



ADV200-...-SI with External safety modules

English

User manual



1S9SFTYEN

GEFRAN

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Rev 0.2	2-10-2017	BRI	EXP-SFTy-ADV = Safety interface; mod ch. 4 Wiring and Installation note. EXP-SFTy-ADV manual = Safety manual (code 1S5F94, EN)

Thank you for choosing this Gefran product.

We will be glad to receive any possible information which could help us improve this manual. The e-mail address is the following: techdoc@gefran.com.

Before using the product, read the safety instruction section carefully.

Keep the manual in a safe place and available to engineering and installation personnel during the product functioning period.

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1 Introduction

This manual covers the implementation of operational safety functions, as described and specified in EN61800-5.2, EN61508, EN 13849-1.

Specifically, the Gefran ADV200-...-SI series drives, which come with internal and external safety modules, support the following safety functions:

- **STO** (Safe Torque Off)
- **SLS** (Safe Limited Speed)
- **SDI** (Safe Direction)
- **SS1** (Safe Stop 1)

These safety functions meet the requirements of the EN61800-5-2 and EN13849-1/2 standards, and with the exception of the STO function are implemented using external safety modules of the *ReeR*® S.p.A. *Mosaic* series ("Safety Modules").

The safety functions require the components listed in the table below.

Important: The listed ReeR components should be ordered directly from the ReeR SpA sales network (<http://www.reer.it/reer/reti-di-vendita>).

Table 1: Hardware configuration specifications for supporting safety functions

			STO	SLS	SDI	SS1
Drive	ADV200-XXXX-SI	The Gefran ADV200-...-SI series drives come with the EXP-SFTy-ADV Safety interface	●	●	●	●
	M1	Safety module (MOSAIC Main Unit, code 1100000)	X	●	●	●
ReeR components	MV2S (Dual encoder control)	Safety module (MOSAIC SIN/COS Expansion Unit, code 1100076)	X	■	■	■
	MV1S (1 encoder and proximity control)	Safety module (MOSAIC SIN/COS Expansion Unit, code 1100072)	X	■	■	■
	MV2TB (Dual encoder control)	Safety module (MOSAIC TTL Expansion Unit, code 1100087)	X	■	■	■
	MV1TB (1 encoder and proximity control)	Safety module (MOSAIC TTL Expansion Unit, code 1100086)	X	■	■	■
	MV2H	Safety module (MOSAIC HTL Expansion Unit, code 1100074)	X	■	■	■
	Mosaic Safety Designer (1)	Software for Mosaic safety modules' configuration, testing and reporting	X	●	●	●
	CSU USB cable	USB cable for PC connection (code 11100062)	X	●	●	●
	MSC Connector (2)	Rear connector for installing an MV2S Module and connecting to M1 (cod. 11100061)	X	●	●	●
ADV200 encoder card (3)	EXP-DE-I1R1F1-ADV	TTL/HTL digital incremental encoder expansion card 1 encoder input - 1 encoder output - 2 freeze channels	X	■	■	■
	EXP-DE-I2R1F2-ADV	TTL/HTL digital incremental encoder expansion card 1 encoder input - 1 encoder output - 2 freeze channels		■	■	■
	EXP-SE-I1R1F2-ADV	Sinusoidal incremental encoder expansion card 1 encoder input - 1 encoder output - 2 freeze channels		■	■	■
	EXP-SESC-I1R1F2-ADV	Sincos incremental encoder expansion card 1 encoder input - 1 encoder output - 2 freeze channels		■	■	■
	EXP-EN/SSI-I1R1F2-ADV	Absolute EnDat/SSI encoder expansion card 1 encoder input - 1 encoder output - 2 freeze channels		■	■	■
	EXP-HIP-I1R1F2-ADV	Absolute Hiperface encoder expansion card 1 encoder input - 1 encoder output - 2 freeze channels		■	■	■
	EXP-ASC-I1-ADV	Absolute SinCos expansion card 1 encoder input		#	#	#
	EXP-RES-I1R1-ADV	Resolver expansion card 1 Resolver input - 1 Resolver repetition output		#	#	#

- Required
- Alternative
- X Not required
- # Unused

- (1) Requires Windows XP (SP3) or higher and Microsoft .NET Framework 4.0 (or higher). The MSD software is included in the CD-ROM supplied with the M1 module
- (2) Two connectors are required: 1 connector is included; one should be ordered as an accessory (code 1100061)
- (3) In case of using absolute encoders SinCos, EnDat, SSI or Hiperface for the feedback to drive, it is necessary to use the encoder versions that implement also incremental tracks.

1.1 Safety modules

The safety modules are certified modules for running various, also complex, safety functions, configurable by using the special software suite that is shipped with them.

Main specifications

Protection level	Housing, IP 20 - Terminal block IP 2X
Operating temperature	-10 to 55 °C
Dimensions (HxWxD)	99 x 22.5 x 114 mm
Mounting	On an omega-type rail in accordance with EN 50022-35
Installation environment	Protection level IP54 (min)
Rated voltage	24V DC
Dissipated power	3W max
Conformity	CE, cUL, TÜV
Safety level	SIL 3 – SILCL 3 – PL e – Cat. 4 – Type 4

For all safety modules' technical information, including dimensions, mounting, specifications, software, etc., please read the documentation on the manufacturer's web site at <http://www.reer.it/>, under the section dedicated to the Mosaic Modules series).

2 Safety Precautions

2.1 Symbols used in the manual



Indicates a procedure, condition, or statement that, if not strictly observed, could result in personal injury or death.
Indique le mode d'utilisation, la procédure et la condition d'exploitation. Si ces consignes ne sont pas strictement respectées, il y a des risques de blessures corporelles ou de mort.



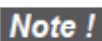
Indicates a procedure, condition, or statement that, if not strictly observed, could result in damage to or destruction of equipment.
Indique le mode d'utilisation, la procédure et la condition d'exploitation. Si ces consignes ne sont pas strictement respectées, il y a des risques de détérioration ou de destruction des appareils.



Indicates that the presence of electrostatic discharge could damage the appliance. When handling the boards, always wear a grounded bracelet.
Indique que la présence de décharges électrostatiques est susceptible d'endommager l'appareil. Toujours porter un bracelet de mise à la terre lors de la manipulation des cartes.



Indicates a procedure, condition, or statement that should be strictly followed in order to optimize these applications.
Indique le mode d'utilisation, la procédure et la condition d'exploitation. Ces consignes doivent être rigoureusement respectées pour optimiser ces applications.



Indicates an essential or important procedure, condition, or statement.
Indique un mode d'utilisation, de procédure et de condition d'exploitation essentiels ou importants

2.2 Safety Requirements



Drive-integrated safety functions should not be viewed as functions meant for a single device and isolated from the device surrounding context but rather as functions run by one or more components that are integrated with other devices to ensure safety, that is to provide operation certainty of mechanisms set to protect machine operators.



It is important to note that it is the responsibility of the manufacturer, OEM or integrator ("Machine Manufacturer") to ensure that EN13849-1 Safety of Machinery requirements and applicable laws are complied with, and to verify that all devices operate regularly, both individually and as a whole.

Since these are machine functions, two fundamental aspects should be noted:

- The implementation of safety functions necessarily requires studying and mastering the ADV200 device and related modules as well as supporting devices, ways and methods to integrate machine-related functions and applicable general and specific regulations. Trained personnel should assess safety and coherence of implemented machine functions and complete a comprehensive safety report.
- Machine operators should be specially trained and prepared to run machine and device functions so they are ready to deal with any eventuality and minimize the probability of hazardous incidents, in accordance with EN 62061.

3 Installation and use of safety functions

The installation and use of safety functions calls for several study and execution phases, specifically:

1. Risk analysis;
2. Identification and configuration of machine safety functions;
3. Design, integration and use of components involved in the safety functions;
4. Installation and Wiring of ADV200-xxx-SI
5. Testing the safety functions.

This manual provides information and help for phases 3 and 4, as it is the task and responsibility of the machine manufacturer to design and integrate all safety functions.

Specifically, Paragraphs 4.1 and 4.2 provide the necessary guidelines on how to wire the ADV200-...-SI device with the safety modules and how to use them for running the basic functions (STO, SS1, SLS, SDI).

The basic security functions provided by the ADV200 + safety module system should be designed for its specific use (see Paragraphs 3.1, 3.2, 3.3, 3.4) by the machine manufacturer in order to fulfill the needs and achieve the goals specified under points 1, 2 and 5.

4 Wiring and Installation

Running the safety functions requires one or both of the following configurations:

- STO (**EXP-SFTy-ADV**) Safety Interface (*) installed on all drives with the "SI" suffix (e.g., ADV200-...-SI)
- Optional Encoder Card installed on the ADV200-...-SI (EXP-DE/EXP-SE) drives.

The requirement for one or both would depend on which basic functions are to be used. For choosing the most suitable configuration, see the respective specifications under [table 1](#).



The cards are to be installed in the proper slots as shown in Figure 1:

- Encoder cards must be installed in either slot 1, 2 or 3. For details, see the ADV200-QS User Manual.
- (*) STO Safety Interface is factory-installed as card in its special slot (EXP-SFTy-ADV) or integrated in the INT-P-ADV power card (sizes ≥ 71600 from "L" HW version). For more details, see the ADV200 QS manual (cod 1S9H49) and the STO safety function manual (code 1S5F94, Safety manual -EN).

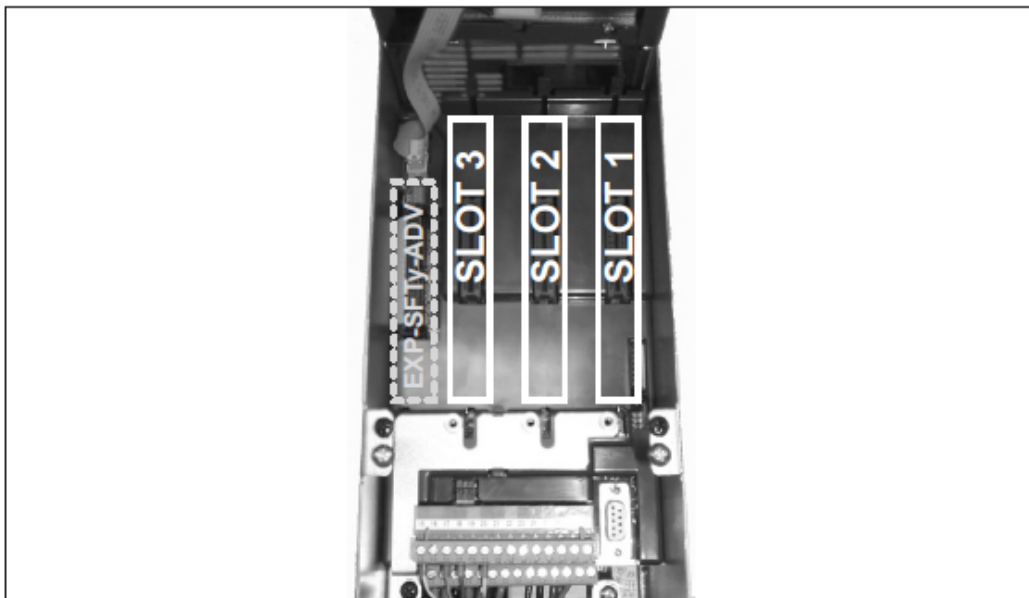


Figure 1. ADV200 slot diagram for optional cards

4.1 Encoder wiring

Motor speed data is required for many safety functions to run, namely the following:

- SLS (Safe Limited Speed)
- SDI (Safe Direction)
- SS1 (Safe Stop 1)

To ensure the safety of speed data, more than one channel/reading-sensor must be used so as to guarantee the integrity of data read by the sensor.

The possible position sensors combinations are as follows:

- Encoder TTL/sincos + proximity sensors
- Encoder TTL/sincos + 2nd encoder TTL/sincos

In the first case, if not in conflict with other problems, a single-channel Reer speed module (MV1x) should be used. In the second case, when a dual encoder is installed, a double-channel Reer speed module (MV2x) should be used.

In any case, the wiring diagram requires an encoder whose signals can be used by both the ADV200 and the safety module.

TTL and sin/cos encoders should be wired as specified and illustrated in [Figure 2](#), connecting first to the ADV200 expansion card and then retransmitting the signal (repetition) from the drive to the safety module. The same figure also illustrates a second encoder channel (possibly for a proximity signal) that is connected to the second safety module channel to complete the safety network.

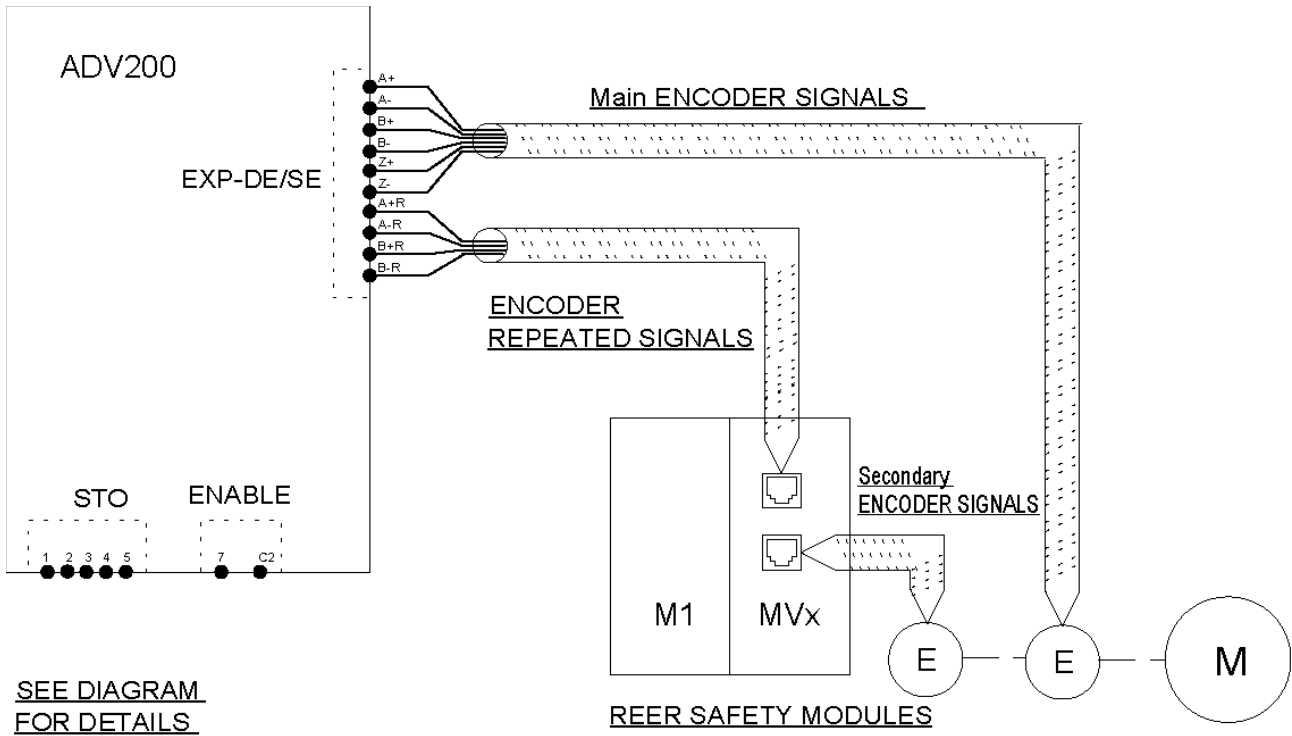


Figure 2. Encoder cable wiring diagram for implementing safety functions.

With regard to connecting repeated signals to the safety module, please see the user manuals for the ReeR M1, MVxS or MVxTB modules. Of particular importance is the wiring diagram for TTL signals, considering repeated signals as encoder source, see [Figure 3](#). In [Figure 3](#), it is important to note the power connection between the encoder card and the ReeR MVx module: the encoder card power supply should **not** be connected to the ReeR module. The used speed module must be one of those listed in [Table 1](#), that is MVxS or MVxTB.

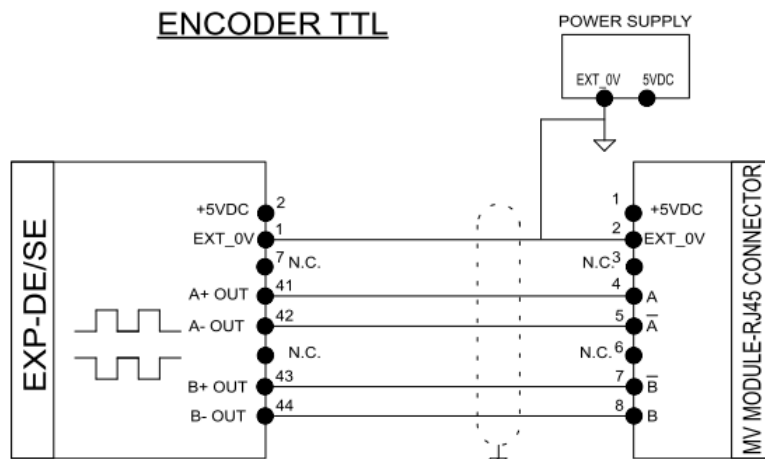


Figure 3. Wiring diagram for repeated encoder signals - safety module.

All safety functions that check for risks operate by running the drive-integrated STO function, which disengages the motor from the drive system torque. In addition to implementing the STO function, safety modules can protect the system by applying other means (motor brakes, mechanical blockage, etc.) according to the machine-related function.

4.2 STO Wiring

All safety module functions listed above must be programmed correctly and coherently based on the specific machine safety requirements as described in Chapter 1.

The following diagram covers several installation possibilities, as the STO wiring does not depend on the performed function, while still fulfilling the specific functions described in paragraphs §5.1, §5.2, §5.3 and §5.4. Indeed, all safety functions, in cases when work interruption is called for, require the activation of the Safe Torque Off (STO) function as a means for machine shutdown or return to safe operation.

To allow the safety modules to activate the ADV200 STO function and, at the same time, to monitor the STO state through inputs with automatic reactivation configuration, the wiring diagram in Figure 4 should be used. In this diagram, the outputs of safety module M1 (OSSD1_A, OSSD2_B) control the ADV200 Enable and STO Enable inputs. The Feedback output of the STO function is fed to the Restart_Fbk1 input so that the module can automatically check the machine status and restart it (if programmed to do so).

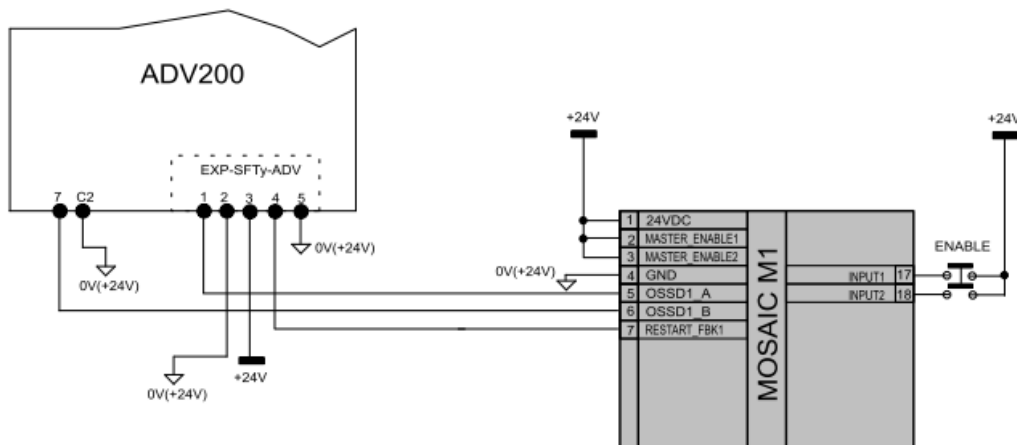


Figure 4. Connecting the safety module for activating the STO function with automatic restart.

Figure 5 shows a diagram that requires/allows a manual restart, using a special safety function button (RESTART).

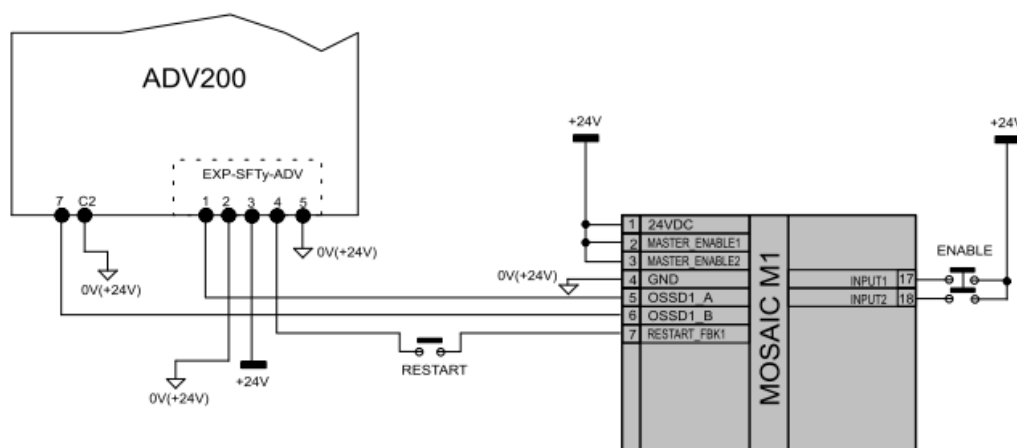


Figure 5. Connecting the safety module for activating the STO function with a manual restart.

5 Use and Integration

5.1 STO Function

The STO function is integrated within the ADV200 drive as an optional. It requires no external modules but the use of a drive from the ADV200 series with the STO safety function integrated (**ADV200-....-SI**).

For additional details about running the ADV200 STO safety function, please see the Safety manual (code 1S5F94, EN).

5.2 SLS Function

The Safe Limited Speed function controls motor rotation speed limits: a properly wired and configured safety module checks that the motor rotation speed does not exceed a preset value (**SafeSpeedMax**). When the speed exceeds the **SafeSpeedMax** value, the safety module triggers an alarm. Configuration and detection methods related to the condition of an exceeded speed limit are described in the safety module manual.

Upon detecting an exceeded speed limit condition, the safety module activates the ADV200 integrated STO function.

In order to comply with the functional specifications, the safety module response times should be added to those of the STO function, as described in the Safety manual (code 1S5F94, EN) and shown in the table and figure below.

Name	Description	Limits
Ttoff	Time from enable signals down to motor torque disable	240ms
TStop	Time from torque disable to motor 0 speed	Depends on the motion conditions
Tfboff	Time from torque disable to feedback signal deasserted	40ms

Table 2: ADV200-integrated STO safety function response times.

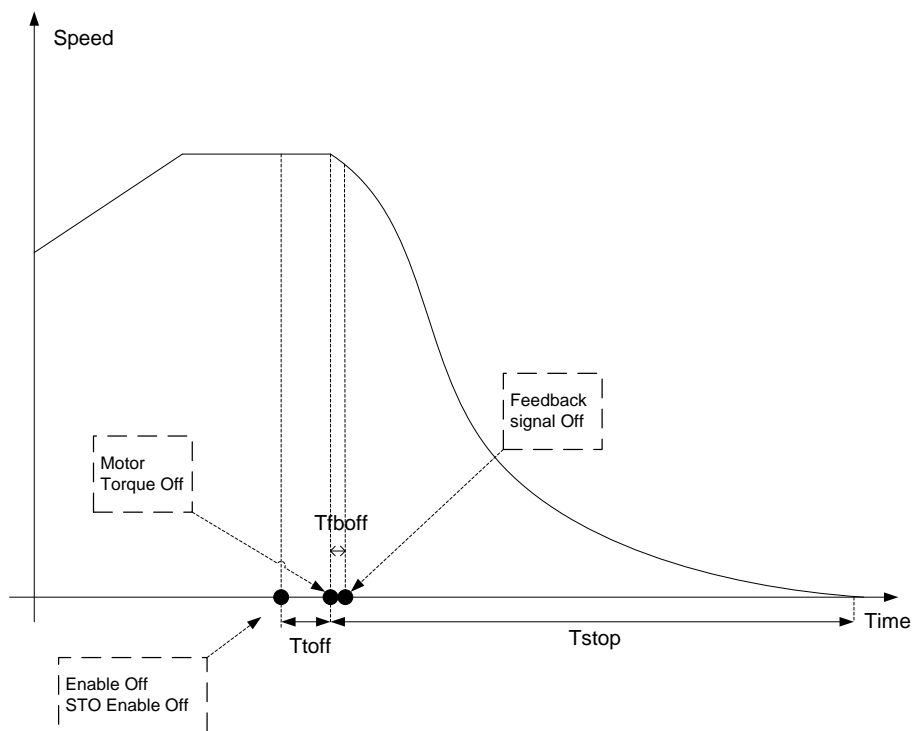


Figure 6. ADV200-integrated STO function behavior.

5.3 SDI Function

The Safe Direction (SDI) function controls motor rotation direction: a properly wired and configured safety module checks that the motor turns in one direction only. Upon detecting that the motor rotates in the reverse direction, the safety module triggers an alarm. Configuration and detection methods related to the condition of reverse rotation are described in the safety module manual.

Upon detecting that the motor rotates in the reverse direction, the safety module activates the ADV200 integrated STO function.

In order to comply with the functional specifications, the safety module response times should be added to those of the STO function, as described in the Safety manual (code 1S5F94, EN) and shown in [Figure 6](#) and [Table 2](#) above.

5.4 SS1 Function

The Safe Stop 1 (SS1) function brakes the motor along a quick-stop ramp then activates the ADV200 STO function. The safety module SS1 function is configured in the best and most responsive way to meet the requirements of the system it controls.

The SS1 function is generally designed to ensure that, after a certain time (T_{delay}) following a request to activate the SS1 function, the ADV200 integrated STO function is activated.

The safety function **does not guarantee compliance with the descent ramp** but rather the activation of the STO function below a certain speed or after a certain period of time (T_{delay}), as shown in the following figure.

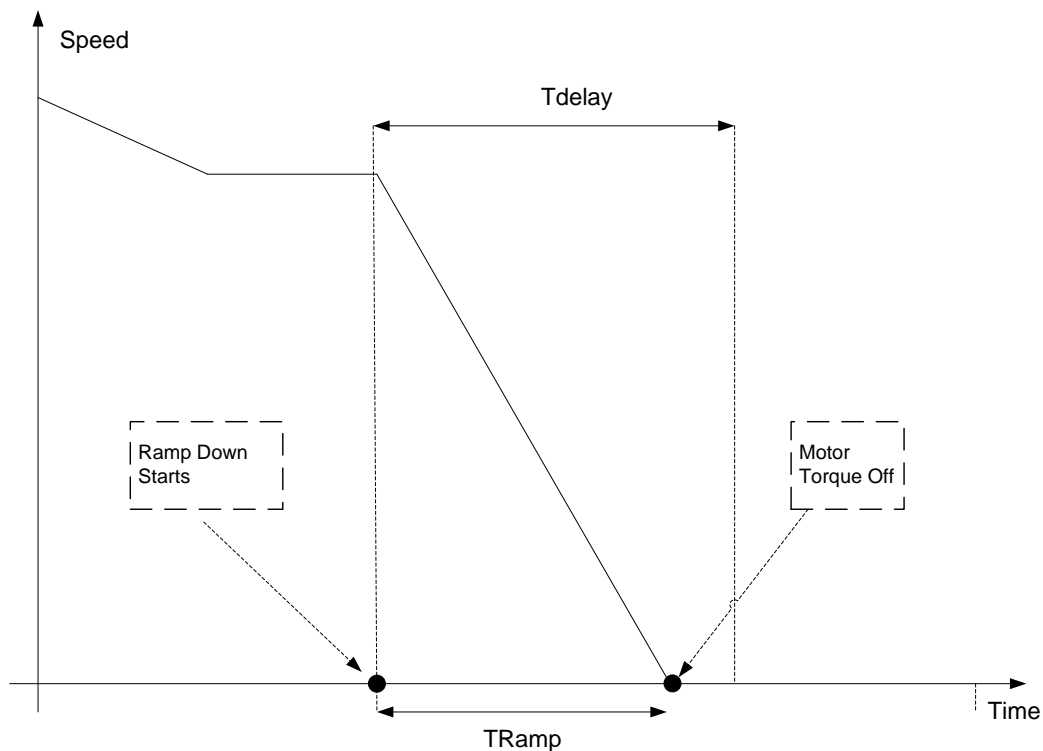


Figure 7. SS1 safety function timeline diagram

Upon detecting the end of the set delay time, the safety module activates the ADV200 integrated STO function.

In order to comply with the functional specifications, the safety module response times should be added to those of the STO function, as described in the Safety manual (code 1S5F94, EN) and shown in [Figure 6](#) and [Table 2](#) above.

6 SIL levels provided by safety functions

The ReeR modules used together with the Gefran AD200-xx-SI drives allow the implementation of the STO, SS1, SDI and SLS safety functions as described in Paragraph §5, providing a SIL3 safety level according to EN 61508 standards and PI level according to EN13849-1/2 standards when properly designed and used following the recommendations of both manufacturers.

It should be emphasized that, when implementing the safety functions, data related to STO function reliability (listed in the 1S5F94 Safety manual-EN) as well as data related to the encoder signal repetition reliability should be taken into consideration.

Regarding the latter component, the following factors should be considered as well:

1. Signal repetition is purely an invariant hardware function. Thus its functioning is not affected by other factors or operations. Each potential internal hardware failure that might hold back or alter the repeated signal is taken into consideration in the PFH (rep) data.
2. Encoder repetition failures that might occur are detectable by the ReeR speed module, which can provide to a component a maximum diagnostic fault coverage (99%)

The encoder repetition PFH data is assumed to be less than 1×10^{-9} .

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