

SIEMENS

Ingenuity for life



Simply safe –
twice the efficiency!

Safety Integrated for drive
technology and motion control

[siemens.com/safety-drives](https://www.siemens.com/safety-drives)

Focused approach for more safety

As machine builder and company operating machines, your topmost priority is to guarantee the safety of man and the environment when your machines are being used and to boost productivity. We can support you in achieving this goal – with integrated safety functions in our drives and more than 100 years of experience in industrial safety systems.

Safety Integrated – including higher performance

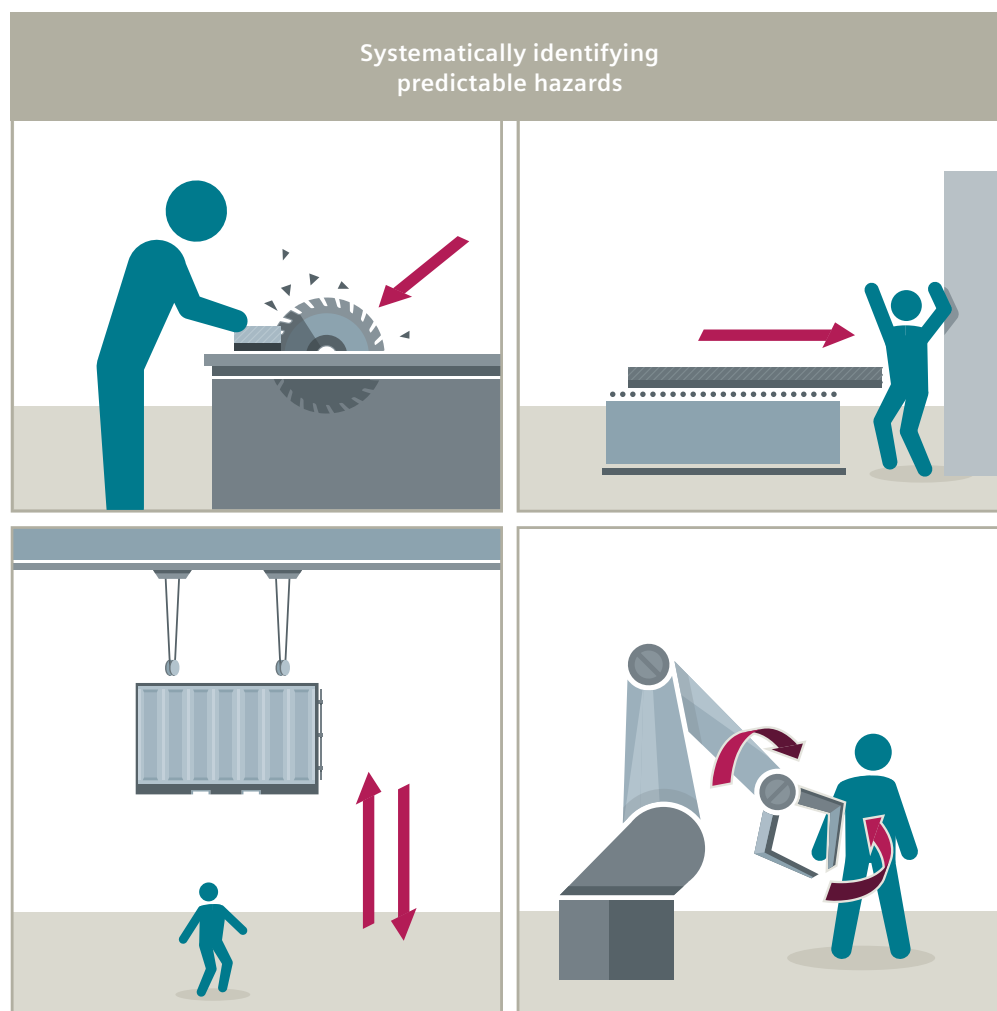
Today, machines and plants are becoming increasingly more flexible and productive – not least as a result of new safety concepts, which facilitate faster operation but at the same time safer operation. Conventional safety technology quickly reaches its limits. On the other hand, SINAMICS with Safety Integrated provides you with shorter response times and a higher degree of cost-effectiveness as a result of the lower wiring costs. These integrated safety functions allow you to implement new safety concepts in an especially cost-effective way.

Identify and assess hazards

The European Machinery Directive 2006/42/EC specifies that a risk analysis must be performed when a machine is being designed. The iterative procedure described in ISO 12100 provides valuable support when assessing risks. If the outcome is that measures must be taken to minimize risks, then this is done with the following steps:

Initially, an attempt is always made to minimize the risk through a **safe design**, for example by avoiding crushing edges or by providing protective enclosures.

ISO 12100 can be applied to assess the risk of a machine.



“The prevention of accidents must be seen not as a regulation prescribed by law but as a dictate of human obligation and sound economic sense.”

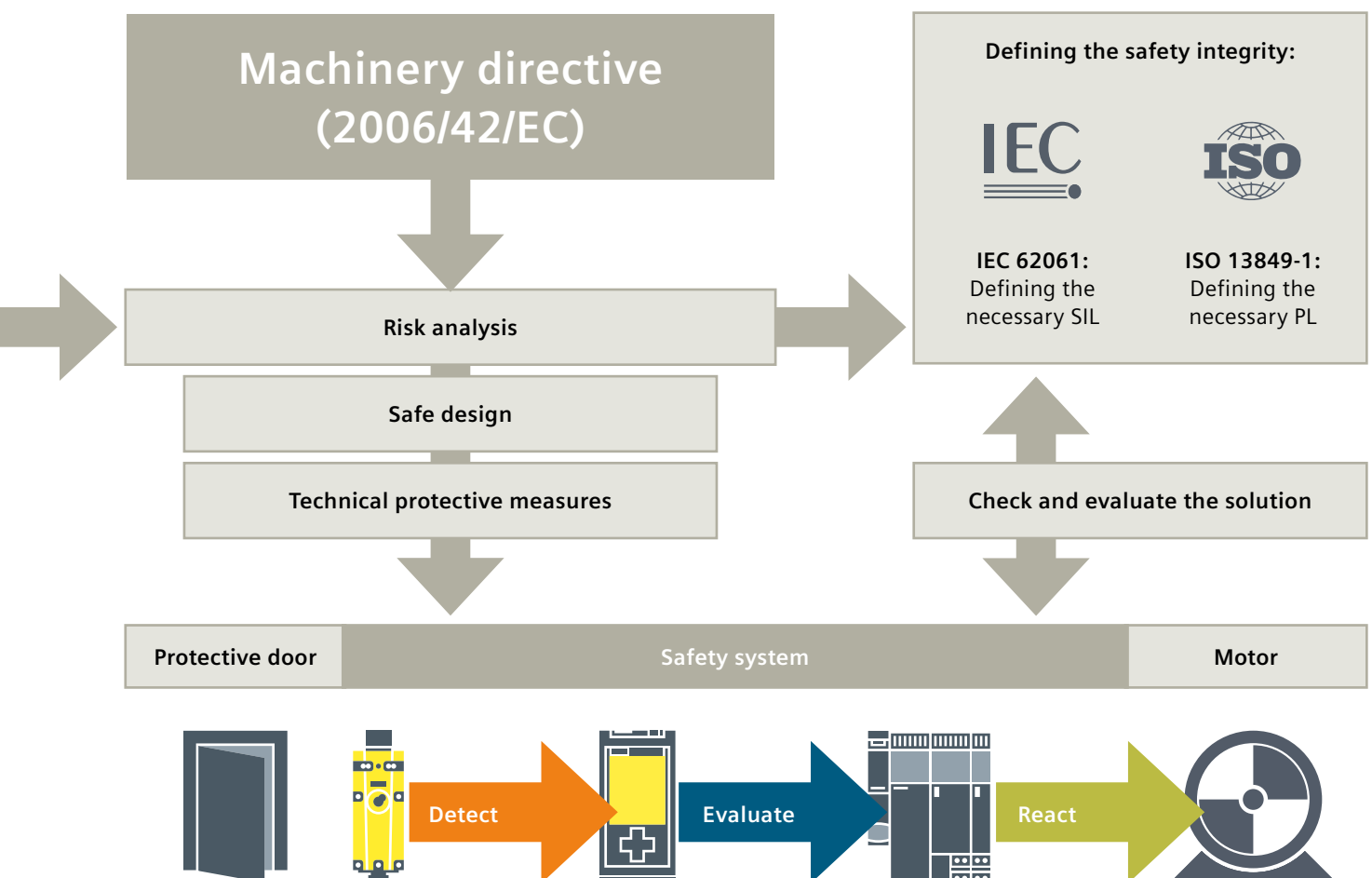
Werner von Siemens, 1880

If this is not fully possible, or if not all of the risks can be avoided by taking the appropriate design measures, then the appropriate protective measures must be implemented. For example, by embedding one or several safety functions in the system.

Normally, a safety function comprises three subfunctions:

- **Detect** (position switch, Emergency Stop, light curtain etc.)
- **Evaluate** (fail-safe control, safety relays, modular safety systems etc.)
- **React** (drives, motor starters, motor management systems)

Together, these subfunctions must create a safe and effective chain. IEC 62061 or ISO 13849 can be applied to structurally configure the safety functions. We recommend that products certified according to these standards are used.

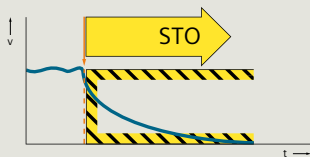


Safety functions according to IEC 61800-5-2 – integrated in the drive

Automated operation of plants and machinery assumes that suitable safety functions are available, so that operating and maintenance personnel can always work safely in any situation. For SINAMICS with Safety Integrated, these functions are already integrated in the drive. Safety functions in SINAMICS drives can be split up into four categories:

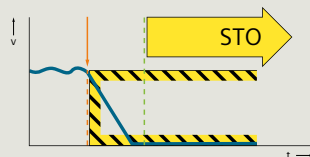
Functions to safely stop the drive

Safe torque off (STO)



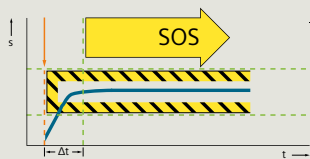
- **Function:** STO safely sets the drive into a torque-free condition; an undesirable restart is safely prevented. STO acts directly. After STO has been deselected, the drive can quickly restart as the DC link remains active
- **Application:** for example, operating and maintenance personnel can safely work with the protective door open (restart inhibit)
- **Benefits:** No wearing parts as a result of the electronic shutdown. The converter remains connected to the line supply and can still be fully diagnosed

Safe stop 1 (SS1)



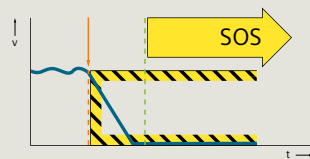
- **Function:** The drive is quickly stopped and safely monitored, especially for high moments of inertia
- **Application:** Drive is quickly stopped with subsequent transition into the STO state. Typical examples include: saws, grinding machines, centrifuges, storage and retrieval machines, winders
- **Benefits:** The productivity of a machine is increased as a result of the lower safety clearances; no mechanical braking that involves intensive wear is required

Safe operating stop (SOS)



- **Function:** The position is safely held and monitored at standstill for each drive control
- **Application:** For certain work, the machine or parts of the machines must be safely at standstill – however, the drive can still provide a holding torque. Typical applications include: Winders, converting and packaging machines – as well as machine tools
- **Benefits:** Shorter equipping and downtimes thanks to permanently active closed-loop position control. A motor is quickly restarted

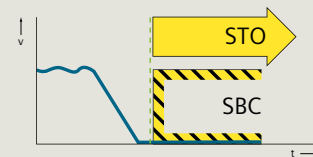
Safe stop 2 (SS2)



- **Function:** A motor is quickly and safely stopped and then SOS is activated (Safe Operating Stop)
- **Application:** The drive independently brakes the motor along an emergency stop ramp; however, the motor can provide the full torque to maintain standstill
- **Benefits:** Safe standstill monitoring; productive operation is immediately resumed without referencing; high degree of productivity and short equipping and downtimes

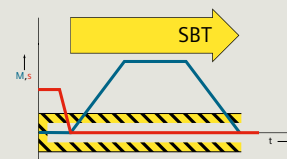
Functions for safe brake management

Safe brake control (SBC)



- **Function:** A holding brake is safely controlled and monitored, especially for vertical axes; is always activated in parallel with STO
- **Application:** In conjunction with STO or SS1 functions, an axis in the torque-free state is prevented from moving, e.g. as a result of gravity
- **Benefits:** The monitored brake operates safely, even in the no-current state without requiring external components and wiring; this prevents vertical/pulling loads from sagging

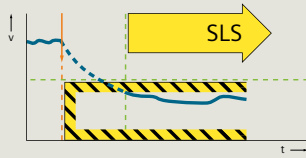
Safe brake test (SBT)



- **Function:** Using the SBT diagnostic function, up to two brakes per axis can be cyclically tested
- **Application:** Can be used for vertical axes and suspended loads, e.g. for gantry cranes and presses; in conjunction with SBC, it is suitable for implementing a safe brake
- **Benefits:** Faults and wear can be detected in the mechanical system of a brake. Automatically testing the braking effectiveness reduces maintenance costs and increases the safety and availability of the system/machine

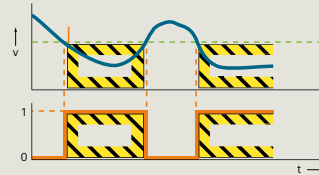
Functions for safely monitoring drive motion

Safely-limited speed (SLS)



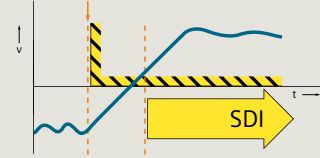
- **Function:** A specific speed/velocity limit of a drive is safely monitored – and a configurable fault response initiated when a limit value is violated
- **Application:** If the safety of personnel when carrying out maintenance or setting-up work is only guaranteed when operating at reduced speed/velocity (e.g. manually threading material in a winder etc.)
- **Benefits:** Downtimes are shortened, setup is simplified, higher productivity and system availability; an external speed monitor is not required

Safe speed monitor (SSM)



- **Function:** Supplies a safety-related signal as long as the drive operates below a specified speed/feed velocity
- **Application:** When a non-critical speed is reached, for example, a protective door can be released or a centrifuge filled
- **Benefits:** Depending on the particular situation, different response options to the safe feedback signal, evaluation using a safety-related control

Safe direction (SDI)



- **Function:** It is safely monitored that the drive can only move in the permissible direction; if the drive moves in the incorrect direction, then a configured stop response integrated in the drive is initiated
- **Application:** Allows material to be fed/workpieces to be removed as long as the machine moves in the safe direction, namely away from the operator
- **Benefits:** Higher productivity/shorter cycle times, mechanical damage to the machine is prevented when tools move with different directions of rotation, e.g. for processing machines

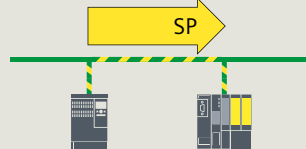
Functions for safely monitoring the position of a drive

Safely-limited position (SLP)



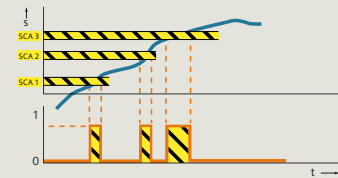
- **Function:** Protective zones are safely monitored using defined traversing ranges
- **Application:** Wherever traversing ranges cannot be (completely) secured using protective doors or protective measures, e.g. for storage and retrieval machines, gantry cranes, machining centers
- **Benefits:** Safety software limit switches are implemented using SLP; mechanical limit switches can be eliminated

Safe position (SP)



- **Function:** The SP function transfers safe position actual values of the drive to the F control for further processing via PROFIsafe. Complex monitoring functions can be implemented when required
- **Application:** Can be used with a high degree of versatility for cam sequencers, cross-axis safety concepts, multidimensional protective areas and zone concepts. Additional sensors and/or external safe transmitters/encoders, their installation and evaluation are not required
- **Benefits:** Suitable for machines where flexible safety functions are required. Engineering customized safety concepts based on SIMATIC F controls

Safe cam (SCA)



- **Function:** Supplies a safety-related signal as long as the drive operates within a specified position range
- **Application:** Can be used with a high degree of versatility for safety-related, axis-specific range identification or working area/protective area demarcation
- **Benefits:** Used to implement safe electronic cam sequencers without requiring any hardware cams

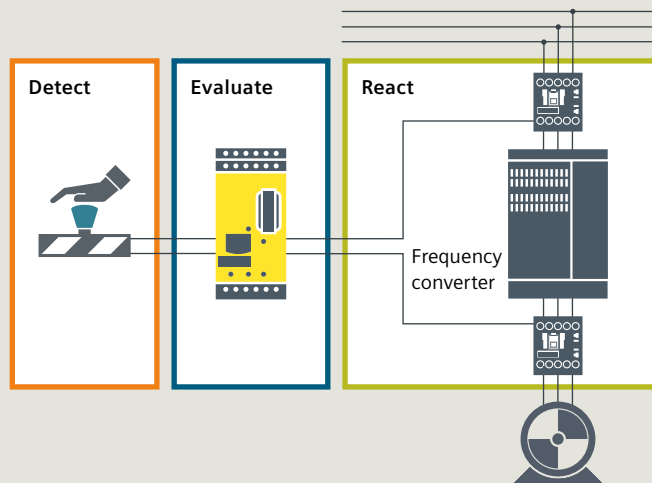
Safety Integrated – simply better

We have equipped our SINAMICS drives with Safety Integrated, as this functionality directly supports you in building better machines. Based on Safety Integrated, your machines provide an increased level of safety – with low associated costs – today, and also when the system is expanded in the future.

Compare for yourself!

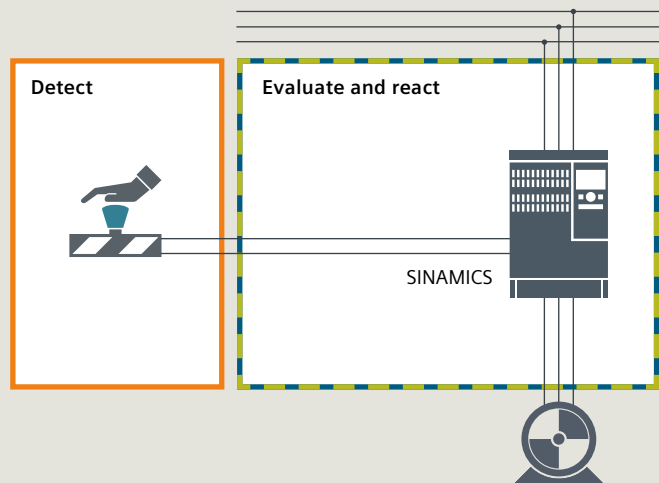
When designing and implementing safety-related solutions, in addition to ensuring that they function absolutely perfectly, what is especially important is the costs associated with achieving the required result. This is not only as a result of the solution design, but also the practical implementation. And it is precisely here that SINAMICS drives with Safety Integrated provide decisive advantages. It is irrelevant whether in stand-alone operation or connected to a higher-level control system.

Conventional safety technology



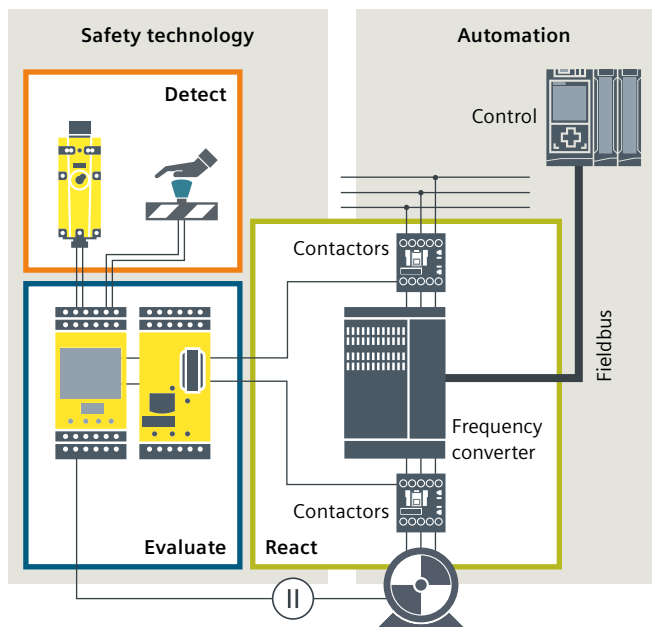
A basic Emergency Stop application with external inter-connection is shown in the diagram. The Emergency Stop push button signal is evaluated using a safety relay. The converter is isolated from the line supply and motor using two contactors. To start the application, the power circuit must be re-closed by switching the contactors and the converter DC link pre-charged again. This takes time and involves switching operations of the electromechanical components.

Safety Integrated



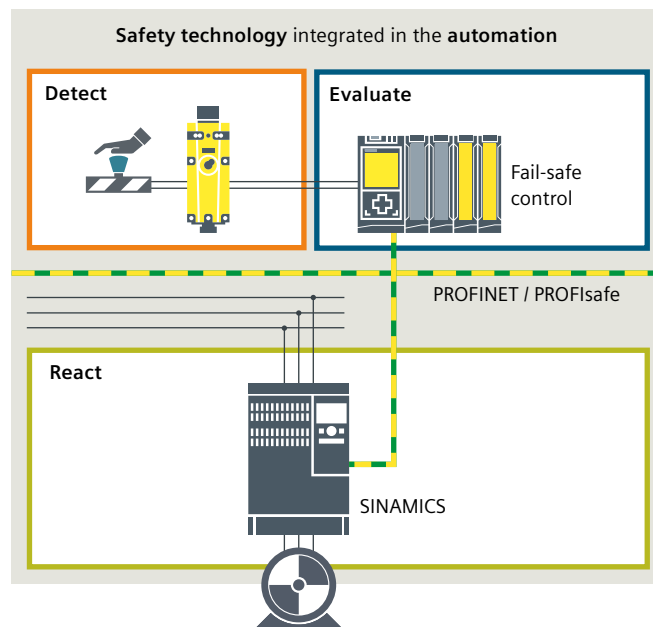
As a comparison, the same application but this time implemented using a SINAMICS converter with Safety Integrated. In this case, the signal from the SIRIUS EMERGENCY STOP push button is directly read into the converter, where it is evaluated. When initiating the Emergency Stop, STO is activated in the converter, for example. The converter is immediately switched into a no-torque condition, is safely protected against an undesirable restart – and does not have to be electromechanically isolated from the line supply. The application can be immediately restarted after the Emergency Stop push button has been released. Here, a higher productivity can be achieved as a result of the shorter downtimes.

Conventional safety technology



A safety application involving Emergency Stop and setting-up operation – where the speed is monitored – is demonstrated in this example. Using conventional safety technology, this application would be implemented in a separate circuit. The Emergency Stop push button signal is evaluated using a safety relay. The converter is isolated from the line supply and motor using two contactors. For setting-up operation, a protective door monitoring function is evaluated, and the drive speed sensed using an encoder. If the speed limit is violated, the converter is isolated from the line supply and brought into a safe state. The converter is connected to the automation control via a fieldbus.

Safety Integrated

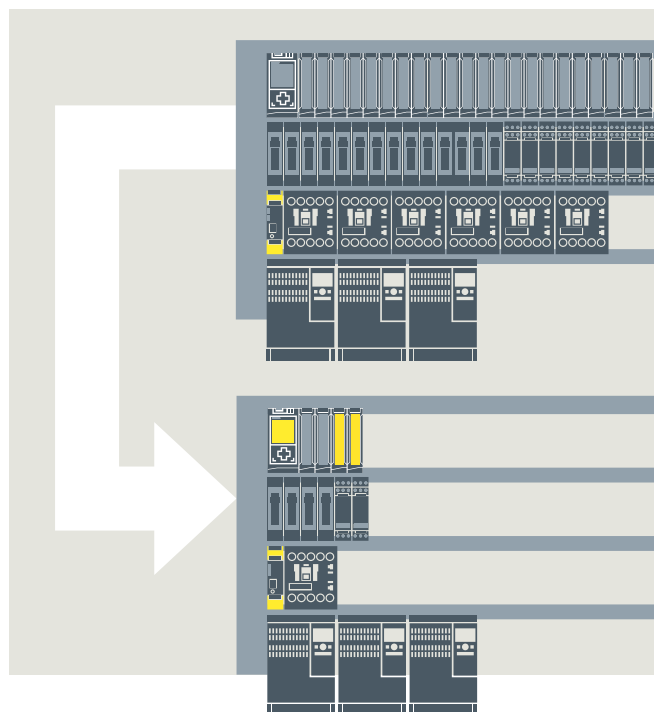


The situation is completely different for a solution based on a SINAMICS drive with Safety Integrated. In this case, the automation and safety solutions are merged to create a fully integrated solution. The signals from the SIRIUS EMERGENCY STOP push button as well as the protective door monitoring are read into a fail-safe SIMATIC S7-1500 F control, and evaluated in the safety program. SINAMICS Safety Integrated functions for Emergency Stop (STO or SS1) as well as speed monitoring (SLS) are controlled via the existing fieldbus and fail-safe communication with PROFIsafe. All of the necessary resources, such as standardized safety blocks for the safety program up to the preconfigured PROFIsafe telegrams are available in the TIA Portal.

Simplified processes based on Safety Integrated

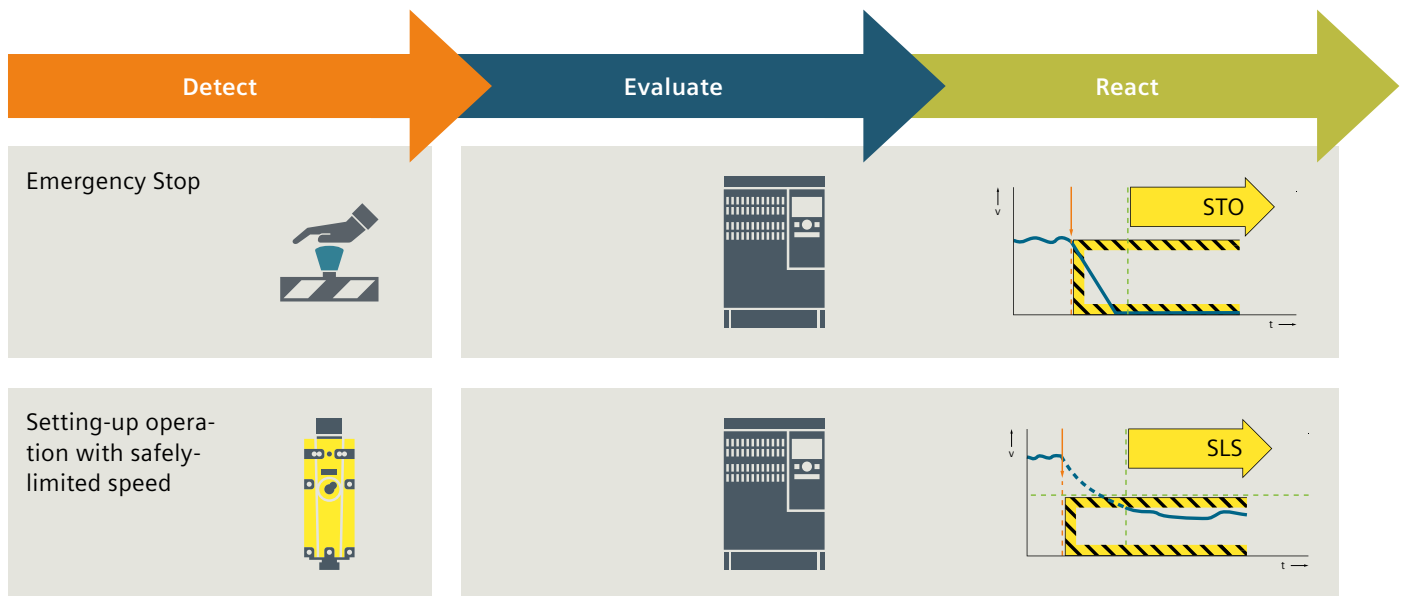
SINAMICS drives with Safety Integrated decisively simplify your work. Although you draw-up a safety concept, you do not have to select any safety relays, which you then have to install and wire up. Instead of this, you simply activate the appropriate safety functions in the SINAMICS drive, and then you can immediately continue with the test and documentation. When using precertified safety functions with SINAMICS Safety integrated, when compared to conventional safety technology, some of the steps involved in creating a safe machine can be simply eliminated. Not only this, the SINAMICS acceptance test provides user-friendly support when validating the machine.

- Less hardware; less volume of control cabinet
- Faster installation and commissioning using certified functions
- Higher flexibility when expanding and modifying existing systems



Safety Integrated – just get started

You can quickly find the solution for your drive and safety application in the extensive SINAMICS portfolio with Safety Integrated – it is simple to implement, straightforward to commission and future-proof in operation.



Objective reached in just a few steps

SINAMICS with Safety Integrated means that you can very simply and reliably engineer your safety functions. In a typical application for SINAMICS with Safety Integrated, the Emergency Stop signal should safely stop the machine and protect against an undesirable restart.

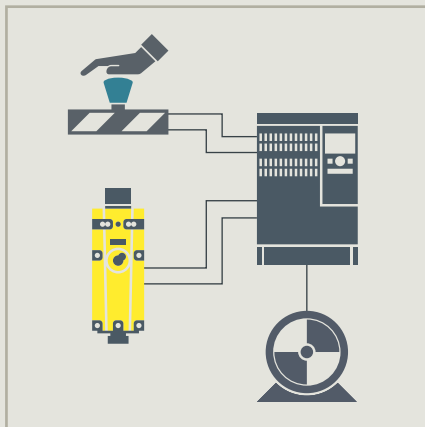
Further, when the protective door is open, the drive should not exceed a velocity/speed configured by the user when setting up the machine. The diagram shows the concept of the two safety functions and its implementation.

Basic stand-alone safety solution with SINAMICS G120

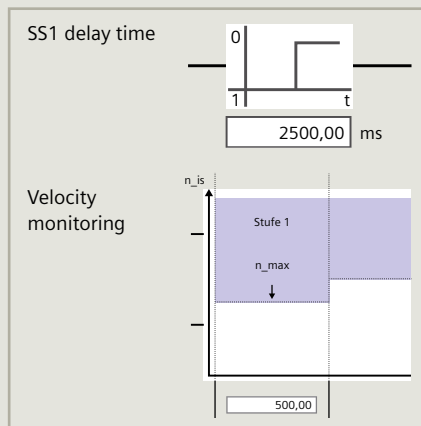
A stand-alone solution based on SINAMICS G120 can be realized in just a few steps:

1. Connect the sensors and operating devices directly to the drive.
2. Parameterize the functions in SINAMICS Startdrive.
Standard default values for most of the parameters are already preconfigured. Application-related parameters still have to be set, for example, the SS1 delay time.
→ The fail-safe system is now active.

Step 1



Step 2

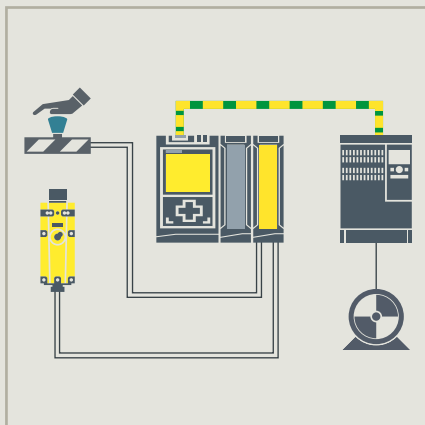


Integrated safety solution with SINAMICS G120

The integrated safety solution with SIMATIC via safe communication based on PROFIsafe also only involves just a few steps:

1. Connect the sensors and operating devices of your integrated safety solution with the SIMATIC I/O. The signals can then be processed in the safety program (F program) of the control.
2. In the hardware configuration in the TIA Portal, select the components and the preconfigured PROFIsafe telegram. Then generate the safety program (F program) using preconfigured blocks from the library.
3. Parameterize the functions in SINAMICS Startdrive.
Standard default values for most of the parameters are already preconfigured. Application-related parameters still have to be set, for example, the SS1 delay time.
→ The fail-safe system is now active.

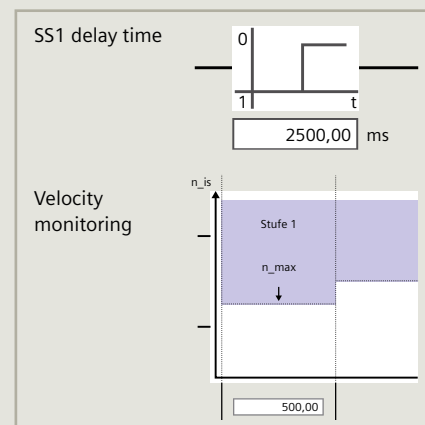
Step 1



Step 2



Step 3



Integrated safety with SINUMERIK

SINAMICS drives teamed up with SINUMERIK controls equipped with Safety Integrated also offer a wealth of advantages for machine tools: lower engineering costs, less external wiring, faster commissioning – and all of this with customized safety functions.

Integrated – and “ready-to-run”

This is all possible as the safety functions integrated in the system are ready-to-run – and fulfill the requirements of Category 3/SIL 2/PL d.

Documentation is part of the solution

The partially automated acceptance test is yet another advantage. It simplifies commissioning – and with all of the required reports to verify the safety – provides you with all of the documentation you require.

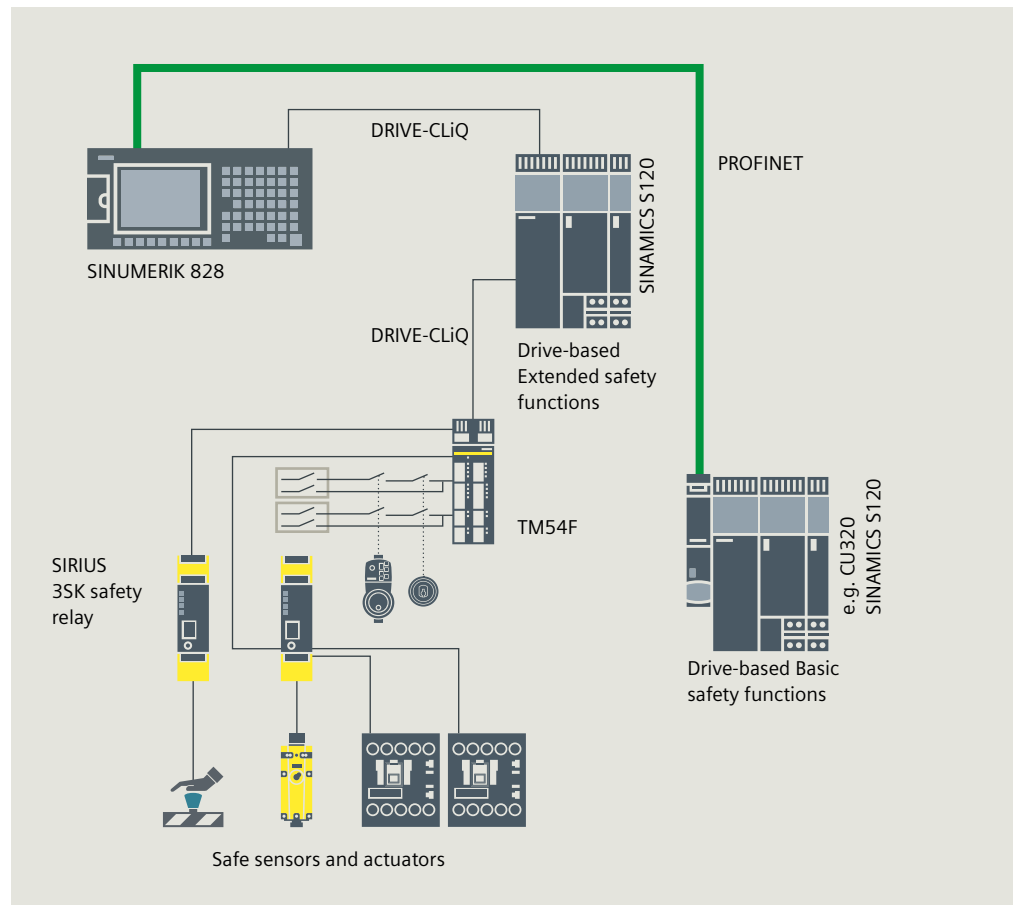
Perfect interaction with SINUMERIK

Simply program your own customized safe logic: A wide range of safety concepts is available for perfect interaction between SINAMICS with Safety Integrated and SINUMERIK. You can individually adapt, change and expand these, so that you can implement your own individual safety concept with minimum associated costs.

The practical examples on this page clearly demonstrate the advantages of SINAMICS with Safety Integrated teamed up with SINUMERIK.

1. Simple safety requirements with few sensors and actuators at the machine

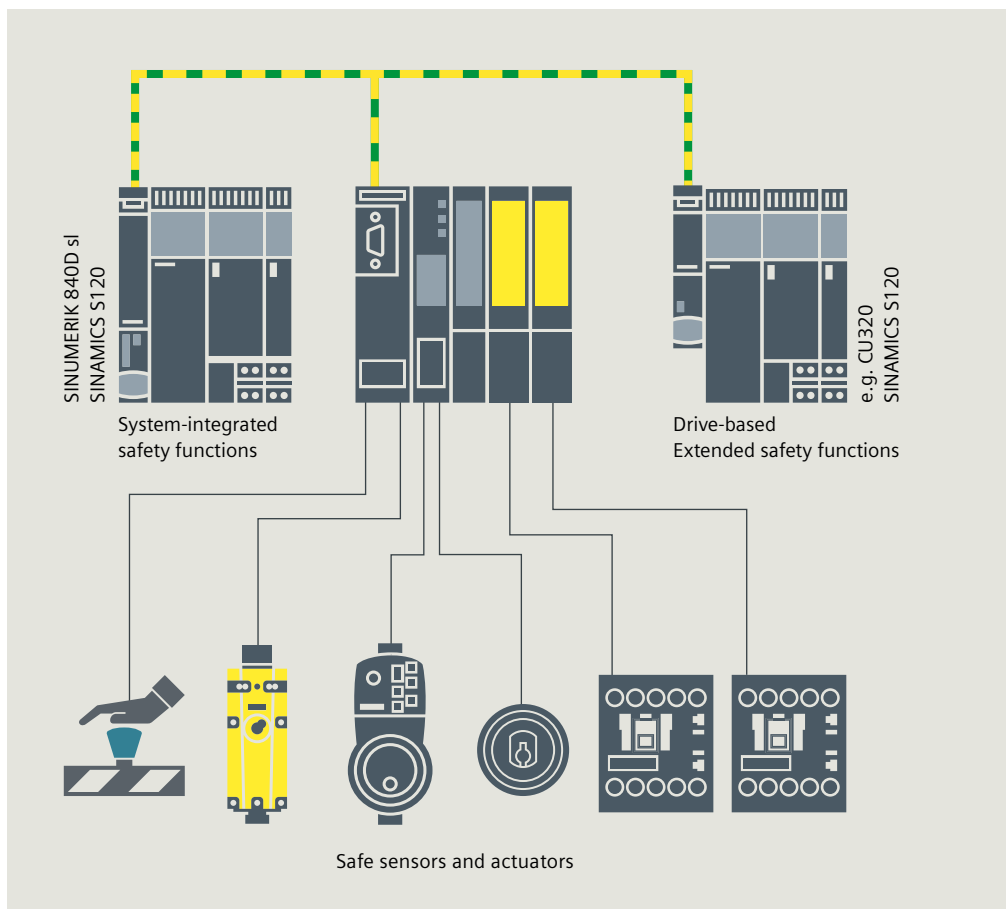
This solution operates with a SINUMERIK 828 and a SINAMICS S120 for extended as well as with CU320 SINAMICS S120 for basic safety functions. The control is connected to the converter via DRIVE-CLiQ or PROFINET; the operating devices and actuators are directly connected through a TM54F Terminal Module. The safety concept can be optimally adapted to address the potential hazards of the machine using this cost-effective solution. The high degree of safety corresponds to Category 3/SIL 2/PL d.





2. Complex machine with SINUMERIK 840D sl and SINAMICS

All safety functions are integrated in the SINUMERIK 840D and the SINAMICS drive (ready-to-run) with this solution for complex machines. Communication between the control, intelligent I/O and converter is realized via PROFIBUS or PROFINET; the safe actuators and sensors are connected via ET 200SP, for example. This concept facilitates extensive adaptation and expansion options – and can be simply commissioned and documented.



Optimum support for every safety task

With Safety Integrated in SINAMICS drives, you are not only selecting an outstanding technical solution, but also perfect support relating to all safety issues. This starts with the seamless integration of safety technology in SINAMICS drives and SIMATIC or SINUMERIK and SIMOTION controls – and continues in the accompanying work steps, for instance, engineering in the TIA Portal or the documentation in-line with the standards using the Safety Evaluation Tool.



Communicating safely

Yet another advantage of Safety Integrated can be leveraged in automation solutions with a higher-level fail-safe SIMATIC CPU: All SINAMICS drives can be connected to the control via safe PROFIsafe communication. Signals are exchanged between the control and the drives in a safety-related fashion via the fieldbus system that is being used anyway for the standard communication. No additional components are required.



Checked safety

With our Safety Evaluation Tool for standards IEC 62061 and ISO 13849-1, you quickly know just where you stand with your safety function. With this TÜV-tested (TÜV = German Technical Inspectorate) online tool you can quickly and reliably assess the safety functions of your machine. It goes without saying that this includes a report in conformance with the standard, which can be integrated in the documentation as proof of the safety.

www.siemens.com/safety-evaluation-tool



Scalable solutions for every safety task

A significant advantage of our portfolio of Safety Integrated products is the fact that you can scale your own individual solution to practically any degree of complexity and each machine and/or system size, and more precisely, with "standard components." This is complemented by the straightforward and seamless integration data exchange via PROFINET and PROFIsafe. Benefit from this unique level of integrated seamlessness over the complete portfolio.

www.siemens.com/safety-integrated



SIRIUS Safety Integrated – seamless and safe

Completely safe functioning is absolutely mandatory when it comes to implementing safety-related systems. This is the reason that our SIRIUS Safety Integrated switchgear technology is specialized to address seamlessly integrated safety applications in your machines and systems to sense, command and signal, to monitor and evaluate or to safely shut down. SIRIUS products offer high system availability and optimum protection for man, machine and the environment. In conjunction with standard fieldbus systems, such as AS Interface and PROFIBUS, also in networked, more complex automation landscapes.

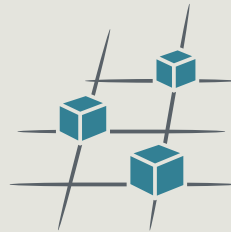
www.siemens.com/safety-relays



SIMATIC Safety Integrated – the safe automation solution

SIMATIC Safety Integrated allows you to seamlessly integrate machine safety into the SIMATIC automation solution. This means that you use just one system for your standard automation and your fail-safe automation. The advantages: high cost-effectiveness and reliability, less hardware, simplified engineering, lower stock inventory costs – to name just a few. This is how SIMATIC Safety Integrated supports you, for example, by reducing the amount of cabling. This is achieved by being able to utilize the existing network infrastructure including the WLAN plug connectors for the fail-safe communication.

www.siemens.com/simatic-safety



Complete holistic solutions with TIA

Safety and productivity with just one tool – Safety Integrated is an integral part of Totally Integrated Automation. TIA seamlessly integrates our innovative products to create homogeneous, highly specialized automation solutions. These begin with our SINAMICS drives with Safety Integrated, through space-saving controls for standard and safety-related communication up to ET 200SP motor starters.

“We started by planning the hardware and simply added the safety functions using a memory card. We were able to engineer our systems as usual and commission them 30% faster.”

Thomas Wolf, electrical design MiniTec GmbH & Co. KG

“By using Safety Integrated, we reduce the wiring costs for each machine by between 50 and 70%, i.e. time and materials; in so doing, space has been freed up in our electrical cabinets.”

Armin Daum, Head of electrical design WEILER Werkzeugmaschinen GmbH


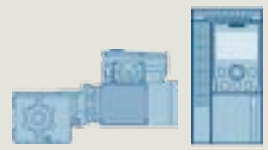
SINAMICS Safety – simply safe, twice the efficiency

Machine builders and users both enjoy considerable benefits by integrating the safety functions into the drives: The machine or system becomes safer, but the costs to achieve this drop – and the reliability of the solution has been proven around the world in many thousands of successful applications. You can also profit from the simplified engineering, faster commissioning and increased availability with lower maintenance costs. Or put another way: You can benefit from higher productivity, reduced costs and increased competitiveness of the machine.

More space – lower costs

SINAMICS with Safety Integrated are not only packed with functions, but they reduce the amount of installation work and space in the electrical cabinet. With SINAMICS, you can simply activate the safety functions instead of having to install and wire individual components – a tedious task. Not only this, you can be absolutely secure knowing that these functions work perfectly.



	SINAMICS V90	SINAMICS G110M/G120C
		
Designation	Performance-optimized and easy-to-use servo drive system	Distributed and compact converters for variable-speed, low rating, single-motor drives
Application examples	<ul style="list-style-type: none"> • Electronics and assembly industry • Processing/printing industry • Packaging industry • Material handling machines 	<ul style="list-style-type: none"> • Conveyor technology • Handling equipment • Extruders, mixers • Pumps and fans • Compressors <p>in the production and process industries</p>
Power range	0.05–0.75 kW (1 AC 200–240 V) 0.05–2 kW (3 AC 200–240 V) 0.4–7 kW (3 AC 380–480 V)	G110M: 0.37–4 kW G120C: 0.55–18.5 kW
Motors	Synchronous motors	Asynchronous motors
Fail-safe communication PROFIBUS/PROFINET with PROFI-safe profile	–	✓
Integrated safety functions		
Safe torque off (STO)	✓	✓
Safe stop 1 (SS1)	–	–
Safe brake control (SBC)	–	–
Safe brake test (SBT)	–	–
Safely-limited speed (SLS)	–	–
Safe direction (SDI)	–	–
Safe speed monitor (SSM)	–	–
Safe operating stop (SOS)	–	–
Safe stop 2 (SS2)	–	–
Safe position (SP)	–	–
Safely-limited position (SLP)	–	–
Certifications		

Variable-speed drive applications

SINAMICS G120



The modular converter for single-motor drives with low up to medium power ratings

- Conveyor technology
- Handling equipment
- Extruders, mixers
- Pumps and fans
- Compressors

in the production and process industries

0.37–250 kW

Asynchronous motors

✓

✓

✓

✓

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✓

✓

✓

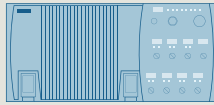
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SINAMICS G120D



Modular, distributed converters for variable-speed single-motor drives with a high degree of protection

- Conveyor technology and many more for high-performance solutions

0.75–7.5 kW

Asynchronous motors

✓

✓

✓

–

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✓

✓

✓

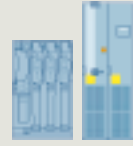
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SINAMICS G130/G150



Converters for variable-speed single-motor drives with average up to high power ratings

- Pumps and fans
- Compressors
- Extruders and mixers
- Mills

G130: 75–800 kW/
G150: 75–2700 kW

Asynchronous/synchronous motors

✓

✓

✓

✓

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SIL 2 acc. to IEC 61508, Cat. 3 or PL d according to EN ISO 13849-1

High-performance and motion control applications

SINAMICS S110



Single-axis positioning drive

- Handling equipment
- Feed/removal equipment
- Automatic assembly machines
- Adjuster axes
- Tool changers

0.12–90 kW

Asynchronous/synchronous motors

✓

SINAMICS S120



Modular drive system
for demanding single-axis/multi-axis applications

- Production machines: machines, systems and process lines in the packaging, textile, printing, paper, wood, glass, ceramic and plastic sectors
- Presses
- Converting applications
- Handling equipment
- Paper machines, rolling mills, marine applications

1.6–4500 kW

Asynchronous/synchronous/torque/linear motors

✓

SINAMICS S150



Converters for demanding variable-speed single-motor drives

- Test stand drives
- Centrifuges
- Elevator and crane systems
- Cross-cutters and shears
- Conveyor belts
- Presses
- Cable winches

75–1200 kW

Asynchronous/synchronous/torque motors

✓

✓

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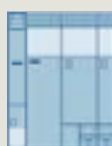
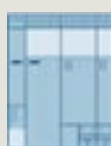

✓

✓

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✓

✓

	SIMOTION D	SINUMERIK 840D sl		SINUMERIK 828
				
Designation	Automation solution for production machines Control and drive system for production machines based on the SINAMICS S120 drive system	Automation solution for machine tools		
Application examples	<ul style="list-style-type: none">Automation equipment for machines in the packaging, textile, printing, wood, glass, ceramic and plastic sectors along with metal forming technologyConverting applicationsHandling equipment	<ul style="list-style-type: none">Machine tools: milling, turning, grinding, nibbling, ...	<ul style="list-style-type: none">Machine tools: milling, turning, grinding	
Power range	1.6–107 kW	1.6–107 kW	1.6–107 kW	
Motors	Asynchronous/synchronous/torque motors	Asynchronous/synchronous/torque/linear motors	Asynchronous/synchronous/torque motors	
Fail-safe PROFIBUS/PROFINET communication with PROFIsafe profile	✓	✓	–	
Integrated safety functions				
	SIMOTION Safety Integrated	Safety Integrated SINUMERIK 840D sl	Safety Integrated plus* SINUMERIK 840D sl	Safety Integrated SINUMERIK 828
Safe torque off (STO)	✓	✓	✓	✓
Safe stop 1 (SS1)	✓	✓	✓	✓
Safe stop 2 (SS2)	✓	✓	✓	✓
Safe operating stop (SOS)	✓	✓	✓	✓
Safe brake control (SBC)	✓	✓	✓	✓
Safe speed monitor (SSM)	✓	✓	✓	✓
Safely-limited speed (SLS)	✓	✓	✓	✓
SLS override	–	✓	✓	–
Safe acceleration monitor (SAM) (n<nx)	✓	✓	✓	✓
Safe cam (SCA)	–	✓	✓	–
Safely-limited position (SLP)	✓	✓	✓	✓
Safe position (SP)	✓	–	✓*	–
Safe direction (SDI)	✓	–	✓*	✓
Safely-limited speed (SLS) sensorless	✓	–	✓*	–

* With Safety Integrated plus, available from SINUMERIK software release 4.8 SP2



Specific advantages of drives with Safety Integrated

- Essential safety functions are simply activated instead of having to tediously create them using additional components
- Certified system solution in compliance with the applicable standards, including documentation
- Fewer components, simplified engineering, lower system costs
- No additional wiring costs, less space required in the electrical cabinet
- Faster commissioning/maintenance
- Drive response in-line with the situation, faster restart for a high degree of productivity

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