Safety Integrated for Drives and Motion Control

All-in-one solution for standard and safety technology

Brochure · April 2011
Safety Integrated in automation and drive technology

Today, machines and systems are becoming increasingly flexible and productive. Nevertheless, the machines must satisfy the safety requirements of the respective country and they must not pose risks to operating personnel.

Conventional safety technology is at its limits here. With integrated safety technology, you can satisfy today's requirements. With integrated safety functions, entirely new safety concepts can be cost-effectively implemented thanks to the short response times and the low wiring overhead. This means that safety and productivity can both be increased at the same time. Siemens offers a comprehensive range of products for this, which can be used to create a coherent overall concept for safety.

Integrated safety technology from Siemens is characterized by:

• An extensive range of products, from safety sensors, switching devices, controllers and communication to drive technology, all from a single source
• Integration of safety technology into the standard automation and drive technology
• Uniform engineering
• Reliable communication via standard fieldbus systems

Benefits

• Highly effective safety: integrated, from the sensor and processing unit all the way to the actuator
• Extremely cost-effective: thanks to reduced hardware and installation costs
• Easy system coupling: by means of safety-related communication via standard field buses
• Effective and fast diagnostics: for a high degree of availability of machines and plants
• Products, systems, solutions, and service: everything from a single source
• Increased productivity:
  - Fast troubleshooting and comprehensive diagnostics functions reduce downtimes
  - The products are certified according to the applicable safety standards (see tables on pages 28 - 31)
  - Rapid restart of systems after operator interventions

The Siemens product portfolio for safety engineering

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Communicate safely

▪ AS-Interface with ASIsafe, PROFIBUS and PROFINET with PROFIsafe (PROFINET also wireless)
Safety Integrated

Customized safety solutions for any automation task

With its range of safety components, Siemens is able to offer a customized safety solution for almost any application. This includes both stand-alone solutions in simple automation tasks and integrated solutions with a higher-level controller in comprehensive automation applications.

Stand-alone safety solutions for small to medium-sized automation tasks

For small automation solutions, it is often sufficient to connect (hardwire) a limited number of safety-related components to an evaluation unit. To do this, you can use either the SIRIUS 3TK28 safety relay or a modular SIRIUS 3RK3 safety system. The SIRIUS 3TK28 with special functions such as standstill or rotary speed monitoring can be used for monitoring applications with drives without a safety function. For an extensive plant, the AS-i safety monitor is suitable for the evaluation of safety-related signals via an AS-interface.

Integrated safety solutions for production automation with SIMATIC

The SIMATIC automation system plays a central role in processing and coordinating safety-relevant processes in industrial automation and it is now the standard in many instances. The Safety Integrated portfolio is harmonized along these lines so that applications can be integrally designed. A SIMATIC operates without any problems in conjunction with the drive technology (SINAMICS, SIMATIC ET 200), low-voltage switchgear and controlgear (SIRIUS), and sensors from Siemens. Communication is carried out via PROFIBUS or PROFINET using the PROFIsafe standard.

Integrated safety solutions for machine tools with SINUMERIK

The integrated safety functions of SINUMERIK Safety Integrated are used in the machine tools sector. They are redundantly integrated in NC\textsuperscript{1)}, the drive and the internal PLC and are used to monitor speed, standstill, and position. Such monitoring is necessary if the danger zone of the machines and systems is not blocked off. However, even in test mode or production mode, it provides effective operator protection as well as protection of tools, materials, and machines.

\textsuperscript{1) NC: Numeric Control}

In machines and systems, automated movements present huge potential risks. For this reason, drives always play a central role in safety solutions, regardless of the complexity of an automation task. Siemens drives are designed in such a way that they can be easily integrated into any of the safety solutions shown. With their integrated safety functions, they provide the basis for implementing highly effective safety concepts.
Advantages of drive-integrated safety functions

Electrically driven assemblies and machine components often pose a huge potential risk. Rotating units such as saws, rollers and spindles can cause serious or even fatal injuries. The same applies to machine units that have a linear motion such as handling axles and machine slides. The measures for guaranteeing the safety of the operating personnel are governed by country-specific regulations.

When drives without integrated safety technology are used, operator protection was previously implemented through the use of additional hardware components such as contactors and safety relays, and interlock circuits. In danger situations, the systems are shut down and have to be restarted later. This sometimes leads to long downtimes and has a negative impact on productivity. In the worst case scenario, the operator is tempted to manipulate the safety devices.

In modern drives, safety functions are becoming increasingly integrated. Using drives with integrated safety technology can mean that previously required electromechanical components and their associated wiring can be omitted. Even the transmission of safety-relevant signals can be done via standard field buses, which reduces the complexity and overhead of wiring. This considerably simplifies the implementation of safety concepts. In addition, they allow for considerably more efficient safety concepts, both in terms of functionality and in terms of response times. This often even causes an increase in productivity.

The use of certified integrated safety functions simplifies the certification of the safety category that is required for a machine. The user is also supported by the online safety evaluation tool (see www.siemens.com/safety-evaluation-tool).

Integrated safety technology reduces the costs for components and wiring.
The most important integrated safety functions for drives

Description of possible application areas and advantages for the customer

The implementation of safety concepts is based on the idea that safety-relevant events will first be recorded, then evaluated, and then responded to accordingly. An overview of the Siemens components available for this purpose can be found in the table on page 2.

Fail-safe drives are characterized by their "integrated safety functions", which they provide to the user as possible responses to safety-relevant events. The most important integrated safety functions available for Siemens drives are described in the following. The functional safety of all of the functions satisfies the requirements defined in Part 5-2 of the international standard IEC 61800 for variable-speed drive systems.

The drive-integrated safety functions can be roughly divided into two categories:

Functions for safely stopping the drive without having to disconnect the connection to the mains. This includes the following functions:

- **Safe Torque Off (STO):**
  This function ensures that no torque is released at the motor shaft any longer.

- **Safe Stop 1 (SS1):**
  This function actively brakes a drive before the STO function is activated. In the event of danger, drives with a high kinetic energy can be brought to a standstill as quickly as possible using this function.

- **Safe Stop 2 (SS2):**
  Like the SS1 function, the SS2 function actively brakes the drive. In a standstill, however, the SOS function is used instead of STO. Just as with SS1, drives with a high kinetic energy can be brought to a standstill extremely quickly in a hazardous situation.

- **Safe Operating Stop (SOS):**
  As an alternative to STO, you can use the SOS function. In contrast to STO, the motor is not released from all torque. Instead, the drive remains in position control, holds its position, and it is monitored to detect zero speed.

- **Safe Brake Control (SBC):**
  This function safely applies a holding brake after STO is activated, which means that the drive can no longer move, e.g. due to gravity.

Functions for safely monitoring the speed of a drive:

- **Safe Speed Monitor (SSM):**
  This function reports the failure to reach a specified speed. No drive-autonomous response occurs.

- **Safe Direction (SDI):**
  This function monitors adherence to the selected direction of motion/rotation of the drive.

Further additional safety functions are available specially for safety solutions in machine tools in connection with the SINUMERIK computerized numerical control.

- **Safely-Limited Position (SLP):**
  This function prevents a specified position from being exceeded. With this function, a work area/protected area limitation or traversing range limitation can be implemented for specific axes.

- **Safe Cam (SCA):**
  This function outputs a safe signal if the drive is within a specified position range. This function can be used to implement a reliable range recognition for specific axes.

- **Safe brake management (SB):**
  Safe brake management consists of a safe braking signal and a safe brake test. The safely activated and tested brake, in combination with the safely monitored drive, results in a redundant stopping system for fall protection at vertical axes.

- **Safe programmable logic:**
  Using safe programmable logic, it is possible to connect safety-related sensors and actuators directly to the control unit’s I/O, without external evaluation units, and to evaluate them using software.
The most important integrated safety functions for drives

Description of possible application areas and advantages for the customer

Safe Torque Off (STO)

The STO function is the most common and basic drive-integrated safety function. It ensures that no torque-generating energy can continue to affect a motor and prevents unintentional start-ups.

Effect
This function is a mechanism that prevents the drive from restarting unexpectedly, in accordance with EN 60204-1, Section 5.4. The Safe Torque Off function clears the pulses of the drive. The drive is reliably torque-free. This state is monitored internally in the drive.

Applications
STO has the immediate effect that the drive cannot supply any torque-generating energy. STO can be used wherever the drive will reach a standstill in a sufficiently short time based on the load or friction or when coasting down of the drive will not have any relevance for safety.

Customer benefits
The advantage of the integrated STO safety function compared to standard safety technology using electromechanical switchgear is the elimination of separate components and the effort that would be required to wire and service them. Because of the rapid electronic switching times, the function has a shorter switching time than the electromechanical components in a conventional solution.

Safe Stop 1 (SS1)

The SS1 function causes a motor to stop rapidly and safely and switches the motor to torque-free mode after the standstill, i.e. STO is activated.

Effect
The Safe Stop 1 function can safely stop the drive in accordance with EN 60204-1, Stop Category 1. When the SS1 function is selected, the drive brakes along a quick stop ramp autonomously and automatically activates the Safe Torque Off and Safe Brake Control functions (if enabled) when the parameterized safety delay timer expires.

Applications
The SS1 function is used when in the event of a safety-relevant incident the drive must stop as quickly as possible with a subsequent transition into the STO state. It is thus used to bring large centrifugal masses to a stop as quickly as possible for the safety of operating personnel, or to brake motors at high speeds as quickly as possible. Typical application examples include:

- Saws, grinding machine spindles, centrifuges, stacker cranes

Customer benefits
The targeted stopping of a drive by means of SS1 reduces the risk of danger, increases the productivity of a machine, and allows safety clearances in a machine to be reduced. The reason is the active stopping of the drive compared to the use of the STO function alone.
Safe Operating Stop (SOS)

With the SOS function, the stopped motor is kept in its position and monitored by a drive control.

Effect
The Safe Operating Stop function represents safe standstill monitoring. The drive control remains in operation. The motor can therefore deliver the full torque to hold the current position. The actual position is reliably monitored. In contrast to safety functions SS1 and SS2, the speed setpoint is not influenced automatically. After SOS has been activated, the higher-level control must bring the drive to a standstill within a parameterized time and then hold the position setpoint.

Applications
SOS is an ideal solution for applications in which the machine or parts of the machine must be at a safe standstill in certain steps, but the drive must also supply a holding torque. It is ensured that despite counter torque the drive remains in its current position. In contrast to SS1 and SS2, the drive does not brake autonomically in this case. It expects the higher-level controller to shut down the relevant axes as a coordinated group within an adjustable delay time. This can be used to prevent any damage to the machine or product.

Customer benefits
No mechanical components are necessary to keep the axis in position despite any counterforce that might appear. Due to the short switching times and the fact that the position control always remains active, setup and downtimes are reduced. Recalibration of the axis after exiting the SOS function is not necessary. The axis can immediately be moved again after deactivation of the SOS function.

Safe Stop 2 (SS2)

The SS2 function shuts down a motor quickly and safely and then monitors the standstill positions.

Effect
The Safe Stop 2 function can safely stop the drive in accordance with EN 60204-1, Stop Category 2. When the SS2 function is selected, the drive brakes autonomously along a quick-stop ramp. In contrast to SS1, the automatic speed control remains operational afterwards, i.e. the motor can supply the full torque required to maintain zero speed. Standstill is safely monitored (Safe Operating Stop function).

Applications
As with SS1, the SS2 function ensures the quickest possible deceleration of the motor. However, the motor power is not switched off, but prevented by a control system from leaving the standstill position even if affected by external forces.

Customer benefits
The SS2 function ensures a rapid axis stop. Because the control remains active, after the safety function is deselected, productive operation can continue without referencing. This ensures short setup and standstill times and high productivity.
The most important integrated safety functions for drives

Description of possible application areas and advantages for the customer

Safe Brake Control (SBC)

The SBC function permits the safe control of a holding brake. SBC is always activated in parallel with STO.

Effect
A holding brake which is active in a de-energized state is controlled and monitored using safe two-channel technology. Due to the two-channel control, the brake may still be activated in the event of an insulation fault in the control cable. Errors of this kind are detected early by means of test pulses.

Application
The SBC function is used in conjunction with the functions STO or SS1 to prevent the movement of an axis in the torque-free state, e.g. because of gravity.

Customer benefits
Again, the function saves the use of external hardware and the associated wiring.

Safely-Limited Speed (SLS)

The SLS function ensures that the drive does not exceed a preset speed limit.

Effect
The drive reliably monitors the speed and activates a fault response defined by the configuration if the set speed.rpm limit is exceeded.

Application
The SLS function is used if people are in the danger zone of a machine and their safety can only be guaranteed by reduced speed. First, therefore, the speed is reduced, then safe monitoring is activated using the SLS function so that accidental exceeding of the set speed limit is prevented. Typical examples are cases in which an operator must enter the danger zone of the machine for maintenance or setup. A typical use of SLS is a winder, in which the material is manually threaded by the operator. To prevent injury to the operator, the roller may only spin at a safe reduced speed. SLS is often also used as part of a two-stage safety concept. While a person is in a less critical zone, the SLS function is activated, and the drives are only stopped in a smaller area with higher potential risk. SLS can be used not only for operator protection, but also for machinery protection, e.g. if a maximum speed must not be exceeded.

Customer benefits
The SLS function can contribute to a significant reduction in downtime, or greatly simplify or even accelerate setup. The overall effect achieved is a higher availability of a facility. Moreover, external components such as speed monitors can be omitted.
Safe Speed Monitor (SSM)

The SSM function warns when a drive is working below a specified speed/feed speed. As long as it remains below the threshold, the function issues a safety signal.

Effect
If a speed value drops below a parameterized level, a safety signal is generated. This can be processed, for example, in a safety controller to respond to the event by programming, depending on the situation.

Application
With the SSM function, in the simplest case, a safety door can be unlocked if the speed drops below a non-critical level.

Customer benefits
Unlike SLS, there is no drive-independent fault reaction when the speed limit is exceeded. The safe feedback can be evaluated in a safety control unit, allowing the user to respond appropriately to the situation.

Safe Direction (SDI)

The SDI function ensures that the drive can only rotate in the selected direction.

Effect
A deviation from the currently monitored direction of motion/rotation is reliably detected and the configured autonomous fault response of the drive is initiated. It is possible to monitor both directions of motion optionally.

Application
The SDI function is used if the drive must only move in one direction. A typical application is to make a danger zone accessible to the operator, provided the machine is moving in the safe direction, i.e. away from the operator. In this status, the operator can safely feed material into or remove it from the work area.

Customer benefits
The function does away with the use of external components such as speed monitors and the associated wiring expense. The release of a danger zone while the machine is moving away from the operator also raises productivity. Without the SDI function, the machine would have to be stopped safely while material was fed in or removed.
Motor starters, drives, and motion control systems with integrated safety functions

Depending on the required motion profile, a variety of components will in practice be deployed for the movement of the motors.

Siemens offers a comprehensive product portfolio with integrated safety features that allows the economical implementation of effective safety concepts for each application profile:
- Motor starters and motor management system for the simplest of movements with fixed speed
- Frequency converters for variable-speed operation of motors
- Drives for precise and dynamic positioning and motion control tasks
- Numerical controls for path control in machine tools and production machines.

The following table provides an overview of which products are available for which applications. More information about the individual products is provided in the following chapters.

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<td>Conveyor systems, pumps, extruders, mixers, mills, aggregates</td>
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<td>Frequency converters SIMATIC ET 2005 FC SINAMICS G120C SINAMICS G120 SINAMICS S110G120D SINAMICS G130 SINAMICS G150</td>
<td>Positioning drives SINAMICS S110 Drive for high-performance and motion control applications SINAMICS S120 SINAMICS S150</td>
<td>Automation system for machine tools and production machines SINUMERIK 840D SINUMERIK 840D sl SINUMERIK 828D</td>
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Additional information:
www.siemens.com/sinamics
www.siemens.com/sinumerik
Safety motor starters and safety motor management system

For applications with fixed speed

If an application only needs to operate motors in network mode with a fixed speed, motor starters are used to control the motors, to limit start-up currents, and for soft starting. In addition to the individual devices from the SIRIUS product family, Siemens offers motor starters integrated into the SIMATIC ET 200 I/O system, specifically for use in a SIMATIC environment. These are especially useful for use in materials handling applications, for example in the automotive field. The STO safety function can be optionally implemented with the motor starters of the SIMATIC ET 200S/ET 200pro I/O systems via an add-on module.

The motor starters are fully integrated with the SIMATIC ET 200S/ET 200pro I/O systems, both in terms of construction and data. Mounting, wiring, and commissioning can thus be implemented very efficiently. The motor starters utilize the system mechanisms of these I/O systems and thus also simplify diagnostics in the event of a fault.

Most important features:
• Switching of three-phase induction motors as direct starter, reversing starter
• Simple assembly and wiring
• Simple setup of multi-motor drive solutions by self-assembling communication and supply rails in the backplane bus
• Efficient diagnostics

The SIMOCODE pro motor management system is also used for fixed-speed motors. By combining the widest range of protection, control, communication and monitoring functions, it is particularly suitable for use in the process industry. The extension of the basic system with a safety digital module permits the safe shutdown of motors according to the applicable standards.

Most important features:
• Optimum connection of operational and safety-related switching of induction motors
• Flexibly adjustable safety functions
• Integrated diagnostics

As a matter of principle, two different safety concepts are available:

- LOCAL SOLUTION:
  ideal for safety applications limited to a local area. They function autonomously and are therefore not dependent on a safe control.

- PROFIsafe SOLUTION:
  optimum solutions for particularly demanding and intermeshed safety applications; in combination with a safety controller and the PROFIBUS bus system (safety motor starter and SIMOCODE pro) or PROFINET (safety motor starter).

The control of the safety functions via PROFIBUS DP or PROFINET is possible by using a PROFIsafe profile. The motor starters and the motor management system are certified for applications up to Cat. 4 (EN 954-1), up to SIL 3 (IEC 61508/62061) and up to PL e (EN ISO 13849-1).
**Frequency converters with integrated safety functions**

**For applications with variable speed**

Frequency converters are used to operate motors with variable speed. Typical areas of application are standard applications in which the operation of the motors with variable speed is desired: pumps, fans, compressors, conveyor applications; but frequency converters are also used in the operation of extruders and hoists.

Siemens offers a comprehensive range of frequency converters in various forms for different key applications. They not only have the basic integrated safety features such as Safe Torque Off, but are also characterized by high-quality integrated safety functions.

The following frequency converters with integrated safety functions are available:

- **SINAMICS G120D**
  Frequency converter for single drives with low performance of 0.37 – 7.5 kW with high degree of protection for distributed use

- **SINAMICS G120C**
  Compact frequency converter for individual drives with outputs from 0.55 to 18.5 kW as built-in device

- **SINAMICS G120**
  Modular, flexible frequency converter for single drives with low to medium performance of 0.37 – 250 kW as a built-in unit for use in the control cabinet

- **SINAMICS G130**
  Modular frequency converter as built-in unit for single drives with medium to high performance of 75 – 800 kW

- **SINAMICS G150**
  Ready-to-use converter cabinet for medium to high performance of 75 – 2700 kW

These frequency converters are complemented by converters in SIMATIC design for integrated solutions with SIMATIC:

- **SIMATIC ET 200pro FC**
  Frequency converter for single drives with low performance of up to 1.5 kW with high degree of protection for distributed use in the SIMATIC ET 200pro I/O system

- **SIMATIC ET 200S FC**
  Frequency converter for single drives with low performance of up to 4 kW for distributed use in the SIMATIC ET 200S I/O system

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**SINAMICS G120C/G120 – Frequency converter for single drives with low to medium performance as a built-in unit for use in the control cabinet**

**SINAMICS G120C, G120 – central frequency converters**

SINAMICS G120C and G120 are frequency converters with IP20 degree of protection for installation in control cabinets. Both converters are provided for the variable-speed operation of induction motors in conveyor systems, but also in pumps, fans, compressors and other units in the commercial and industrial sectors. Due to their high pulse frequency, they are characterized by low-noise motor operation.

SINAMICS G120C is a
- compact device
- with V/f control or vector control (without encoder), and
- covers the power range from 0.55 kW to 18.5 kW.

SINAMICS G120C has a
- Profibus interface and controls the
- STO safety integrated function.

By comparison, the SINAMICS G120 is characterized by
- modular design and
- a wide performance range from 0.37 to 250 kW.
- It is equipped with a
- host of drive functions: V/f control, vector control (with/without encoder), torque control, ...
- in addition to STO, the safety integrated functions SS1, SBC, SLS, SSM and SDI and can be supplied with
- several fieldbus interfaces, including Profibus and Profinet.

Due to the option of line regeneration, particularly energy efficient operation is possible with the SINAMICS G120.

The control of the safety functions via PROFIBUS DP or PROFINET is possible by using the PROFIsafe profile. Likewise, the safety functions can be controlled locally via the onboard fail-safe inputs. The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).
**SINAMICS G120D** – Frequency converter for single drives with low performance and high degree of protection for distributed use

The SINAMICS G120D is a frequency converter with high IP65 degree of protection for distributed use. The main areas of use are conveyor systems, e.g. in the automotive, airport logistics, distribution logistics/overhead monorail conveyors as well as in the food and beverage sectors (without tensides).

**Most important features:**
- Variable-speed operation of three-phase induction motors with capacities ranging from 0.75 to 7.5 kW using V/f control or vector control (with/without a speed sensor)
- Digital inputs/outputs onboard for connection and processing of drive-related sensors and actuators
- Optional communication via PROFINET DP, PROFINET connection
- Compact, space-saving, slim design
- Energy-efficient operation through line regeneration
- Cooling by means of convection (0.75 – 3 kW) or integrated fan (from 4 kW)
- Integrated EMC filter, integrated brake control, and integrated protection against overtemperature

STO, SS1, and SLS are available as integrated safety functions. The functions require no encoders\(^1\). The safety functions are controlled via PROFINET DP or PROFINET using the PROFINet profile. The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).\(^1\)

\(^{1}\) SS1 and SLS are not allowed in encoderless operation for drawing loads such as hoisting gear or unwinders. The use of SINAMICS S110/S120 is recommended for this purpose.
Frequency converters with integrated safety functions

For applications with variable speed

SINAMICS G130 / SINAMICS G150 – Frequency converters for single drives with medium to high performance of 75 – 2700 kW

SINAMICS G130 built-in devices and SINAMICS G150 cabinet units are designed for high-performance variable-speed drives without line regeneration. Their main fields of application are material handling equipment, pumps, fans, compressors, extruders, mixers, and mills. While the SINAMICS G130 is a modular built-in unit with low degree of protection for installation in the control cabinet, the SINAMICS S150 is a ready-to-connect cabinet device.

Most important features:
- Variable-speed operation of induction and synchronous motors using V/f control or vector control (with/without speed sensor) in the performance range:
  - 75 – 800 kW (SINAMICS G130)
  - 75 – 2700 kW (SINAMICS G150)
- Digital inputs/outputs, analog inputs/outputs onboard for connection and processing of drive-related sensors and actuators
- Optional communication with PROFINET and PROFIBUS DP
- Compact, space-saving design
- Integrated EMC filter, integrated brake control, and integrated protection against overtemperature
- Cooling via heat sinks and integrated fan
- Menu-driven commissioning, operation, and diagnostics with the Advanced Operator Panel AOP30
- Degree of protection:
  - SINAMICS G130: IP00 or IP20, depending on type
  - SINAMICS G150: IP20, optional IP21, IP23, IP43 and IP54

STO and SS1 are available as integrated safety functions. The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).

SINAMICS G130 and G150 support the PROFIsafe profile both with PROFIBUS and with PROFINET.
SIMATIC ET 200pro FC/SIMATIC ET 200S FC – Frequency converter integrated into the ET 200 I/O system for use with PLCs

Complementing the frequency converters of the SINAMICS drive family, Siemens also offers frequency converters integrated in the SIMATIC ET 200 I/O system specifically for use in a SIMATIC environment. They are also optionally available with integrated safety features.

- **SIMATIC ET 200S FC**
  Frequency converters with IP20 degree of protection and outputs up to 4 kW.

- **SIMATIC ET 200pro FC**
  Frequency converters with high IP65 degree of protection and outputs up to 1.5 kW.

The converters are fully integrated with the SIMATIC ET 200S/ET 200pro I/O systems, both in terms of construction and data. Mounting, wiring, and commissioning can thus be implemented very efficiently. The converters utilize the system mechanisms of these I/O systems and thus also simplify diagnostics in the event of a fault.

Most important features:
- Variable-speed operation of induction motors using V/f control, SLVC or vector control (ET 200S FC only) for outputs up to:
  - 4 kW (SIMATIC ET 200S FC)
  - 1.5 kW (SIMATIC ET 200pro FC)
- Torque control
- Degree of protection
  - SIMATIC ET 200S FC: IP20
  - SIMATIC ET 200pro FC: IP65
- Energy-efficient operation through line regeneration facility
- Simple setup of multi-motor drive solutions by self-assembly of communication and supply rails in the backplane bus
- Efficient diagnostics

STO, SS1, and SLS are available as integrated safety functions. The SS1 and SLS functions do not require an encoder\(^1\). The control of the safety functions via PROFIBUS DP or PROFINET is possible by using a PROFIsafe profile. The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).

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\(^1\) SS1 and SLS are not allowed in encoderless operation for drawing loads such as hoisting gear or unwinders. The use of SINAMICS S110/S120 is recommended for this purpose.
High-performance and motion control drives with integrated safety functions

For demanding single and multi-axis applications

Siemens offers drives with integrated safety functions for every kind of demanding application.

Given the often rapid movement sequences, the high forces, and the sometimes large moving masses, the short delay times of integrated safety functions also offer a much higher level of protection against personal injury and material damage than conventional safety concepts. In addition, completely new safety functions that were not previously possible allow the implementation of innovative safety concepts in a cost-effective manner.

The result is machines and systems that offer increased safety without a serious reduction in productivity.

The following drives are available:

- **SINAMICS S110**
  - the single-axis drive for simple positioning tasks
- **SINAMICS S120**
  - the drive system for demanding and high-performance applications
- **SINAMICS S150**
  - the converter cabinet for demanding, variable-speed single drives.

Together with other safety components, the SINAMICS S110 and SINAMICS S120 can be integrated in automation solutions that satisfy the highest safety requirements either with fixed wiring or - even simpler - via a standard fieldbus using the PROFINET profile.

**SINAMICS S110 – The single-axis drive for simple positioning tasks**

When it comes to a solution for standard positioning tasks with synchronous servo motors or induction motors, the SINAMICS S110 is the first choice.

The most important characteristics of the SINAMICS S110 are:
- Servo-controlled positioning of synchronous servo motors and induction motors in the output range of 0.12 – 90 kW
- The positioning of rotary and linear axes
- Point-to-point positioning, simple traversing profiles, flying positioning, travel to fixed stop
- Relative traversing procedures, positioning at absolute positions
- Positioning with jerk limitation

STO, SOS, SS1, SS2, SLS, SSM, and SBC are available as integrated safety functions. Safety-related signals can be transmitted via fail-safe onboard inputs/outputs, or via PROFIBUS and PROFINET using the PROFINET profile. The SS1, SLS and SDI functions can also be used without encoders.

SINAMICS S110 is suitable for use in
- Handling equipment, feed and removal facilities
- Stacking units, assembly machines
- Laboratory automation
- Metalworking, wood, glass, ceramics industries
- Printing machines
- Tool changers, positioning axes
- Examination tables
- Solar panel tracking

The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).
SINAMICS S120 –
Drive system for demanding and high-performance applications.

Due to its high variance and scalability, a suitable drive solution for almost every motion control application in mechanical and plant engineering can be based on SINAMICS S120.

STO, SS1, SS2, SOS, SLS, SDI, SSM, and SBC are available as integrated safety functions. The SS1, SLS, SSM and SDI functions can also be used without encoders. Safety-related signals can be transmitted via fail-safe inputs/outputs, or via PROFINET using the PROFIsafe profile. The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).

Due to its properties, SINAMICS S120 is especially suitable for use in
- Packaging machines
- Plastics processing machines
- Textile machinery
- Printing machines
- Paper machines
- Hoisting gear
- Handling and assembly systems
- Rolling mills
- Test bays
- Machinery for the wood, glass, and ceramics industries

<table>
<thead>
<tr>
<th>SINAMICS S120 – designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modular drive system for demanding single/multi-axis applications</td>
</tr>
<tr>
<td>Units for single-axis applications</td>
</tr>
<tr>
<td>Blocksize</td>
</tr>
<tr>
<td>0.12 – 90 kW</td>
</tr>
</tbody>
</table>

SINAMICS S120 – The various designs with their respective performance ranges

SINAMICS S120 is the universal drive system for high-performance tasks in single and multi-axis applications.

It has the following features and characteristics:
- Different versions for single and multi-axis applications with outputs of 0.12 - 4500 kW which can also be combined with each other (see figure).
- Support for various types of control: V/f control, vector control, servo control
- Operation of both synchronous and induction motors including direct drives (torque motors, linear motors)
- Comprehensive range of functions: Positioning functions, integrated function modules, logic and arithmetic functions; along with the SIMOTION Motion Control system, machinery and systems can be fully automated even with the highest requirements regarding synchronization, dynamics, and performance.
- Various cooling types: Air, liquid, and cold plate cooling
- Different infeed concepts:
  - Basic Line Module (unregulated infeed),
  - Smart Line Module (unregulated infeed and feedback)
  - Active Line Module (regulated infeed and feedback)
Sample configurations of Safety Integrated solutions with SINAMICS S120

- Main applications:
  - motion control in multi-axis applications
  - SIMOTION D motion controller performs motion control tasks including machine control and drive-integrated safety functions
  - A SIMATIC F-CPU acts as a coordinating, higher-level safety controller, in the example shown a CPU 315F
  - Communication between drives and safety controller, e.g. via standard fieldbus (e.g. PROFINET) using the Profisafe profile

Additional information: www.siemens.com/simotion

- Main applications:
  - simple to medium-grade motion control in multi-axis applications
  - SIMATIC S7-300 TF CPU performs machine control including coordinating safety functions and motion control tasks.
  - Execution of the drive-integrated safety functions in the SINAMICS S120 drive system
  - Communication between drives and safety controller, e.g. via standard fieldbus (e.g. PROFINET) using the Profisafe profile

Additional information: www.siemens.com/t-cpu
SINAMICS S150 –
The converter cabinet for demanding, variable-speed single drives.

Because of their controlled infeed and energy recovery abilities, the SINAMICS S150 cabinet units are particularly suitable for requirements with high dynamics and speed accuracy, frequent braking cycles with high braking energies, and 4-quadrant operation.

The converter cabinet units are available for the output range 75 kW – 1200 kW.

SINAMICS S150 can be used in any application with the most stringent requirements for processes with dynamic and reproducible procedures, such as:
• Test bay drives
• Centrifuges
• Elevators and cranes
• Cross cutters and shears
• Conveyor belts
• presses
• Cable winches

STO, SS1, SS2, SOS, SLS and SSM are available as integrated safety functions. Safety-related signals can be transmitted via fail-safe inputs/outputs, or via PROFIBUS and PROFINET using the PROFIsafe profile.

The integrated safety functions are certified for applications up to Cat. 3 (EN 954-1), up to SIL 2 (IEC 61508) and up to PL d (EN ISO 13849-1).
CNC systems with integrated safety functions
For machine tool and production machines

For machine tool and production machines, user input is particularly frequent due to the individual production of workpieces. Situations in which a tool or workpiece is damaged after a long processing time because of the response to a safety-related incident are to be avoided. Often this involves considerable financial and time losses. For these reasons, powerful safety concepts are particularly important here.

With SINUMERIK Safety Integrated, the integrated package of safety functions for our SINUMERIK machine tools control, the implementation of innovative safety concepts that offer maximum protection for people and machines is particularly easy.

SINUMERIK Safety Integrated is a comprehensive safety package that helps to protect people as well as machines – and this very efficiently and economically – thanks to complete integration of safety functions in the control and drive technology. Plus, it makes your machine safe and practical to operate under all required operating conditions. For example, in setup and test operation while the protective door is opened.

SINUMERIK Safety Integrated is available for the following systems:

- **SINUMERIK 840D sl**
  Universal machine tool control with the SINAMICS S120 drive system

- **SINUMERIK 840D**
  Universal machine tool controller with the SIMODRIVE 611 drive system

- **SINUMERIK 828D**
  Compact universal machine tool controller for standard turning and milling machines

The function scope includes, e.g.:

- Functions for safely monitoring of speed and standstill
- Functions for establishing safe boundaries in work spaces and protected spaces, and for range recognition
- Direct connection of all safety-related signals and their internal logical linkage

The integrated safety functions meet the requirements of Category 3 as well as performance level PL d according to DIN EN ISO 13849-1 and the Safety Integrity Level SIL 2 to DIN EN 61508. This enables the essential requirements for functional safety to be implemented easily and economically.

**SINUMERIK 840D sl – Universal machine tool control with the SINAMICS S120 drive system**

SINUMERIK 840D sl is the new machine tool control with the SINAMICS S120 drive system. It provides modularity, openness, flexibility, a uniform operating and programming structure, visualization, optimal integration into networks, and provides a system platform with groundbreaking functions for virtually any technology. Integrated into the SINAMICS S120 compact modular drive system with high power density and supplemented by the SIMATIC S7-300 automation system, the SINUMERIK 840D sl is a powerful integrated system that is best suited for the medium and upper performance ranges.

**Benefits**

SINUMERIK 840D sl, the powerful CNC system for demanding solutions, is

- **Efficient** in terms of programming, installation, commissioning, and design
- **Innovative** in terms of NC functions, communication, operation, and openness
- **Compatible** with SINUMERIK 840D in terms of programming, operating philosophy, machine interface, and motors

**Operating range**

The SINUMERIK 840D sl can be used worldwide for turning, drilling, milling, grinding, laser machining, nibbling, punching, in tool and mold making, for high-speed cutting applications, for wood and glass processing, for handling operations, in transfer lines and rotary indexing machines, for mass production and shop floor production.
SINUMERIK Safety Integrated is extremely flexible in terms of communication with other safety-redundant components:

- Safety-related communication via standard bus
  Connection of distributed I/O for process and safety signals via PROFIBUS with PROFIsafe.
- Safe communication between several F controllers (e.g. SINUMERIK 840D sl, SIMATIC) via the PROFIBUS and PROFINET standard.
- Safe gateway between AS-i and PROFIBUS. Using the DP/AS-i F-Link, a safe gateway from ASIsafe to PROFIsecure can be implemented. The safety-related signals are collected via the AS-i bus.

Customer benefits

- High safety: Full implementation of safety functions in Category 3/SIL 2/PL d
- High flexibility: Practical safety and operating concepts can be implemented
- Very cost-effective: Reduction of hardware and installation costs
- High availability: Electromechanical switching elements susceptible to interference are omitted

Typical configuration of an automation solution based on SINUMERIK 840D sl with integrated safety functions
CNC systems with integrated safety functions
For machine tool and production machines

SINUMERIK 840D —
Machine tool controller with the SIMODRIVE 611 drive system

The following safety functions are available for SINUMERIK 840D and can be implemented for each axis and spindle:

- **Safe Stop 1 (SS1) and Safe Stop 2 (SS2)**
  Provides safe transition of the drive from motion to standstill when a monitoring device or a sensor (e.g. a light barrier) is triggered.

- **Safe Operating Stop (SOS)**
  Monitors the drives for standstill. The drives remain fully functional for position control.

- **Safe Torque Off (STO)**
  Pulse suppression of drives, providing safe electronic interruption of the power supply.

- **Safe Limited Speed (SLS)**
  Monitoring of configurable velocity limit values, e.g. during setup without acknowledgement button.

- **Safe Limited Position (SLP)**
  Variable traversing range limitations.

- **Safe Cam (SCA)**
  Range recognition.

- **Safe Programmable Logic (SPL)**
  Direct connection of all safety-related signals and their internal logical linkage.

- **Safe Brake Management (SBM)**
  Dual-channel brake control and cyclical brake test.

- **Integrated acceptance test.**
  Partially automated acceptance test for all safety-related functions. Simple operation of the test process, automatic configuration of trace functions and automatic generation of an acceptance record.

The SINUMERIK 840D is the CNC system platform for the automation of machine tools based on the SIMODRIVE 611 drive system, which has been on the market for many years. It is characterized by its scalability in terms of CNC functionality, performance, and quantity structure, so that based on the SINUMERIK 840D a suitable CNC solution can be created for almost every machine tool type.
SINUMERIK 828D – Compact universal machine tool controller for standard turning and milling machines

The SINUMERIK 828D is a panel-based CNC controller for demanding applications on turning and milling machines such as those typically used in the workshop. It combines CNC, PLC, operating and axis control functions in one compact and rugged unit. The safety functions of the SINUMERIK 828D are implemented on the basis of the drive-integrated safety functions of the SINAMICS S120 drive system.

The user has access to the following safety functions:

- Safe Torque Off (STO)
- Safe Stop 1 (SS1)
- Safe Brake Control (SBC)
- Safe Operating Stop (SOS)
- Safe Stop 2 (SS2)
- Safely-Limited Speed (SLS)
- Safe Speed Monitor (SSM)

The safety functions are controlled by means of external sensors and actuators and via the TM54F terminal module. This terminal module is a dual-processor IO interface with 4 failsafe digital outputs and 10 failsafe digital inputs. The failsafe digital inputs and outputs are designed as dual channels with an internal crossover data comparison.

Additional information: www.siemens.com/sinumerik
Innovative solutions for applications for standstill and speed monitoring

Standstill and speed monitoring – Appropriate solutions for any plant configuration

Automated production machines can generally be operated without manual intervention. But on every occasion there may be danger to the operating personnel which must be determined by means of risk assessment. As a result of this risk assessment, protective measures such as speed or standstill monitoring may be required.

A standstill monitor ensures that, if a person enters the danger zone, any motion that presents a danger is promptly brought to a standstill. The monitoring of speeds is necessary if personnel are to be protected during manual intervention in the process (e.g. maintenance) by reducing the linear or rotational speed of any moving machinery.

Safety Integrated offers reliable solutions for speed and standstill monitoring that are easily implemented for a wide variety of automation configurations. Apart from machine safety, however, productivity is also a crucial factor. Safety Integrated significantly reduces the length of machine standstills and waiting times for the personnel, facilitating a significantly quicker restart.

The chart below provides an overview of the various solutions for speed and standstill monitoring depending on the application.

The various options for speed and standstill monitoring of drives
SIRIUS safety relays for standstill and speed monitoring

The SIRIUS 3TK2810-0 standstill monitor detects the standstill status of a motor after shutdown and then enables access to the hazardous zones. Additional sensors are not necessary. The standstill monitor measures the induced voltage directly at the stator winding of the motor as it runs down. When this approaches zero, the unit recognizes the motor standstill and then controls the release of the safety door lock, for example. The voltage threshold $U_{on}$ and a subsequent delay time can be set by the user as required.

Advantages at a glance:

- Flexible in use – for use with a variety of motors or frequency converters
- Economical – no additional sensors required
- Higher plant availability – due to faster fault diagnosis and display on the fault LEDs

The SIRIUS 3TK2810-1 speed monitor simultaneously monitors three programmable limits for standstill, setup speed and automatic speed. In addition, a complete protective door monitoring with spring-loaded locking is integrated. The speed monitor is suitable for all common sensors for speed monitoring and meets all requirements according to SIL 3 or PL e. Simple parameter assignment and continuous diagnostics via the display enable faults to be corrected quickly at any time, often before they lead to a plant standstill.

Advantages at a glance:

- Speed and standstill monitoring with integrated protective door monitoring
- Shaft break detection
- Universal speed encoder can be used
- Parameter assignment via display
Sample configurations for speed and standstill monitoring

Standstill and speed monitoring in individual drive applications with SINAMICS frequency converters

Your requirement

You have a drive application in which an individual drive is to be operated with variable speeds. For safety reasons and/or to comply with applicable guidelines, you want a simple way of monitoring for standstill and/or adhering to a specified speed.

Our solution

In order to solve your application problem, you can use a frequency converter from the SINAMICS series with the integrated SOS and SLS safety functions, e.g. SINAMICS S110, SINAMICS S120 AC-Drive or SINAMICS S150; if you only want to monitor the speed, then the SINAMICS G120 and SINAMICS G120D can also be considered.

Example configuration

![Diagram of a drive system with safety components and connections]

Your benefits

Powerful and easily implemented solution:

- Because the safety functionality is integrated into the converter, no additional safety components are required
- Speed control possible without encoder
- No wiring expense (configuration instead of wiring)
- Small space requirements
- Flexible in its connection to higher level evaluation units/controllers (F-CPU, modular safety system, safety relay)
- With permanent wiring
- By fieldbus with PROFIsafe (PROFIBUS or PROFINET)
- Use of additional properties possible for energy-efficient operation, such as line regeneration capability of the converter
- Additional integrated safety functions can be used (STO, SS1, SSM, SDI, ...)

Notes on the diagrams:

- Connection is also possible to PROFINET or conventionally by means of terminals
- SIMATIC S7 F–CPU representing further possible safety evaluation units: WinAC RTX-F, SIRIUS 3RK3 modular safety system, SIRIUS 3TK28 safety relays, ASisafe safety monitor

Standstill and speed monitoring in multi-axis applications with SINAMICS drive system

Your requirement

You have a drive application in which several drives are to be operated at variable speeds (e.g. highly dynamic motion control applications). For safety reasons and/or to comply with applicable guidelines, you want a simple way of monitoring for standstill and/or adhering to a specified speed.

Our solution

To solve your application problem, you can use the SINAMICS S120 drive system with the integrated SOS and SLS safety functions.

Example configuration

![Diagram of a drive system with safety components and connections]

Your benefits

Powerful and easily implemented solution:

- Because the safety functionality is integrated into the converter, no additional safety components are required
- Speed control possible without encoder
- No wiring expense (configuration instead of wiring)
- Small space requirements
- Flexible in its connection to higher level evaluation units/controllers (F-CPU, modular safety system)
- With permanent wiring
- With fieldbus (PROFIBUS or PROFINET)
- Use of additional properties possible for energy-efficient operation, such as line regeneration capability of the converter
- Additional integrated safety functions can be used (STO, SS1, SSM, SDI, ...)
Standstill recording in single-drive applications with standstill monitor

Your requirement

You have a drive application in which an individual drive is to be operated at a fixed speed. In addition, for safety reasons and/or in order to comply with applicable guidelines, you want a simple way of monitoring for standstills.

Our solution

The sensorless standstill monitoring is provided by SIRIUS 3TK2810-0 safety relay. An evaluation unit is responsible for the protective door monitoring, guard control and emergency-stop shutdown.

Example configuration

![Diagram](image)

Your benefits

Simple, economical solution for implementing or retrofitting standstill monitoring in a plant.

- Solution requiring no software knowledge, implemented by hardware wiring alone.
- Solution that, due to the evaluation of the motor current, requires no encoder or other components for standstill recording.
- Flexible in its connection to higher level evaluation units/controllers (F-CPU, modular safety system, safety relay)
- With permanent wiring

Standstill and speed monitoring in individual drive applications with speed monitors

Your requirement

You have a drive application in which an individual drive is to be operated with variable speeds. For safety reasons and/or to comply with applicable guidelines, you want a simple way of monitoring for standstill and/or adhering to a specified speed. There are reasons for choosing a solution with an external speed monitoring device. For example, frequency converters without safety functions are already in use in the plant.

Our solution

The SIRIUS 3TK2810-1 safety relay for speed and standstill monitoring has an integrated protective door monitoring and guard control and is able to evaluate any encoder or NPN/PNP proximity switch.

Example configuration

![Diagram](image)

Your benefits

Simple, economical solution for implementing or retrofitting speed and standstill monitoring in a plant, if a converter with an integrated SOS or SLS safety function cannot be used.

- Solution requiring no software knowledge, implemented solely by assigning parameters via the display.
- Integrated protective door monitoring with guard control
- Use of universal speed encoders or proximity switches is possible
- Flexible in its connection to higher level evaluation units/controllers (F-CPU, modular safety system, safety relay)
- With permanent wiring
<table>
<thead>
<tr>
<th>Numeric control in machine tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SINUMERIK 840D sl</strong></td>
</tr>
<tr>
<td><img src="image1.png" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Designation</th>
<th>Automation solution for machine tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main applications</td>
<td>Control and drive system for machine tool and production machines on the basis of the SINAMICS S120 drive system</td>
</tr>
<tr>
<td>Application examples</td>
<td>• Machine tools: Milling, turning, grinding, nibbling...</td>
</tr>
<tr>
<td>Performance range</td>
<td>1.6 – 107 kW</td>
</tr>
<tr>
<td>Degree of protection</td>
<td></td>
</tr>
<tr>
<td>Line regeneration</td>
<td>Yes, optional</td>
</tr>
<tr>
<td>Control method</td>
<td></td>
</tr>
<tr>
<td>- V/f control</td>
<td>Yes</td>
</tr>
<tr>
<td>- Vector control with/without encoder</td>
<td>Yes</td>
</tr>
<tr>
<td>- Servo control</td>
<td>Yes</td>
</tr>
<tr>
<td>Motors</td>
<td>Induction/synchronous/torque/linear motors</td>
</tr>
<tr>
<td>Fail-safe communication</td>
<td>PROFIBUS with PROFIsafe profile</td>
</tr>
<tr>
<td>Integrated safety functions</td>
<td></td>
</tr>
<tr>
<td>- Safe Torque Off (STO)</td>
<td>Yes</td>
</tr>
<tr>
<td>- Safe Stop (SS1) (with/without encoder)</td>
<td>Yes/–</td>
</tr>
<tr>
<td>- Safe Brake Control (SBC)</td>
<td>Yes</td>
</tr>
<tr>
<td>- Safe Brake Test (SBT)</td>
<td>Yes</td>
</tr>
<tr>
<td>- Safely Limited Speed (SLS) (with/without encoder)</td>
<td>Yes/–</td>
</tr>
<tr>
<td>- Safe Direction (SDI) (with/without encoder)</td>
<td>Yes/–</td>
</tr>
<tr>
<td>- Safe Speed Monitor (SSM) (with/without encoder)</td>
<td>Yes/–</td>
</tr>
<tr>
<td>- Safe Operating Stop (SOS) (with encoder)</td>
<td>Yes</td>
</tr>
<tr>
<td>- Safe Stop (SS2) (with encoder)</td>
<td>Yes</td>
</tr>
<tr>
<td>- Safe Cam (SCA) (with encoder)</td>
<td>Yes</td>
</tr>
<tr>
<td>- Safely Limited Position (SLP) (with encoder)</td>
<td>Yes</td>
</tr>
<tr>
<td>Approvals</td>
<td>Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to EN 61508, PL d according to EN ISO 13849-1</td>
</tr>
</tbody>
</table>

Note:
- The encoderless safety functions on pages 28-31 apply in connection with induction motors.
- Induction motors and synchronous motors from Siemens AG for motion control applications (www.siemens.com/servomotors) are typically available with integrated sin/cos encoders. The application of the safety functions with encoder operation is therefore typical for them.
## Drive applications with fixed speed

<table>
<thead>
<tr>
<th>ET 200S motor starters</th>
<th>ET 200pro motor starters</th>
<th>SIMOCODE pro</th>
<th>SIMATIC ET 200S FC</th>
<th>SIMATIC ET 200pro FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor starter for distributed use</td>
<td>Motor starter for distributed use with high degree of protection</td>
<td>Motor management system for centralized and distributed use</td>
<td>System-integrated drive for demanding single or multi-axis applications</td>
<td>System-integrated distributed drive for demanding single or multi-axis applications with high degree of protection</td>
</tr>
<tr>
<td>Plant engineering</td>
<td>Machinery, manufacturing and assembly lines</td>
<td>Industrial machines and plants, particularly in process industry</td>
<td>Machinery and plants in industry (mechanical engineering)</td>
<td>Machinery and plants in industry (mechanical engineering)</td>
</tr>
<tr>
<td>• Greenhouses</td>
<td>• Food &amp; beverages</td>
<td>• Steel industry</td>
<td>• Pumps, fans, compressors</td>
<td>• Conveyor solutions</td>
</tr>
<tr>
<td>• Conveyor systems</td>
<td>• Transfer lines</td>
<td>• Machine tools</td>
<td>• Conveyor solutions</td>
<td>• Distributed conveyor systems, especially for high-performance solutions</td>
</tr>
<tr>
<td>Extendable to 16 A/7.5 kW</td>
<td>Up to 5.5 kW</td>
<td>IP20</td>
<td>Up to 800 kW</td>
<td>IP20</td>
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<td>IP65</td>
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<tr>
<td>Induction motors</td>
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<td>PROFIBUS/PROFINET with PROFIsafe profile</td>
<td>PROFIBUS with PROFIsafe profile</td>
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<td>Cat. 4 according to EN 954-1</td>
<td>Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to IEC 61508, PL d according to EN ISO 13849-1</td>
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</tbody>
</table>

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## Drive applications with variable speed

<table>
<thead>
<tr>
<th>SINAMICS G120C</th>
<th>SINAMICS G120</th>
<th>SINAMICS G120D</th>
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<tbody>
<tr>
<td>![Image]</td>
<td>![Image]</td>
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</tbody>
</table>

### Name
- **SINAMICS G120C**: Compact frequency converter for variable-speed individual drives with low outputs.
- **SINAMICS G120**: Modular frequency converters for variable-speed individual drives with low to medium output.
- **SINAMICS G120D**: Modular, distributed frequency converters for variable-speed individual drives with high degree of protection.

### Main applications
- **SINAMICS G120C**: Machines and plants for industrial and commercial applications (mechanical engineering, automotive, textiles, chemicals, printing, steel).
- **SINAMICS G120**: Machines and plants for industrial and commercial applications (mechanical engineering, automotive, textiles, chemicals, printing, steel).
- **SINAMICS G120D**: Machines and plants for industrial applications, particularly automotive, but also in airports (wet area without tensides), the food, beverages and tobacco industry, and distribution logistics (e.g. overhead monorail conveyors).

### Application examples
- **SINAMICS G120C**: • Conveyor systems • Handling devices • Extruders, mixers • Pumps and fans • Compressors in the production and process industry.
- **SINAMICS G120**: • Conveyor systems • Handling devices • Extruders, mixers • Pumps and fans • Compressors in the production and process industry.
- **SINAMICS G120D**: • Conveyor technology, above all for high-performance solutions.

### Performance range
- **SINAMICS G120C**: 0.55 – 18.5 kW
- **SINAMICS G120**: 0.37 – 250 kW
- **SINAMICS G120D**: 0.75 – 7.5 kW

### Degree of protection
- **SINAMICS G120C**: IP20
- **SINAMICS G120**: IP20
- **SINAMICS G120D**: IP65

### Line regeneration
- **SINAMICS G120C**: No
- **SINAMICS G120**: Yes, optional
- **SINAMICS G120D**: Yes

### Control method
- **SINAMICS G120C**: - V/f control: Yes
- **SINAMICS G120**: - V/f control: Yes
- **SINAMICS G120D**: - V/f control: Yes
- **SINAMICS G120C**: - Vector control with/without encoder:–/Yes
- **SINAMICS G120**: - Vector control with/without encoder:–/Yes
- **SINAMICS G120D**: - Vector control with/without encoder:–/Yes
- **SINAMICS G120C**: - Servo control: –
- **SINAMICS G120**: - Servo control: –
- **SINAMICS G120D**: - Servo control: –

### Motors
- **SINAMICS G120C**: Induction motors
- **SINAMICS G120**: Induction motors
- **SINAMICS G120D**: Induction motors

### Fail-safe communication
- **SINAMICS G120C**: PROFIBUS with PROFIsafe profile
- **SINAMICS G120**: PROFIBUS/PROFINET with PROFIsafe profile
- **SINAMICS G120D**: PROFIBUS/PROFINET with PROFIsafe profile

### Integrated safety functions
- **SINAMICS G120C**: - Safe Torque Off (STO): Yes
- **SINAMICS G120**: - Safe Torque Off (STO): Yes
- **SINAMICS G120D**: - Safe Torque Off (STO): Yes
- **SINAMICS G120C**: - Safe Brake Control (SBC): –
- **SINAMICS G120**: - Safe Brake Control (SBC): –
- **SINAMICS G120D**: - Safe Brake Control (SBC): –
- **SINAMICS G120C**: - Safe Brake Test (SBT): –
- **SINAMICS G120**: - Safe Brake Test (SBT): –
- **SINAMICS G120D**: - Safe Brake Test (SBT): –
- **SINAMICS G120C**: - Safely Limited Speed (SLS) (with/without encoder): –/–
- **SINAMICS G120**: - Safely Limited Speed (SLS) (with/without encoder): –/–
- **SINAMICS G120D**: - Safely Limited Speed (SLS) (with/without encoder): –/–
- **SINAMICS G120C**: - Safe Direction (SDI) 1) (with/without encoder): –/–
- **SINAMICS G120**: - Safe Direction (SDI) 1) (with/without encoder): –/–
- **SINAMICS G120D**: - Safe Direction (SDI) 1) (with/without encoder): –/–
- **SINAMICS G120C**: - Safe Operating Stop (SSM) (with encoder): –
- **SINAMICS G120**: - Safe Operating Stop (SSM) (with encoder): –
- **SINAMICS G120D**: - Safe Operating Stop (SSM) (with encoder): –
- **SINAMICS G120C**: - Safe Stop (SS1) (with/without encoder): –/–
- **SINAMICS G120**: - Safe Stop (SS1) (with/without encoder): –/–
- **SINAMICS G120D**: - Safe Stop (SS1) (with/without encoder): –/–
- **SINAMICS G120C**: - Safe Stop (SS2) (with encoder): –
- **SINAMICS G120**: - Safe Stop (SS2) (with encoder): –
- **SINAMICS G120D**: - Safe Stop (SS2) (with encoder): –

### Approvals
- **SINAMICS G120C**: Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to IEC 61508, PL d according to EN ISO 13849-1
- **SINAMICS G120**: Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to IEC 61508, PL d according to EN ISO 13849-1
- **SINAMICS G120D**: Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to IEC 61508, PL d according to EN ISO 13849-1

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1) Firmware version 4.4. (or higher)  
2) Applies only to Blocksize and Booksize devices  
3) In connection with sin/cos encoders
<table>
<thead>
<tr>
<th>SINAMICS G130/G150</th>
<th>SINAMICS S110</th>
<th>SINAMICS S120</th>
<th>SINAMICS S150</th>
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</thead>
<tbody>
<tr>
<td>High-performance and motion control applications</td>
<td>Single-axis positioning drive</td>
<td>Modular drive system for demanding single or multi-axis applications</td>
<td>Frequency converter for demanding variable-speed single drives</td>
</tr>
<tr>
<td>Frequency converters for variable-speed individual drives with medium to high output</td>
<td>Machines and plants for industrial applications, wherever solid, liquid, or gas substances must be moved, transported, pumped, or compressed</td>
<td>Simple positioning tasks with synchronous servo and induction motors</td>
<td>Continuous motion control, motion control tasks (including highly dynamic and coordinated positioning tasks) in multi-axis drives with a common, central power supply and intermediate DC circuit</td>
</tr>
<tr>
<td>Machines and plants for industrial applications, wherever solid, liquid, or gas substances must be moved, transported, pumped, or compressed</td>
<td>• Pumps and fans  • Compressors  • Extruders and mixers  • Mills</td>
<td>• Handling devices  • Feed/extraction equipment  • Assembly machines  • Positioning axes  • Tool changers</td>
<td>• Production machines: Machinery, equipment, and process lines in the packaging, textile, printing, paper, wood, glass, ceramics, and plastics industries  • Presses  • Converting applications  • Handling devices  • Paper machines, rolling mills, marine applications  • Test bay drives  • Centrifuges  • Elevators and cranes  • Cross cutters and shears  • Conveyor belts  • Presses  • Cable winches</td>
</tr>
<tr>
<td>G130: 75 – 800 kW / G150: 75 – 2700 kW</td>
<td>0.12 – 90 kW</td>
<td>1.6 – 4500 kW</td>
<td>75 – 1500 kW</td>
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<tr>
<td>IP20 / optional up to IP54 for SINAMICS G150</td>
<td>IP20</td>
<td>IP20 (optional up to IP54)</td>
<td>IP20 / optional up to IP54</td>
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<tr>
<td>Yes</td>
<td>No</td>
<td>Yes, optional</td>
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<td>Induction/synchronous motors</td>
<td>Induction/synchronous motors</td>
<td>Induction/synchronous/torque/linear motors</td>
<td>Induction/synchronous motors Torque motors</td>
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<td>PROFIBUS/PROFINET with PROFIsafe profile</td>
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<td>Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to IEC 61508, PL d according to EN ISO 13849-1, NFPA 79, NRTL-listed 4)</td>
<td>Cat. 3 according to EN 954-1 or EN ISO 13849-1, SIL 2 according to IEC 61508, PL d according to EN ISO 13849-1</td>
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4) Applies only to SINAMICS S120 Booksize!
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“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