated and it is assumed that the direction of rotation is the expected one (motor start-up). The direction of rotation is therefore evaluated if the frequency measured is greater than f_{RB} and the time period t_{RB} has elapsed.

The parameter t_{RD} introduces a time filter for detecting a new direction of rotation. Therefore, if a new direction of rotation is detected, a waiting time of t_{RD} is applied before confirming it and consequently setting the state of the connected safety outputs.

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10.6.4 "Diagnosis" tab

The "Diagnosis" tab enables module data to be viewed in real time. It consists of two sections: "Monitor" and "Module data". The former provides a real-time graphic representation of the measurements performed by the module in relation to the configured safety functions. The "Module data" section displays various module data.

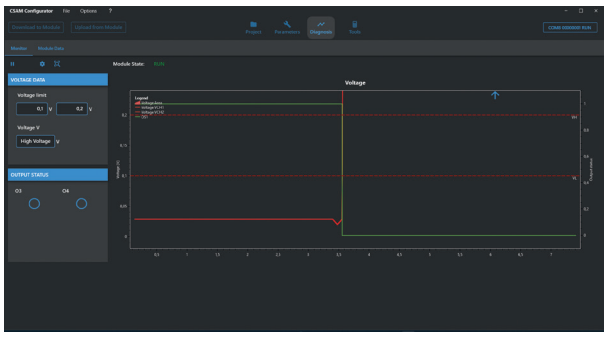
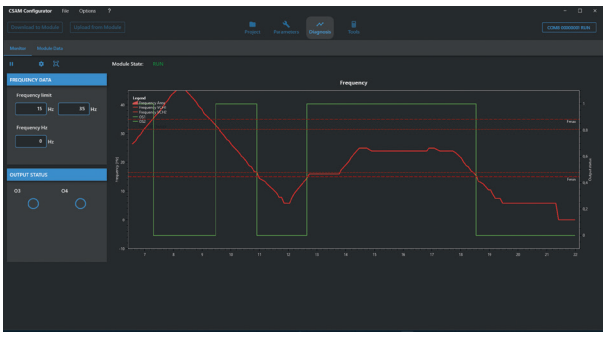
10.6.4.1 Monitor



In the "Monitor" section, on the left are displayed the threshold values and the actual voltage and frequency value measured in real time, in relation to the safety functions enabled.

The voltage value measured is indicated in numerical form for values below 2.5 V. If the value measured is greater than 2.5 V, "High Voltage" is indicated in the corresponding field.

If only the STANDSTILL function or only the SPEED function is enabled, only the relevant data will be displayed:

Monitor STANDSTILL	Monitor SPEED
	

The graphs represent the measurement values in relation to time (red lines), the threshold values (dotted red lines), and the state of safety outputs (green lines).

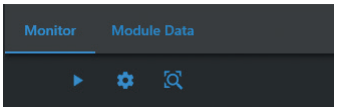
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The section on the left shows the threshold values set (A) and the values in real time of the variables measured in relation to the safety functions configured (B). The states of the signalling outputs O3 and O4 (C) are also given.



Using the controls at the top left, it is possible to:

- stop updating the graph;
- change the graph appearance by selecting the series of data to be displayed and adjusting the range of the time window to be displayed;
- reset the zoom applied to the view.



10.6.4.2 Module data

The "Module data" section displays certain data regarding the module connected, specifically:

- Name of project uploaded
- Digital signature
- Module type
- Firmware version
- Module's internal temperature
- Module supply voltage

10.6.5 "Tools" tab

The "Tools" tab contains a calculation tool providing access to frequency values of the rotating field, starting from the values for:

- Shaft type (linear, rotating, spindle)
- Number of pole pairs (p)
- Transmission ratio (i)
- Radius (r)
- Rotation (s)
- Maximum speed (Vmax)
- Minimum speed (Vmin)

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- Linear shaft

Calculation of the frequency for a linear shaft uses the following formula:

$$f = \frac{V * p * i * 1000}{60 * S}$$

where V is expressed in m/min and S in mm.

The parameter S represents the total progress of the linear actuator per screw revolution.

- Rotating shaft

Calculation of the frequency for a rotating shaft uses the following formula:

$$f = \frac{V * p * i * 1000}{60 * 2\pi r}$$

where V is expressed in m/min and r in mm.

- Spindle

Calculation of the frequency for a spindle uses the following formula:

$$f = \frac{V * p * i}{60}$$

where V is expressed in rpm.

10.7 Project validation

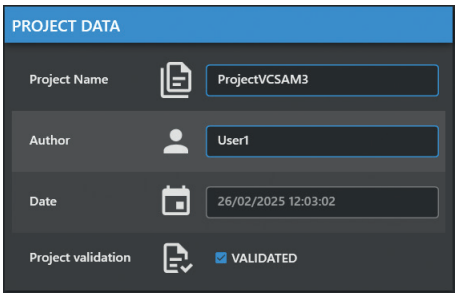
Project validation formally concludes the configuration design cycle. For this reason, validation should be carried out by another user, different from the one who created the configuration. Formal validation includes, and requires, that a configuration check has been carried out through tests in the final application, to confirm its correctness.

Validation is closely linked to the digital signature of the project. The digital signature uniquely represents the configuration project, and consequently it changes every time changes are made to the configuration itself.

To proceed with project validation, follow the steps described in chapter 10.8.4, where it is indicated how to transfer the configuration from the computer to the connected module.

The validation procedure involves the generation and saving of the Configuration Report document in PDF format (see chapter 10.10).

If the project has been validated, the PROJECT DATA section in the Project screen will be updated accordingly, indicating the validation in the Project validation field.



When the CS AM module is configured with a validated project, the validation information is transferred into the module, and will therefore be visible when importing values from the module (see chapter 10.8.3).

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10.8 Module configuration

Configuration of a module requires the module to be connected and linked to the software.

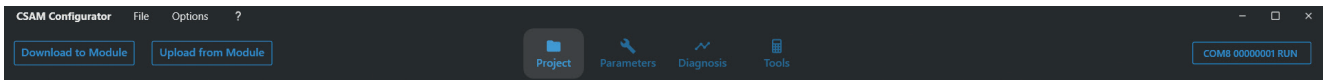
10.8.1 Connecting the module from the home screen

Connect the module to the CS AM Configurator software from the home screen (on launching the software or via the menu File ➔ New).

On the right of the screen, there is a list of connected modules (click on Update if necessary). Once the module has been selected from the list, click on the button Select Module.

A new project screen will open, compatible with the connected module version.

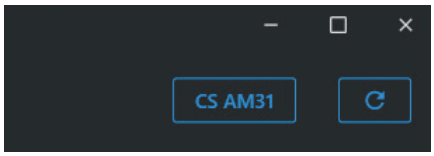
Connection of the module is indicated by the presence of the buttons Download to Module, Upload from Module and, on the right, a field indicating the state of the connected module.



Parameters in the new project have default values.

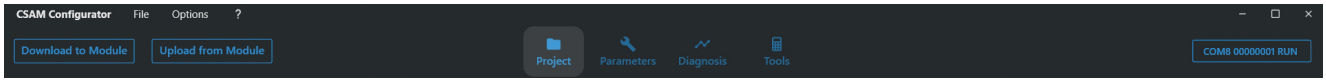
10.8.2 Connecting the module from an open project

To connect the module with an open project, simply click on the button located at the top right with a circular arrow icon:



If the module connected to the USB-C port is compatible with the open project, the connection will be established.

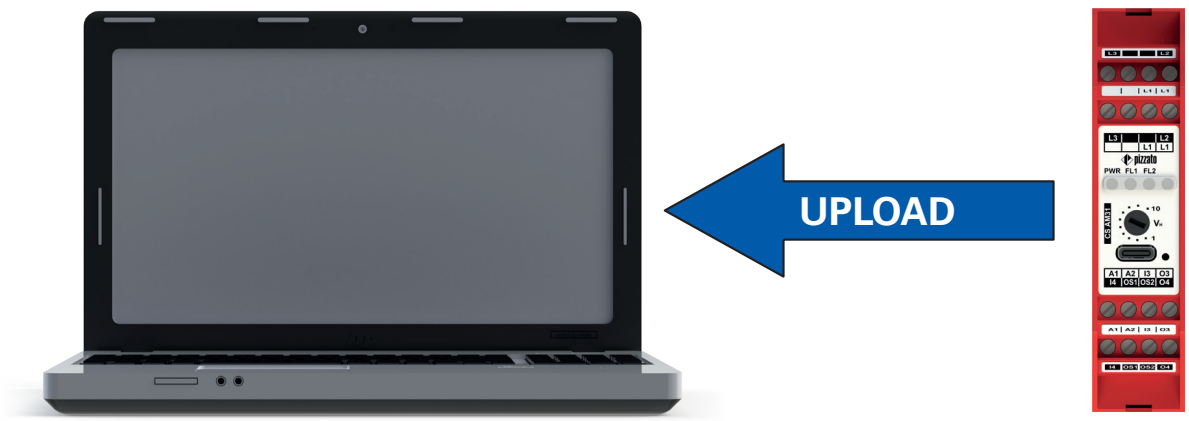
Connection of the module is indicated by the presence of the buttons Download to Module, Upload from Module and, on the right, a field indicating the state of the connected module.



If the module connected to the USB-C port is not compatible with the open project, the connection will not be established and a message will appear indicating that no compatible connected module has been found.

10.8.3 Importing configuration values from a module

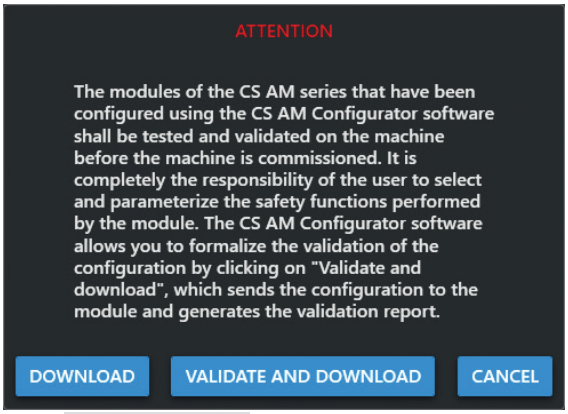
By clicking the Upload from Module button, the parameter values stored on the connected module can be read and imported into the project.



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10.8.4 Configuring the module with the values of the current project

By clicking the Download to Module button, the connected module can be configured with the parameter values from the open project.



Upon clicking the button, a warning window appears, reminding the user of the importance of performing validation tests (see chapter 3.6). In particular, all modules of the CS AM series configured using the CS AM Configurator software must be tested and validated on the application before the machine is put into service. Testing and validation must also be repeated after any modification of the machine's safety configuration, whether the modification occurs in the module's configuration or in the "hardware" part of the machine.

The DOWNLOAD button allows you to proceed with the configuration of the connected module, while the VALIDATE AND DOWNLOAD button allows you to formally validate the current configuration and proceed with the configuration of the connected module. The validation process involves the generation and saving of the Configuration Report document in PDF format.

Once the configuration procedure is complete, the module will automatically restart, therefore performing self-testing on start-up as described in chapter 5.3.



10.8.5 Saving the current project

The current project can be saved locally using the command in the menu File ➔ Save or File ➔ Save as. A file with the extension "*.pzzam" will be created containing all values of the configuration parameters.

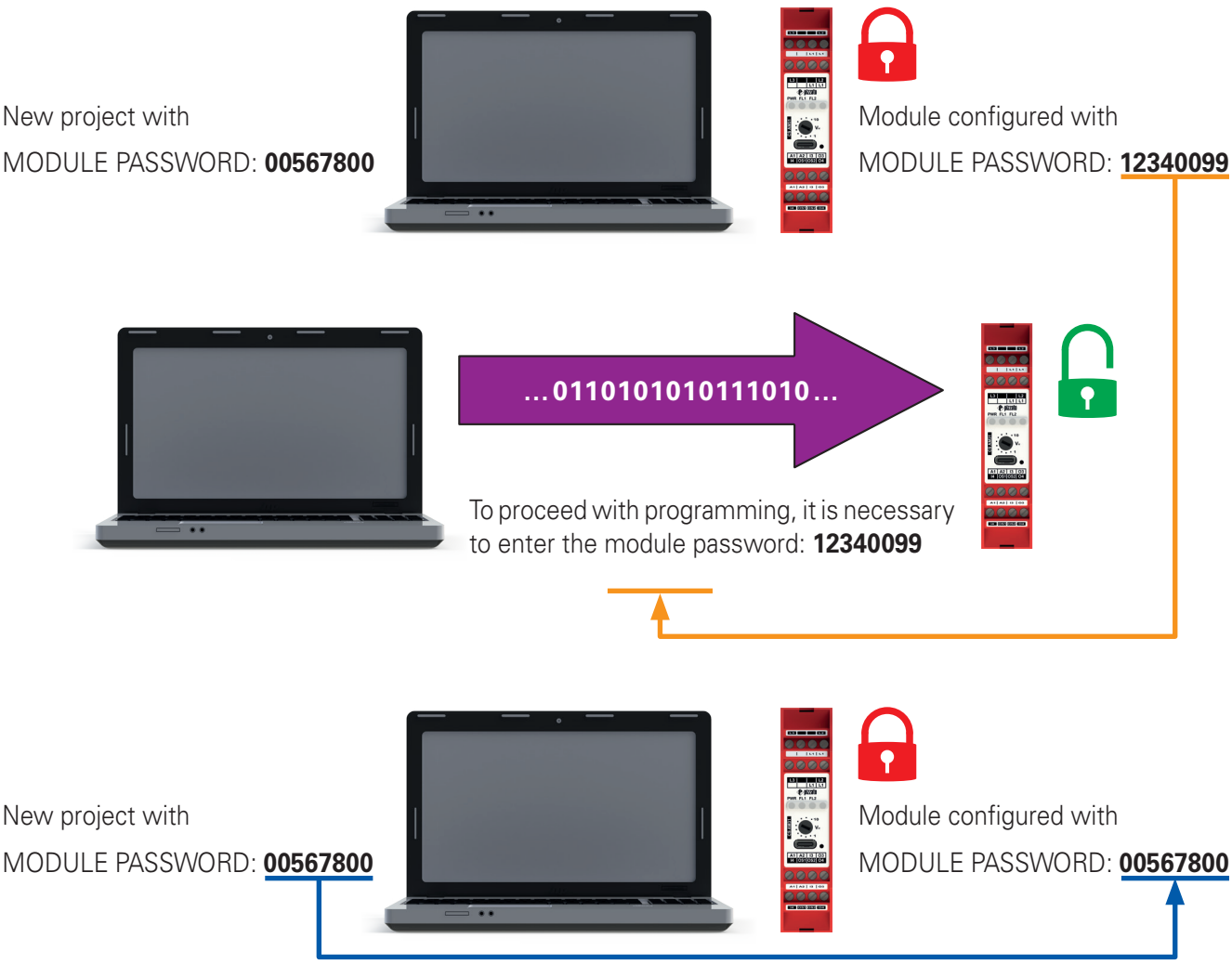
Each project is associated with the specific model of CS AM module. If the model of the module associated to the project is different from the model connected, it is not possible to proceed with configuration. The user must therefore create a new project associated to the same model of module connected.

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10.9 Password management

On the "Project" tab, in the section "MODULE PASSWORD", the user can enter a password to protect the module from further changes. The password entered in this field is associated with the project and will be transferred to the module during the configuration procedure.

If the user wishes to re-configure a module that has already been configured in the past and which is password-protected, the password protecting the module must be entered in order to configure it with a new project. If the new project contains a new password, once the procedure for configuring the module is complete, the module will be protected by the new password.



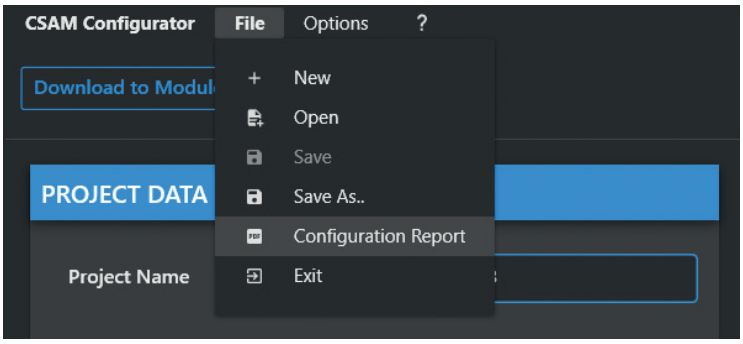
The password must be at least 8 characters.

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10.10 Generating reports

Configuration of the module is represented by a series of values associated with the various parameters. The CS AM Configurator software enables exporting of a document in PDF format containing all the values of configuration parameters, including that of the digital signature.

This document can be exported using the menu File ➔ Report PDF.



The Configuration Report is closely linked to the validation of the configuration that has been created. In fact, this document presents, in its final section, the date, name, and signature fields that allow the relevant manager to formally approve the document.

The configuration report is a very useful document for a complete overview of the values of module configuration parameters, particularly for inclusion in the technical file for the machinery.

11 SUPPORT

11.1 Website

This product line is supported online via the www.pizzato.com website, where you can:

- Download the CS AM Configurator installation package (following registration)
- Get the most up-to-date version of the instruction manual (this document)
- Get the most up-to-date version of the file that contains the list of modules available for purchase
- Get any other support information added

11.2 Technical support

Complementary technical support is currently available to users who have registered on the website.

Technical support is provided:

- by telephone at +039-0424-470930 in Italian and English
- by email at tech@pizzato.com in Italian and English

The information requested must be relevant to the functionality of the module. Consultancy service based on the client's application is not available.

Pizzato Elettrica reserves the right, at its sole discretion, to change the terms and conditions of service at any time.

12 MARKINGS

The outside of the device is provided with external marking positioned in a visible place. Marking includes:

- producer trademark
- product code
- firmware version
- serial number (S/N)
- batch number and date of manufacture. Example: CS1-123456 (A25). The last part refers to the month of manufacture (A = January, B = February, etc.) as well as the year of manufacture (25 = 2025, 26 = 2026, etc.)

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13 TECHNICAL DATA

13.1 Housing

Material:	Polyamide PA 66, self-extinguishing V0 acc. to UL 94
Protection degree:	IP40 (housing), IP20 (terminal strip)
Cable cross section:	0.2 … 2.5 mm^2 (24 … 12 AWG)
Terminal tightening torque:	0.5 … 0.6 Nm

13.2 General data

SIL	Suitable for applications up to "Maximum SIL 3" in accordance with IEC 62061:2021 and SIL3 in accordance with EN 61508:2010
Performance Level (PL)	Up to PL e acc. to EN ISO 13849-1:2023
Safety category	Up to cat. 4 acc. to EN ISO 13849-1:2023

Safety details based on the selected safety function:

Safety function	SIL	PL	Cat.	DC	PFH_D	$MTTF_D$
SF1	3	e	4	High	1.00E-09	70
SF2	3	e	4	High	1.00E-09	70
SF3	2	d	2	High	2.06E-08	67
SF2 + SF3 (speed and rotation)	2	d	2	High	2.06E-08	67
SF2 + SF3 (dual speed)	2	d	2	High	2.06E-08	67

Mission time:	20 years
Ambient temperature:	-25°C … +55°C
Storage temperature:	-25°C … +70°C
Mechanical endurance (CS AM•2, CS AM•3):	10 million operating cycles
Pollution degree:	External 3, internal 2
Impulse withstand voltage U_{imp}:	6 kV (L1, L2, L3 domain - SELV domain) 4 kV (phase-to-phase, relay contacts - SELV domain) 2.5 kV (relay contacts - relay contacts) 0.5 kV (SELV domain)
Rated insulation voltage U_i:	690 V (L1, L2, L3 domain - SELV domain, phase-to-phase) 250 V_{ac} (relay contacts - relay contacts, relay contacts - SELV domain) 50 V_{ac}/50 V_{dc} (SELV domain)
Overvoltage category:	II
Air and surface distances:	Acc. to EN IEC 60947-1

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13.3 Electrical data

13.3.1 Power supply electrical data

Rated operating voltage U_e:	24 V_{dc}
Supply voltage tolerance:	±15%
Operating current at U_e voltage (CS AM•1•••U):	
• Minimum:	80 mA
• With all outputs at maximum power:	800 mA
Operating current at U_e voltage (CS AM•2•••U):	
• Minimum:	80 mA
• With relay at inrush current and signalling outputs active:	450 mA
• With relay in holding state and signalling outputs active:	380 mA
Operating current at U_e voltage (CS AM•3•••U):	
• Minimum:	80 mA
• With relay at inrush current and signalling outputs active:	570 mA
• With relay in holding state and signalling outputs active:	430 mA
External protection fuse:	2 A type gG or equivalent device

13.3.2 Electrical data of measurement inputs L1-L2-L3

Voltage between terminals L1-L2-L3:	0 … 690 V_{ac}
Voltage between terminals L1-L2-L3 (CS AM2• and CS AM3•):	15 … 690 V_{ac}
Frequency (CS AM1•):	0 … 3 kHz
Fundamental frequency (CS AM2• and CS AM3•):	0.5 … 1200 Hz
Inverter minimum PMW (CS AM2• and CS AM3•):	Min. 2 kHz
Hysteresis on frequency signal (CS AM2• and CS AM3•):	Adjustable from 2% to 10%
Started-motor threshold voltage V_H:	
• With trimmer enabled:	40 … 500 mV, adjustable in 10 increments 200 … 2000 mV, adjustable in 10 increments
• With trimmer disabled (via software):	40 … 2000 mV, adjustable
Motor-standstill threshold voltage V_L	From 20 mV to 99% of V_H
Frequency measurement tolerance	±2%
Phase-shift threshold between f_{13} and f_{23} to establish the direction of rotation:	
• Clockwise rotation:	30° ÷ 90°
• Anti-clockwise rotation:	270° ÷ 330°
Input impedance:	> 1 MΩ

13.3.3 Electrical data of signalling inputs I3/I4

Rated operating voltage U_{e1}:	24 V_{dc}
Rated current consumption I_{e1}:	5 mA
Proximity sensor frequency (I4):	0.5 … 5000 Hz
Frequency detection accuracy (I4):	±2%
Resolution (I4):	0.1 Hz
Duration of Start impulse t_I:	200 ms ÷ 10 s
Duration of Reset impulse t_{RESET}:	> 100 ms

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13.3.4 Electrical data of safety outputs OS1/OS2 (CS AM•1)

Rated operating voltage U_{e2}:	24 V_{dc}
Output type:	PNP type OSSD
Maximum current per output I_{e2}:	0.25 A
Minimum current per output I_{m2}:	0.5 mA
Thermal current I_{th2}:	0.25 A
Utilization category:	DC-13; U_{e2} = 24 V_{dc}, I_{e2} = 0.25 A
Short circuit detection:	Yes
Overcurrent protection:	Yes
Overvoltage protection:	Yes
Duration of the deactivation impulses at the safety outputs:	200 µs - 1 ms depending on capacitive load of the line
Permissible maximum capacitance between outputs:	< 1 µF
Permissible maximum capacitance between output and ground:	< 1 µF
Maximum EDM signal state change delay, t_{EDM}:	500 ms
Electrical endurance:	1 million operating cycles

13.3.5 Electrical data of O3/O4 signalling outputs

Rated operating voltage U_{e3}:	24 V_{dc}
Output type:	PNP
Maximum current per output I_{e3}:	0.1 A
Utilization category:	DC-13; U_{e3} = 24 V_{dc}, I_{e3} = 0.1 A
Short circuit detection:	No
Overvoltage protection:	Yes

13.3.6 Electrical data of safety relay outputs (CS AM•2 and CS AM•3)

Output contacts (CS AM•2):	3NO
Output contacts (CS AM•3):	3NO + 3NO
Contact type:	Forcibly guided acc. to EN 61810-3 (ex EN 50205)
Material of the contacts:	Silver alloy
Maximum switching voltage:	230/240 V_{ac}
Max. current per contact:	6 A
Conventional free air thermal current I_{th}:	6 A
Maximum sum of squared currents:	36 A^2
Minimum current:	10 mA
Contact resistance:	≤ 100 mΩ, with 1 A, 24 V_{dc}
External protection fuse:	4 A type gG
Maximum switching load per branch:	2000 VA Maximum breaking capacity AC
Electrical endurance:	> 100,000 operating cycles
Utilization categories acc. to EN 60947-5-1:	
- AC-15 (50 ... 60 Hz):	3 A, 250 V_{ac}
- DC-13 (6 op. cycles/minute):	3 A, 24 V_{dc}
Utilization category acc. to UL 508:	R300, B300
Maximum EDM signal state change delay, t_{EDM}:	500 ms

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13.4 Safety-output response times

Safety-output response time	Activation	Deactivation
Motor standstill monitoring (**SF1**) (in relation to the instant in which the voltage falls below the threshold V_L [activation] or above the threshold V_H [deactivation] for both channels)	$t_{ZA} + t_{ZD}$	t_{ZR1}
Rotation speed monitoring (**SF2**)	$t_{SA}+(n_S+1)\,T+t_{SD1}+t_{\alpha}$	$t_{SR1}+(n_S+1)\,T+t_{SD2}$
Motor direction of rotation (**SF3**)	$t_{RA}+3\,T+t_{RD}+t_{\alpha}$	$t_{RR1}+3\,T+t_{RD}$
Release time in absence of power supply	t_R	
Duration of self-test	3 s	

Where:

Safety function	Parameters	CS AM•1	CS AM•2 and CS AM•3
SF1	t_{ZA}	< 100 ms	< 120 ms
	t_{ZR1}	< 40 ms	< 60 ms
	t_{ZD}	Delayed activation of safety outputs (time configurable).	
SF2	t_{SA}	< 30 ms	< 50 ms
	t_{SR1}	< 50 ms	< 60 ms
	t_{SD1}	Delayed activation of safety outputs (time configurable).	
	t_{SD2}	Delayed deactivation of safety outputs (time configurable).	
	n_S	Number of measurements necessary (configurable parameter) to permit a change in state above a certain frequency value (f_S).	
SF3	t_{RA}	< 30 ms	< 50 ms
	t_{RR1}	< 50 ms	< 60 ms
	t_{RD}	Delayed activation/deactivation of safety outputs (time configurable).	
SF2/SF3	T	Input phase period at the evaluation instant. If $T \leq 5.3$ ms it should be considered as equal to 5.3 ms	
	t_{α}	Time difference between voltages V_{13} and V_{23}	
All	t_R	< 20 ms	< 40 ms

13.5 In compliance with standards

EN 60204-1, EN ISO 14118, EN ISO 12100, EN 60529, EN IEC 61000-6-2, EN IEC 61000-6-3, EN IEC 61326-1, EN IEC 60664-1, EN IEC 60947-1, EN IEC 63000, EN ISO 13849-1, EN ISO 13849-2, EN IEC 62061, UL 508, CSA C22.2 No. 14, GB/T14048.5-2017

13.6 In compliance with Directives

Machinery Directive 2006/42/EC
EMC Directive 2014/30/EU
RoHS Directive 2011/65/EU

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14 SPECIAL VERSIONS ON REQUEST

Special versions of the device are available on request.

The special versions may differ substantially from the indications in this instruction sheet.

The installer must ensure that he or she has received written information from the support service regarding installation and use of the specific version requested.

15 DISPOSAL



At the end of its service life, the product must be disposed of properly, according to the rules in force in the country in which the disposal takes place.

16 SUPPORT

The device can be used for safeguarding people's physical safety, therefore in case of any doubt concerning installation or operation methods, always contact our technical support service:

Pizzato Elettrica Srl

Via Torino, 1 - 36063 Marostica (VI) - ITALY

Telephone +39.0424.470.930

E-mail tech@pizzato.com

www.pizzato.com

Our support service provides assistance in Italian and English.

17 EC DECLARATION OF CONFORMITY

I, the undersigned, as a representative of the following manufacturer:

Pizzato Elettrica Srl - Via Torino, 1 - 36063 Marostica (VI) - ITALY

Hereby declare that the product is in conformity with whatever prescribed by the 2006/42/EC Machine Directive. The complete version of the present conformity declaration is available on our website www.pizzato.com

Marco Pizzato

DISCLAIMER:

Subject to modifications without prior notice and errors excepted. The data given in this sheet are accurately checked and refer to typical mass production values. The device descriptions and its applications, the fields of application, the external control details, as well as information on installation and operation, are provided to the best of our knowledge. This does not in any way mean that the characteristics described may entail legal liabilities extending beyond the "General Terms of Sale", as stated in the Pizzato Elettrica general catalogue. Customers/users are not absolved from the obligation to read and understand our information and recommendations and pertinent technical standards, before using the products for their own purposes. Taking into account the great variety of applications and possible connections of the device, the examples and diagrams given in the present manual are to be considered as merely descriptive; the user is deemed responsible for checking that the specific application of the device complies with current standards. This document is a translation of the original instructions. In case of discrepancy between the present sheet and the original copy, the Italian version shall prevail. All rights to the contents of this publication are reserved in accordance with current legislation on the protection of intellectual property. The reproduction, publication, distribution and modification, total or partial, of all or part of the original material contained therein (including, but not limited to, texts, images, graphics), whether on paper or in electronic form, are expressly prohibited without written permission from Pizzato Elettrica Srl.

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