

SAFETY MANUAL FOR INVERTERS C350, C400 AND C700 SERIES

"Safe Torque Off"



Rowan Elettronica

Motori, azionamenti, accessori e servizi per l'automazione

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1 WARNINGS

This document describes the Safe Torque Off (STO) safety function of the Rowan inverters and is completion of the "Installation and Operation Manuals" of the C350, C400 and C700 series Rowan inverters.

The Safe Torque Off (STO) safety function is certified by Underwrites Laboratories (UL).

ROWAN ELETTRONICA s.r.l. declines all responsibility for any inaccuracies contained in this manual due to printing and/or transcription errors. It also reserves the right to make, at its own discretion and without notice, any changes it deems necessary for the best functioning of the product.

1.1 Description of the symbols used in this manual



Indicates that the subject to which it refers is related to an immediate or possible danger, failure to comply with what is described may result in death, serious injury or damage to property.



Indicates that the subject to which it refers indicates the presence of a dangerous voltage. Indicates that there are High Voltage conditions - or in any case dangerous levels - that can cause serious injury or death.

1.2 Important safety and risk assessment warnings



This document can only be used after reading and understanding the installation and operating manual of the inverter you want to use, with particular attention to the chapters: "GENERAL WARNINGS BEFORE INSTALLATION", "MECHANICAL INSTALLATION" and "ELECTRICAL INSTALLATION".

The Installation and User Manuals have the following codes: MANU.350S, MANU.400S and MANU.700S; they can be downloaded in pdf format from the website www.rowan.it in the DOWNLOAD section or be requested directly to Rowan Elettronica.



Do not use the safety functions of Rowan inverters unless you have read and understood all parts of this document.

Rowan recommends testing the safety function at regular intervals based on the outcome of the risk assessment.



Activation of the STO safety function causes the inverter's IGBT driver section to be disconnected from the power supply; if the function is activated, there is always dangerous voltage inside the inverter, at the inverter's power terminals (terminals L1, L2, L3, U, V, W, F, F+, -) and at the engine terminals: the electrical parts of the inverter and engine cannot be accessed.



The use and installation of Rowan inverters - especially in safety function systems - must be evaluated and followed by qualified personnel, with specific knowledge and skills regarding the installation, assembly, functional safety, operation and specificity of the PDS and PDS (SR) - Power Drive System Safety Related drives.



Incorrect use of safety related operations can result in uncontrolled PDS starts that can cause death or serious damage to people and property.



Improper use of the STO function or incorrect connection are responsibility of the user.



If, after activating the STO function, there is a possibility that personnel may be injured, inhibit access to the risk area until the PDS has completely stopped.



After activating the STO function, the engine is free to rotate; the inverter does not apply any electrical braking.

In general, depending on the application, a mechanical brake may be required. In particular, the STO function may not be used in the case of hanging loads (e.g. lifts, cranes, etc.) without mechanical brakes.



In the event of an anomaly or fault relating to the STO function, send the inverter to ROWAN ELETTRONICA Srl for the necessary repair work; any change by the user not specifically indicated by Rowan Elettronica Srl is prohibited.



In case of a voltage dip, the inverters inhibit the engine from running for the duration of the dip and restore it at the end of it; this behaviour must be taken into account for the purposes of managing the safety of the machine.



In the C350 series inverters, if parameter 100.9 POWER LOSS CONTROL is active (set to YES), when there is a voltage dip or no signal or a phase failure, the inverter, after inhibiting the engine from running for a few seconds, resumes control of the engine to brake it even if the connection is missing or disconnected.

This behaviour must be taken into account when managing the safety of the machine or of the system.

This particular function of the C350 inverter cannot and must not be considered as a functional safety function.

2 DEFINITIONS

Definitions are given in IEC 61800-5-1 and IEC 61800-5-2.

PDS (Power Drive System): electric drive, system for controlling the speed of an electric engine, including the CDM and the motor, but not the driven equipment (see fig.1).

PDS (SR) (power drive system - safety related): electric drive suitable for use in safety-related applications (see fig.2).

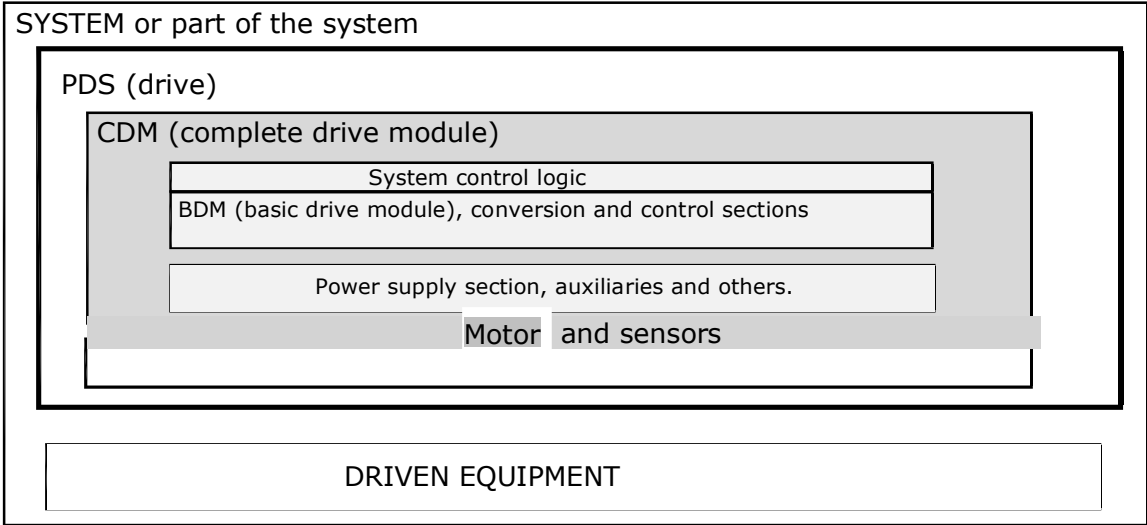


Fig.1: Physical configuration of a PDS in a system.

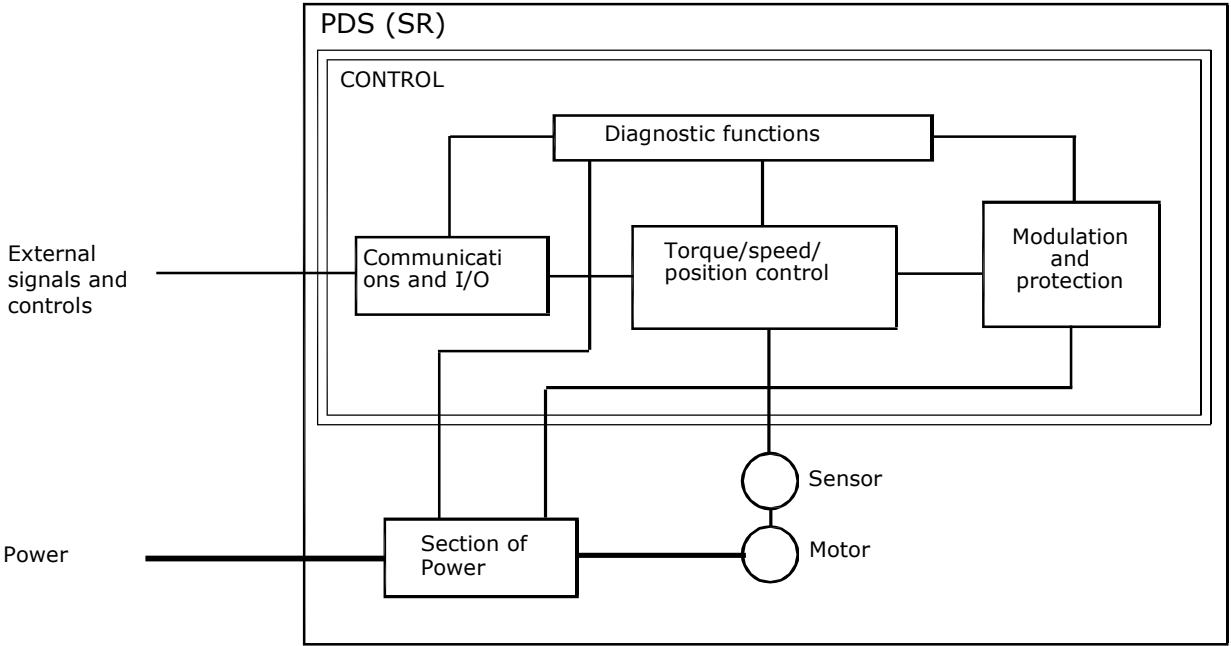


Fig.2: Functional elements of a PDS (SR).

3 THE STO SAFETY FUNCTION (Safe Torque Off)

Rowan inverters integrate the STO safety function, so that they can be used to create a PDS(SR).

The STO safety function is a function that allows you to implement an EMERGENCY RESPONSE with safe inhibition of engine torque, in which case the engine becomes free to rotate based on its own inertia and load (uncontrolled stop, in accordance with stop category 0 according to IEC 60204-1).

This function does not disconnect the machine from the mains.



If it is necessary to intervene on the electrical system of the PDS - i.e. on the inverter, the engine or the wiring - the entire PDS must absolutely be isolated from the power grid (See EN60204-1)

The STO function is defined in EN 61800-5-2 (2007) as follows:

The power supply, which may cause rotation (or movement in the case of a linear engine), is not applied to the engine. The PDS (SR) does not provide the engine with the power to generate a torque (or a force in the case of a linear motor).

Note 1: This function corresponds to an uncontrolled stop, which complies with stop category 0 according to IEC 60204-1.

Note 2: This safety function can be used when disconnection of the power supply to the power circuit is foreseen to avoid an unexpected start.

Note 3: In circumstances with external influences (e.g. falling suspended loads), additional measures (e.g. mechanical brakes) may be necessary to avoid hazards.

Note 4: The electronics and contactors are not suitable for protection against electrocution and additional insulation measures may be necessary.

Rowan inverters that integrate the STO function have a specific connector for joining the inverter to the safety device chosen to carry out the safety function of the system. For this description, see chapter 4 CONNECTIONS FOR THE STO SAFETY FUNCTION on page 7.

The STO safety function of the Rowan inverters is certified by UL (Underwrite Laboratories) and complies with the following standards with the following degrees of integrity and performance:

| | |
|----------------|------------------|
| EN 61800-5-2 | SIL Capability 3 |
| EN ISO 13849-1 | PL "e" |

4 CONNECTIONS FOR THE STO SAFETY FUNCTION

The inverters of the C350, C400 and C700 series, which integrate the STO safety function, have - on the terminal box panel - a terminal dedicated to the connection to the safety device that will activate the STO function.

The following describes the connection of the terminal only for the STO function, for all the other connections refer to the "Installation and Use Manual" of the inverter you are using.

The STO terminal consists of an extractable three-way terminal, the central way is NOT connected, the two external ways (STO1 and STO2) must be connected to the safety device that must provide with a NC contact (normally closed) with a capacity of at least 1.1A at 15Vdc. Opening this contact will activate the STO function.



Closing the contact between STO1 and STO2 guarantees power to the internal driver section of the inverter (the section that turns on IGBT), its opening removes power from the driver section and the inverter is no longer able to modulate an output voltage (turning off the IGBT). When STO function is active, dangerous voltage is present at the inverter power terminals (L1, L2, L3, U, V, W, F, F+, -).

Figure 3 shows a schematic diagram of how the STO function is obtained in Rowan inverters.

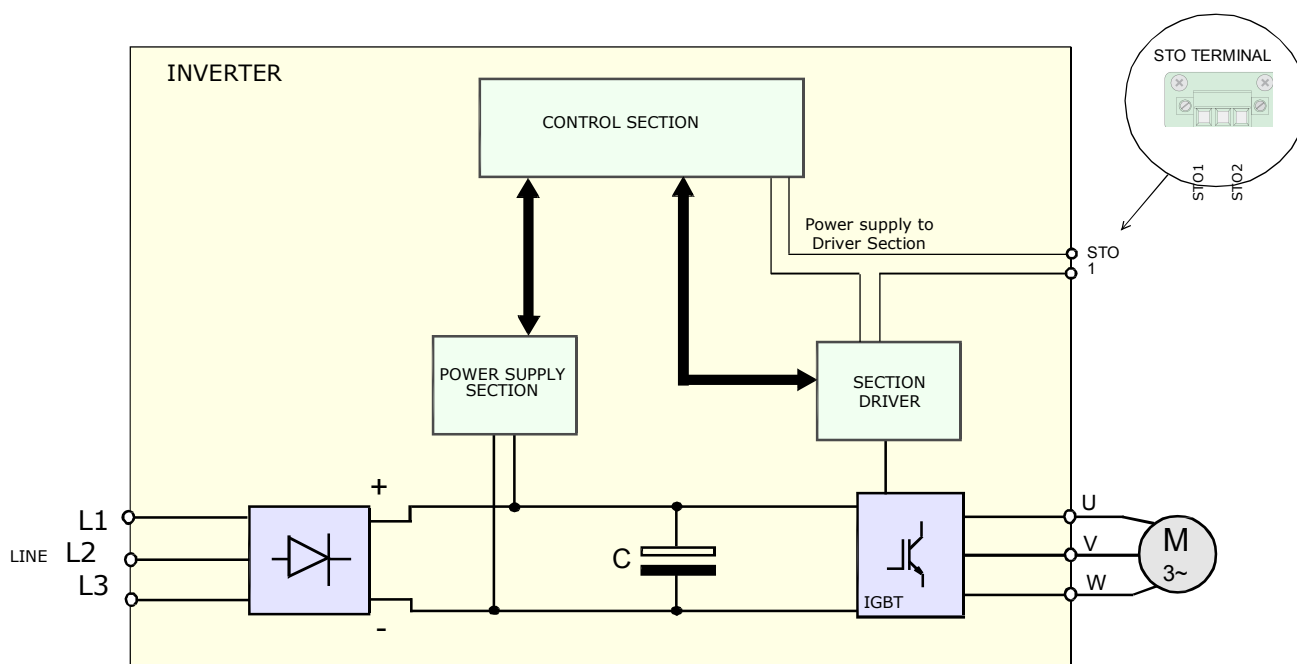


Fig.3: Inverter internal principle diagram for STO function management.

Rowan inverters with STO safety function leave the factory with terminals STO1 and STO2 bridged together to allow the inverter to operate even when the STO safety function is not used. To use the STO safety function, remove the connection jumper between STO1 and STO2 and connect the terminals to the safety device with section shielded bipolar cable of not less than 1mm² and a length of not more than 15m, the shielding must be connected to the ground. For an example of connection, refer to fig.6 of the following paragraph. The NC contact of the safety device must have a capacity of at least 1.1A at 15Vdc.

Figure 4 shows the position of the STO connector on the panels of the Rowan inverters.

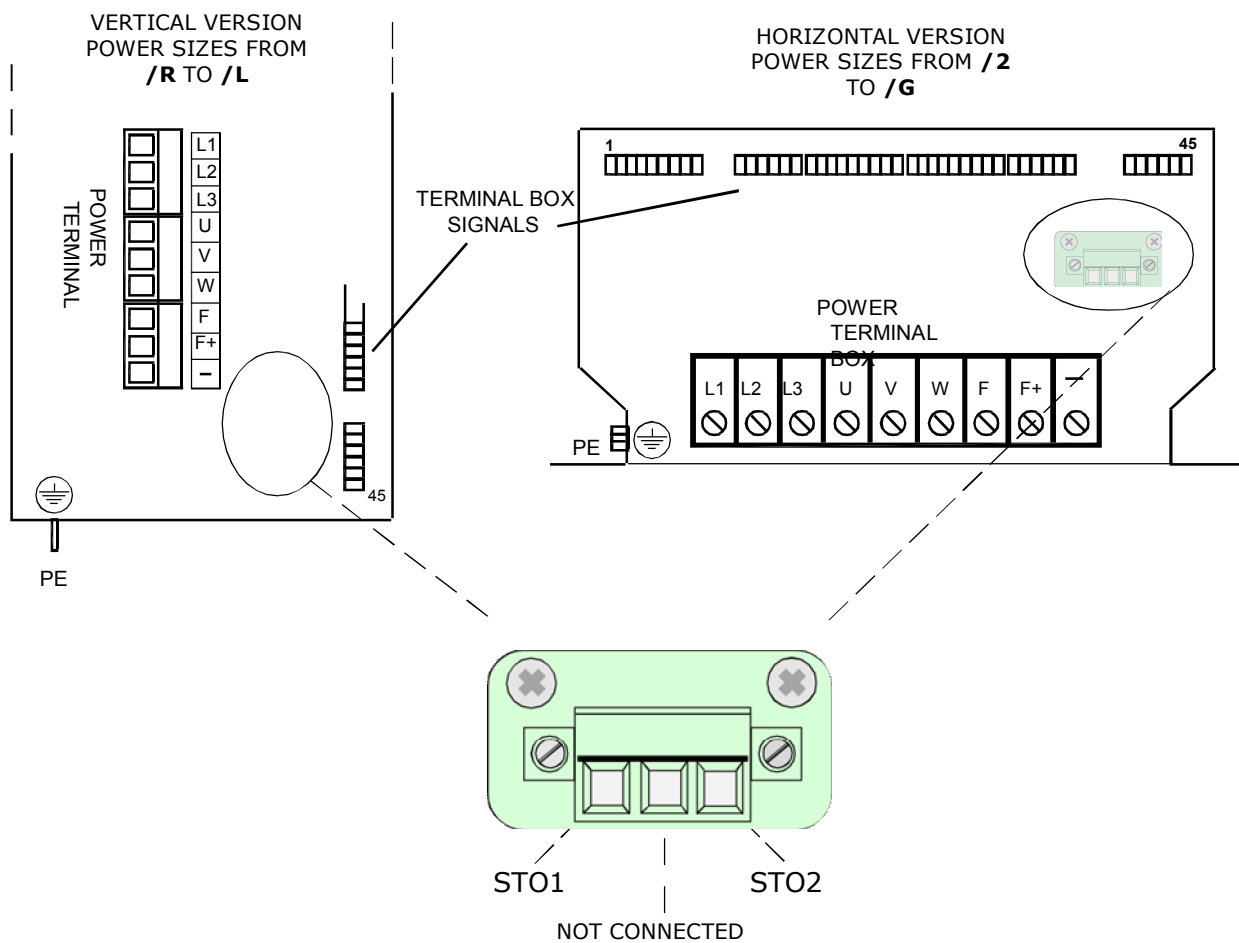


Fig.4: Terminals for the STO function on the inverter's black-and-white panels.

4.1 Example of connection to the security module

An example of how to connect the inverter to the safety system of a plant to implement an STO safety function is shown below.

The safety system uses a safety module (e.g. Pizzato cod. CS AR-01), a safety device consisting of a safety stop button with double contact hold-open device (e.g. Pizzato PE series) and a safety device consisting of a double contact switch (e.g. Pizzato FD 9 series) for controlling a movable guard.

With these devices and the following connection, the machine could reach safety level "SIL 3", "PL e" with safety category "cat.4".

Figure 6 below shows the wiring diagram for the connections for the STO safety function, the diagram is valid for the C350, C400 and C700 inverters.

Refer to the manuals/technical sheets of the individual modules and devices for connections not regarding STO, power supplies, assembly instructions and any other information. For inverters, refer to the Installation and User Manuals.

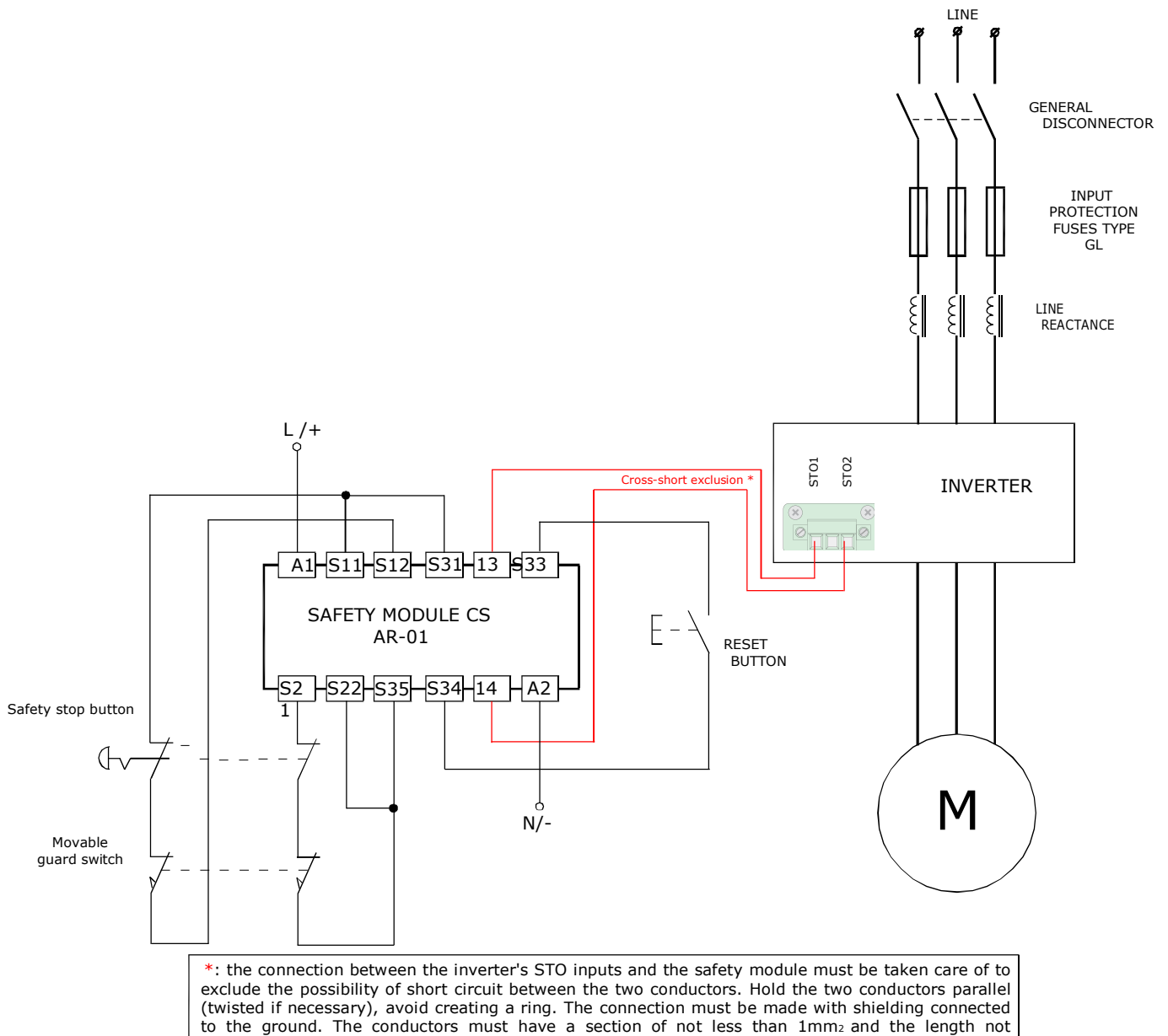


Fig.6: Wiring diagram for STO safety.

4.2 Latency and reset times of the STO function

The latency time of the STO function of the inverter is the time that elapses between the opening of the safety contact and the actual interruption of the PWM modulation to the IGBTs of the inverter, i.e. the shutdown of the IGBTs.



When the IGBT is switched off, dangerous voltage is still present on all power terminals of the inverter!

In Rowan inverters, the latency time does not exceed 10ms for all power sizes.

Figure 7 shows a graphic representation showing the engine speed - as a function of time - around the time when the STO safety function is activated.

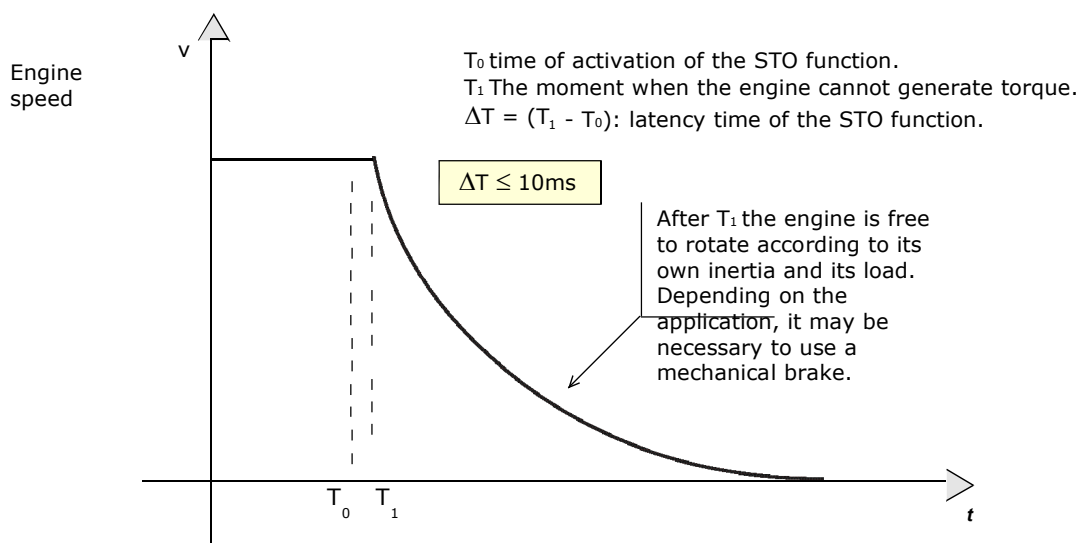


Fig.7: graphic example of $v(t)$ trend with STO request.

The reset time, i.e. the time elapsing between the reclosing of the STO safety contact and the actual PWM modulation at the IGBTs, depends on the system with which the plant controls the inverter and the functions active in the inverter (e.g. on-the-fly recovery).

The reclosing of the safety switch can guarantee - after a certain time - the PWM to the IGBTs if the run commands (RUN) have remained active.

Refer to the "Installation and Use Manuals" of the inverters and the following paragraph for the evaluation of the run-up times.

5 POWER FAILURE DETECTION IN THE DRIVER SECTION

The C350, C400 and C700 series inverters implement a power failure detection system at the inverter driver section; this interruption can also be achieved through a safety device or module. This detection system cannot be part of the safety concept of the machine in which it is used, the user can NOT consider it a fully-fledged system and useful for safety.

When the contact leading the power to the driver section is open, the inverter signals the event with an alarm as follows:

- the FAULT led starts flashing;
- in C350 inverters, alarm number 106 is reported in the variable "6.27 ALARM";
- in C400/C700 inverters, the variable "2.1.50 INVERTER ALARM" shows the string STO OPEN;
- if the gear (RUN) was active before, it is now inhibited.

When this contact is closed, the FAULT led stops flashing and after 2s the gear (RUN) returns active if the gear commands have remained active.

In any case, opening the contact brings to 1 the bit15 of STATUS OF PHYSICAL DIGITAL INPUTS in the C400 and C700 inverters, and the bit15 of var.6.22 DIG.INPUT I1..8 in the C350 inverter; closing the contact brings the bit15 to 0. The bit is readable in serial communication (with all available fieldbuses), as well as variables 6.27 and 2.1.50.

For more details, refer to the inverter Installation and User Manual.

6 INVERTER CODING SYSTEM WITH STO FUNCTION

Below there is a detailed description of the coding of the C350, C700 and C400 series inverters; for further details, please refer to the Installation and User Manuals of the inverters or to the catalogue (all documents available in the download section of www.rowan.it).

Coding system for C400 and C700 inverters

Code : **C400** **A** / **2** . **A** . **E** . **12** . **NN** . **NN** . **S**

I
II
III
IV
V
VI
VII
VIII
IX

- I. Inverters Series: **400** " Series 400 Inverters"; **700** " Series 700 Inverters".
- II. Active applications: A "Axis", R "Regulator", G "Gen-Afe", W "Winder", F "Die".
- III. Power size: R - 0 - 0M - 1 - L - 2 - 2,5 - 3 - 3,5 - 5 - 6 - 6,5 - 7 - 8 - 8,5 - 9 - A
- B - C - D - E - F - G.
- IV. Hardware Release.
- V. Power supply voltage (50/60Hz):
- for sizes /R to /3.5: D (220/240VAC), P (380/460VAC), M (220/240VAC single-phase).
- from size /5 to /G: D (220/240VAC), P (380/400/415VAC), O (440/460VAC), W (690VAC).
- VI. Signals encoders: 05 (5Vdc), 12 (12Vdc), 24 (24Vdc).
- VII. Expansion I/O board and FieldBus options.
- VIII. Customizations.
- IX. "STO" Security Function: N (inverter WITHOUT function), S (inverter WITH function).

Coding system for C350 inverters

Code : **C350** **S** / **2** . **A** . **E** . **N** . **NN** . **S**

I
II
III
IV
V
VI
VII
VIII

- I. Inverters Series: 350 "350 Series Inverter"
- II. Configuration: S "Standard", M "Single-phase Output".
- III. Power size: R - 0 - 0M - 1 - L - 2 - 2,5 - 3 - 3,5 - 5 - 6 - 6,5 - 7 - 8 - 8,5 - 9 - A
- B - C - D - E - F - G.
- IV. Hardware Release.
- V. Power supply voltage (50/60Hz):
- for sizes /R to /3.5: D (220/240VAC), P (380/460VAC), M (220/240VAC single-phase), H (480Vac).
- from size /5 to /G: D (220/240VAC), E (380/400/415VAC), O (440/460VAC), W (690VAC), I (range 35÷130Vac).
- VI. Braking module: N (without module), F (with integrated module).
- VII. Customizations.
- VIII. "STO" Security function: N (inverter WITHOUT function), S (inverter WITH function).



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