The Fast and Easy Way to Safe Machines

Safety Integrated – Exploiting the advantages of integrated safety technology
“Safety Integrated facilitates the easy implementation of powerful safety concepts on the basis of Totally Integrated Automation.”

“The prevention of accidents must not be understood as a regulation required by law, but as a precept of human responsibility and economic reason.”

Werner von Siemens, 1880
Functional safety: From necessity to competitive advantage

The functional safety of machines and systems is subject to increasing requirements. On the one hand, this is owed to strict legal regulations for the protection of persons to be met by machine manufacturers and operators. On the other hand, any potential risks posed by a machine should be largely eliminated from the start for economic reasons.

Safety Integrated: Fast and easy implementation of functional safety
With Safety Integrated, we offer the world’s most unique and comprehensive portfolio of control, drive and switching technology which covers all requirements placed upon the functional safety of machines and systems.

Safety Integrated facilitates the seamless integration of safety technology in standard automation concepts. This entails decisive advantages, both for machine manufacturers and system operators: These advantages include reduced engineering expenditures, increased availability and system consistency. All in all, this means that Safety Integrated significantly eases and accelerates the realization of safe and productive machines.

With Safety Integrated, you receive reliable protection of persons, machines and the environment and benefit from maximum and sustainable efficiency and flexibility!

Functional safety: Success factor for machine manufacturers and system operators
• Enhanced productivity through increased machine availability: Reduction of unplanned downtimes and smoother production workflows
• Prolonged service life of the systems
• Avoidance of direct consequential costs of personal injuries (for medical care, wages and compensations)
• Avoidance of indirect consequential costs of injuries (e.g. fines due to non-compliance with regulations or repair costs)
• Enhanced global competitiveness through improved export capability of machines

The term functional safety refers to the part of the safety of a system which depends on the correct functioning of the safety-related (sub-)systems as well as external risk reduction devices.

Once again, Safety Integrated was honored with an award – the Frost & Sullivan Award. In a current best practice report, the renowned analysis company confirms the feasibility of highly innovative and cost-efficient solutions on the basis of Safety Integrated.
Guaranteed compliance: Standards and regulations

Siemens supports you!
As partner for all safety issues, we not only offer high-quality products and systems, but also help you to comply with international standards and regulations – with safety trainings, functional examples and certified products.

Mandatory in Europe, employed worldwide: Safe machines
European machine manufacturers (product safety) and machine operators (industrial safety) are required by law to ensure the protection of persons and the environment. The safety awareness is constantly increasing in many other countries where such legal regulations are not yet in place. Machines “provided” in Europe have to be safe – whether they are new or old. In this context, the term “provision” implies that the machine is manufactured or significantly modified in Europe – or is imported to and operated in Europe.

The basic requirements for machine manufacturers or system operators who significantly modernize and modify their machines themselves are laid down in corresponding European directives – for example in the machinery directives, EMC directives, etc.
European directives for machines

A machine is considered safe when it complies with the requirements of the machinery directive.

Safety requirements

- Article 95 EC Treaty (free movement of goods)
  - e.g. machines
- Article 137 EC Treaty (industrial safety)
  - Framework directive “Industrial Safety” (86/391/EEC)
- Low-Voltage Directive (2006/95/EC)
- Machinery Directive (2006/42/EC)
- Harmonized European standards
- Directive on health & safety requirements when using work equipment (2009/104/EC)
- National laws
- Machine and system operators

Presumption of conformity: Compliance with the respective directive is assumed with specific application of the harmonized standards.

Declaration of conformity: The machine manufacturer confirms compliance with the directive and attaches the CE mark to the machine.

Phase 1: Determination of applicable directives
Phase 2: Determination of the conformity assessment procedure
Phase 3: Determination of applicable standards
Phase 4: Implementation of risk assessment and measures
Phase 5: Preparation of technical documents
Phase 6: Preparation of declaration of conformity or incorporation
Phase 7: Quality assurance
Phase 8: Product surveillance, surveillance of regulations
Phase 9: Product surveillance, surveillance of regulations

CE conformity process for machines and systems
Step-by-step approach for safe machine concepts

Steps to be carried out by the machine manufacturer

1. Risk assessment
2. Risk reduction
3. Validation

1. Risk assessment: Most important during the planning phase

The machine manufacturer is obliged to implement risk assessment in order to identify all hazards associated with his system, to assess and evaluate the respective risks and to design and construct the system in consideration of such hazards.

Risk assessment implementation is to be considered a design-accompanying process which is to be carried out by experts of various disciplines. In this context, the EN ISO 12100 standard offers support by description of an iterative procedure for risk assessment. Also as an example: in the US, this is covered by the ANSI B11.0 standard.

Free “Machine safety” online training available at: siemens.com/safety-standards

Interactive animation: Make a filling plant safe step-by-step at: siemens.com/safety-integrated

Iterative procedure for risk assessment in accordance with EN ISO 12100
2. Three levels of risk reduction

Following risk assessment, a decision as to whether risk reduction measures have to be initiated must be made. Such risk reduction comprises design measures, technical protective equipment as well as training measures for users – and can be divided into three levels.

**Level 1: Safe design**
Safe design can for example be ensured through the integration of safety in the machine (covers, fences, etc.). These measures take top priority within the scope of risk reduction. They are to ensure the following:
- Avoidance of crushing points
- Avoidance of electric shock
- Concepts for machine shutdown in case of emergency
- Concepts for operation and maintenance

**Level 2: Technical protective measures**
A safety function has to be defined for each hazard which cannot be eliminated by means of design measures. As shown in the following example, such safety function can be executed by a safety system:

“When the protective door is opened during normal operation, the motor has to be switched off.”
A safety system executes safety functions and is comprised of subsystems:
- Detecting (position switch, E-STOP, light curtain, etc.)
- Evaluating (fail-safe controller, safety relay, etc.)
- Reacting (contactor, frequency converter, etc.)

**Level 3: User information on residual risks**
As a matter of fact, users have to be informed of any possible residual risks. However, such information does not replace the request for safe design and technical protective measures, but is merely intended to supplement such measures. User information for example comprises of:
- Warnings in the operating instructions
- Special work instructions
- Pictograms
- Note on the use of personal protective equipment

Safety system for the safety function: “When the protective door is opened, the motor has to be switched off.”
ISO 13849-1 standard:
Safety-related parts of control systems –
Part 1, general principles for design

The ISO 13849-1 standard may be applied to safety-related parts of control systems (SRP/CS) and all types of machines – regardless of the technology and energy used (electrical, hydraulic, pneumatic, mechanical, etc.). It also specifies special requirements for SRP/CS with programmable electronic systems.

Most important changes:
• Performance Level (beyond the exclusive consideration of categories)
• Incorporation of development and application of so-called programmable electronic systems with safety function (PES) in safety-related parts of control systems
• Extended consideration of the control and avoidance of systematic failures and faults

Application of ISO 13849-1
Application of the ISO 13849-1 standard is recommendable when the safety function is mainly realized on the basis of fluid power (hydraulic, pneumatic).

Both standards
The risk of each hazard is estimated on the basis of the risk elements’ determination. This determination is based on:
• Severity of the harm
• Frequency and duration of a person’s exposure to the hazard
• Probability of occurrence of a hazardous event
• Possibilities of avoiding or limiting the harm

The required Safety Integrity Level (SIL in accordance with IEC 62061) or Performance Level (PL in accordance with ISO 13849-1) is determined on the basis of these criteria.
Risk estimation based on determination and evaluation of risk elements

The risk elements (S, F, Pr and P) serve as input parameters for both standards, but their usability within the standard differs. While a Safety Integrity Level (SIL) is determined according to IEC 62061, a Performance Level (PL) is determined according to ISO 13849-1.

IEC 62061
Determination of the required SIL
(by means of SIL assignment)

ISO 13849-1:
Determination of the required PL
(by means of risk graph)
Risk estimation is based on the same risk parameters:

Risk parameters

<table>
<thead>
<tr>
<th>S = Severity of the injury</th>
<th>F = Frequency and/or duration of exposure to the hazard</th>
<th>P = Possibilities of avoiding the hazard or limiting the harm</th>
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</thead>
<tbody>
<tr>
<td>S1 = Minor (generally reversible) injury</td>
<td>F1 = Seldom to more often and/or short duration of exposure</td>
<td>P1 = Possible under certain conditions</td>
</tr>
<tr>
<td>S2 = Severe (generally irreversible) injury, including death</td>
<td>F2 = Frequent to constant and/or long duration of exposure</td>
<td>P2 = Hardly possible</td>
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Starting point for estimation of risk reduction

Required Performance Level PL

Low risk

High risk

Exemplary calculation

Risk estimation based on determination and evaluation of risk elements
Steps to be carried out by the machine manufacturer

1. Risk assessment
2. Risk reduction
3. Validation
4. Provision of the machine
5. Market product monitoring

3. Validation

Validation is important in the development of safety-related components for control systems. A validation plan should include all documents of the validation procedure, the relevant operating and environmental conditions, and the analysis and test methods applied. For this purpose, a test plan first has to be drawn up with the relevant test specification, including a detailed description of the tests, the test setup, the test environment, and the test programs and error simulations. The test plan must also include the expected results of the individual tests. The validation can start in any phase of the machine life, but must be completed before delivery or handover.

Validation target
Assurance of compliance with requirements
• specified in European directives,
• resulting from the customers specification documents, the machine’s application and any further country-specific requirements applicable to the machine
• The purpose of the validation procedure is to ensure that the implemented safety functions make the required contribution to risk reduction to ensure that the machine is safe and remains so.

4. Making the machine available on the market

All machine-relevant information must be disposable when the machine is made available on the market. This comprises: customers specification documents, technical documentation (also see machinery directive, annex VII), certificate of conformity, acceptance report if applicable, transport documents, etc.

5. Product monitoring

Every manufacturer is obliged to monitor his product by means of a survey for any hidden defects after it has been placed on the market. For example, information as to whether the product is actually used as originally intended as well as information regarding its behavior over the course of its lifecycle is to be collected.

In particular, dangerous defects as well as misuse or incorrect product handling are to be rectified by means of corresponding measures. The user has to be informed of any discovered hidden defects.
More efficient implementation of legal functional safety requirements: Safety Evaluation Tool

Fast and easy assessment of safety functions with the Safety Evaluation Tool
The Safety Evaluation Tool for the IEC 62061 and ISO 13849-1 standards facilitates the realization of safe machine concepts without any detours. This TÜV-tested online tool quickly and safely guides you through the safety functions’ calculation steps and supports the successive determination of the attained safety integrity (SIL/PL) – from specification of the system structure down to component selection. The result: A standard-compliant report which can be integrated in your documentation as safety proof.

Neutral data interface:
Safety-relevant characteristic values of third-party products can now be imported into the Safety Evaluation Tool in XML format according to VDMA 66413 specification. The Siemens characteristic values in XML format are also available and can be downloaded from the web page of the Safety Evaluation Tool.

Further information is available at:
siemens.com/safety-evaluation-tool

Your advantages:
• Faster assessment of safety functions
• Calculation in accordance with current standards
• Ease of archiving:
  Projects can be saved and called up as required
• Quick and easy handling:
  Comprehensive, predefined example libraries
• Fast access to product data
• Free use of the online tool*

* Only the usual costs for Internet access accrue.

siemens.com/safety-evaluation-tool

Calculation of SIL or PL for subsystems and the overall system
Exemplary machine with flexible, autonomous safety solution
Result report for machine documentation
Safety Integrated: Consistent integration of safety technology in standard automation

**Added value for machine manufacturers and system operators**
The integration of safety technology in standard automation concepts entails considerable and sustainable user benefits for enhanced competitiveness.

Machine manufacturers benefit from reduced hardware and significantly simplified engineering. The result: Considerably faster realization of machines and systems as well as easier adjustability to new requirements.

The advantages for system operators: They are provided with safe and more productive machines and systems. A single integrated system of safety technology and standard automation reduces downtimes due to improved diagnostics and this also increases the system availability. Retrofits and modernizations are simplified: Due to flexible, modularly expandable concepts, machines and systems can be upgraded to state-of-the-art technology way more efficiently.

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**Safe reaction:**
Drives, motion control, motor starters, motor management system

**Safe evaluation:**
Controllers

**Safe detection:**
Emergency stop, position switches, safety switches, 2nd generation mobile panels

**Safe evaluation:**
Safety relays, modular safety systems

**Safe communication:**
Via AS-Interface, PROFIBUS, PROFINET, also with IWLAN
Functional safety of machines and systems: Scalable solutions

No matter which safety task you need to solve: Safety Integrated offers the easier and faster way to safe and productive machine concepts. This is proven by the following examples of four typical machine concepts – from compact to highly flexible.

1. Simple solutions for few safety functions
   - Compact machine with safety technology and intelligent motor starter connection

2. Machine with flexible, autonomous safety solution

3. Machine and systems with distributed safe sensors and actuators with ASIsafe

4. Integrated solutions for a large number of safety functions
   - Machine with variable quantity structure and flexible requirements regarding safety functions
In many systems, simple solutions for safety applications (e.g. for evaluation of emergency stop, protective door, light barrier, etc.) are absolutely sufficient. This is where the new SIRIUS safety relays come in. They facilitate the effortless implementation of only few safety functions. Their modular design ensures ease of planning, commissioning and expansion – without the need of any programming knowledge.

The result: Fast and easy realization of safe and productive safety solutions.

**Requirements**

- Realization of compact machines with local use of safety technology
- Easy wiring without programming or PC knowledge
- Implementation of simple safety solutions on the basis of example applications
- Few safety functions and minimum space requirements in the control cabinet

**Solution**

SIRIUS 3SK1 safety relays for safety applications up to SIL 3 or PL e

- Easy parameterization with the help of DIP switches
- Elimination of wiring between the switching devices and optional integration of fail-safe SIRIUS 3RM1 motor starters due to device connector

**Advantages**

Fast and easy realization of safe and productive systems

- Cost savings due to compact product portfolio, minimum wiring expenditures and narrow width
- Simplicity and efficiency throughout the system’s entire lifecycle
- Easy realization of application adjustments and expansions due to the system’s modularity

Further information is available at: siemens.com/safety-relays
The SIRIUS 3SK1 system facilitates the easy realization of safety applications and the quick and effortless implementation of numerous applications. If the basic unit's inputs and outputs are not sufficient, the modular system can be easily expanded. The rear device connector ensures minimized wiring expenditures and supplies all devices with power. This eliminates wiring faults between the devices and supports considerable time savings in terms of mounting and commissioning. Actuators and sensors can be easily connected.

Before: Discrete solution with contactors and OLRs

New: SIRIUS 3RM1 compact motor starter

Advantages: Width of only 22.5 mm, economization of up to 3 devices, no wiring, integration in the system of 3SK1 safety relays.

Interactive animation: Make this scrubber of a filling plant safe step by step – at siemens.com/safety-integrated

Safety functions in this example:
1. Monitoring of protective cover
2. Emergency stop

The SIRIUS 3RM1 motor starter represents the ideal solution for space-saving motor starter applications in the control cabinet. Based on hybrid technology, it replaces up to four devices and features integrated safety technology.
Do you want to implement more demanding safety functions with the simplicity that is typical of SIRIUS? And you need a number of safety functions that selectively shut down plant sections for your plant concept? The new 3SK2 basic units could be exactly what you are looking for. With the new software-parameterizable 3SK2 safety relays, fail-safe outputs can be switched off independently of each other. The 3SK2 devices are simple to parameterize via software. As the fail-safe outputs can be freely assigned, it is possible to parameterize which sensors act on which outputs.

Requirements
- Implementation of demanding safety applications, such as protective door with lock or muting
- Implementation of selective shutdowns using separate shutdown paths
- Simple parameterization of more demanding safety applications without the need for programming skills

Solution
- SIRIUS 3SK2 safety relays can be simply parameterized by drag and drop with certified blocks
- Device connectors save wiring between the relays and permit seamless integration of fail-safe SIRIUS 3RM1 motor starters

Advantages
- Achieve safe and productive plants quickly and easily, even for more demanding safety functions, without the need for programming skills
- Simplicity and efficiency over the entire lifecycle of a plant
- Simple and flexible expansion of applications thanks to system modularity
- Engineering, commissioning, and documentation processes are fully supported by functions such as consistency check, online diagnostics, forcing, and engineering documentation

Simple and convenient: SIRIUS Safety ES
- Simple parameterization by drag and drop
- Engineering, commissioning, and documentation processes are fully supported by functions such as consistency check, online diagnostics, forcing, and engineering documentation

SIRIUS Safety ES Trial Version available free of charge from: https://support.industry.siemens.com/cs/ww/de/ps/21192

Further information is available from: siemens.com/safety-relays
The SIRIUS 3SK portfolio provides the ideal solution for all safety applications. Simple, modular, flexible

SIRIUS 3SK is a highly streamlined product portfolio. The 3SK1 range has been developed to allow fast, simple implementation of the most common safety functions. More complex safety systems can be created using devices from the new 3SK2 series.

Highlights of the 3SK2 include the new protective door monitoring safety functions with lock or muting. The 3SK2 devices are parameterized with the intuitive SIRIUS Safety Software – by drag&drop. This opens up new possibilities without complicated wiring or programming. Moreover, extensive diagnostic functions reduce plant standstills.
Machine with flexible, autonomous safety solution

With the SIRIUS 3RK3 modular safety system (MSS), users can rely on an integrated modular system which facilitates machine and system operation with maximum flexibility and efficiency – both with new machine applications and retrofits. Safety functions can be quickly and easily parameterized via the MSS ES software. The SIRIUS 3RK3 MSS can be employed for all safety functions up to SIL 3 in accordance with IEC 62061 and PL e in accordance with ISO 13849-1.

Requirements

- Safe machine concepts which support flexible adjustment to specific requirements and easy configuration
- Easy, quick and cost-efficient realization of modular machine concepts
- Faster parameterization – with optional integration of diagnostics and process data in an automation system

Solution

- 3RK3 modular safety system with modular hardware structure
- Interconnection of logic and safety functions without programming knowledge via prefabricated blocks; easy use of blocks via drag & drop and subsequent parameterization
- Integration in the automation system’s process image
- Utilization of standardized diagnostics mechanisms

Advantages

- Time savings due to intuitive, easy parameterization and comprehensive online test options
- Efficiency due to modular expandability
- Cost savings as a result of reduced type differentiations due to software-based functionality

More efficient diagnostics options

For more complex systems which also include controls, the MSS can be connected to the control via an interface module. This allows for the exchange and visualization of process and diagnostics data. The 3RK3 Advanced central module facilitates cyclic data exchange of up to 64 bit, while up to 32 bit are supported by the 3RK3 Basic central module. In addition, the 3RK3 Advanced module supports the direct transfer of cyclic and acyclic diagnostics data to the control via AS-Interface.
The complete MSS system offers outstanding functionality and diagnostics options. Also the direct connection of safe sensors and actuators as well as direct data exchange with adjacent safety cells is supported via AS-Interface.

The MSS Advanced module facilitates the realization of complex applications with multiple safety functions – e.g. muting functions with light curtains for access protection, protective door monitoring with and without interlocks as well as emergency stop applications. The SIRIUS Safety ES graphical parameterization software provides prefabricated blocks for this purpose.

Safety functions in this example:
1. Protective door monitoring
2. Zone monitoring
3. Emergency stop

Interactive animation: Make this package unit of a filling plant safe step by step – at siemens.com/safety-integrated
Machine and systems with distributed safe sensors and actuators

AS-Interface facilitates the safe and efficient realization of applications with numerous sensors and actuators – also ease of expansion with systems comprising multiple safety areas.

The new central modules of the SIRIUS 3RK3 modular safety system support the easy realization of safe AS-Interface applications.

The ASIsafe basic and ASIsafe extended central modules ensure the distributed detection and switching of sensors and actuators via AS-Interface. The result: Modular machine structure with easy expandability and high flexibility.

Requirements

• Safe expansive machine concepts which comprise of widely distributed safe sensors and actuators in the field
• One bus system for standard and fail-safe communication – without restrictions
• Multiple enabling circuits which can be easily parameterized via a graphical editor – using drag & drop

Solution

• Modular and scalable SIRIUS 3RK3 safety system with 2 to 50 independent enabling circuits (two-channel)
• Fail-safe and standard communication on a single bus line
• On a distributed network, detection of safe sensors and safe switching of actuators via AS-Interface

Advantages

• Easy routing of the AS-i bus in accordance with the system's mechanical design due to topology-free structure
• Intuitive graphical parameterization of the safety function via the SIRIUS Safety ES software on the basis of predefined, certified function blocks
• Easy mounting concept (IP67) and expandability
• Increased availability: Safety cell monitoring by the modular safety system as an autonomous component; this means that safe system operation can be continued even in case of failure of the main standard controller
• Direct data exchange with other safety cells: ASIsafe also supports fail-safe direct data exchange between the respective 3RK3 modular safety systems in various safety areas
• Speed: Faster reaction in case of faults due to the elimination of additional bus runtimes via PROFIsafe; this allows for minimized dimensioning of safety areas

Further information is available at:
siemens.com/as-interface
siemens.com/sirius-mss
SAFETY CONCEPTS

AS-Interface
PROFINET
Safe and standard control cabinet modules

MSS ASIsafe basic
2 to 10 enabling circuits

MSS ASIsafe extended
2 to 20 enabling circuits

MSS Advanced
2 to 50 enabling circuits

Safe and standard field modules
Safe position switches with interlocks

Load feeders with contactors
Load feeders with fail-safe distributed AS-i outputs

Pushbuttons and indicator lights, E-STOP

Safe direct comm. via AS-i

AS-I power supply unit
Control with and without AS-i master

Light grid
MSS ES parameterization software

Interactive animation: Make this palletizing unit of a filling plant safe step by step – at siemens.com/safety-integrated

AS-I safe Solution Local: The AS-I safe Solution Local requires only few components for a safety cell – an MSS central module and safe slaves. Neither fail-safe PLC nor special masters are required. The MSS monitors safe sensors (e.g. emergency stop), evaluates them in accordance with its parameterized safe logic and ensures their safe distributed disconnection via AS-I safe and safe AS-i outputs.

Safety cells with fail-safe direct data exchange can be interconnected via AS-I safe. For example, operation of an emergency stop button in one safety cell also effects safe disconnection in the next safety cell.

Safety functions in this example:
1. Access monitoring
2. Protective door monitoring
3. Emergency stop

Safety solutions with MSS and AS-Interface

MSS Advanced and MSS ASIsafe

Safety solutions with MSS and AS-Interface

MSS ASIsafe basic
2 to 10 enabling circuits

MSS ASIsafe extended
2 to 20 enabling circuits

MSS Advanced
2 to 50 enabling circuits
SIMATIC controllers with Safety Integrated offer the greatest possible integration: one controller, one communication system, and one engineering concept for standard and fail-safe automation. Ensuring efficient and reliable protection of people, machines, and the environment.

Thanks to the standardized engineering in the TIA Portal, safety-related programs can be simply ported from one SIMATIC controller to another SIMATIC controller. This saves time and reduces costs.

All SIMATIC controllers with Safety Integrated are designed for safety-related use up to SIL 3 according to EN 62061 and PL e according to ISO 13849.

### Requirements
- Integration of the safety function into the automation concept
- Flexibility in the type and number of safety functions and the devices that can be connected
- Standardized engineering for standard and fail-safe automation
- Effortless but detailed diagnostics
- Remote access for diagnostic purposes (including safety)
- Protection against tampering

### Solution
- One SIMATIC controller with Safety Integrated
  - Integrated system diagnostics
  - Web server
  - Integrated access protection
- Standard and fail-safe communication via PROFIBUS and PROFINET, as well as wirelessly via IWLAN
- Efficient engineering with the TIA Portal

### Advantages
- Cost reduction and economic efficiency achieved with just a few safety functions
- Integrated solution for small to complex applications
- Better integration of the safety functions into the overall sequence of production processes
- Productivity thanks to minimized downtimes achieved by efficient fault diagnostics
- Future-proof with investment protection

Further information is available at: siemens.com/simatic-safety
The Totally Integrated Automation Portal (TIA Portal) offers the latest software technology that reveals its true potential by means of an intuitive user interface. Thanks to the user-friendly layout and the simple navigation, the important programming and editing functions are quick and easy to understand – leaving users to concentrate fully on their engineering task.

**STEP 7 Safety Advanced/STEP 7 Safety Basic**

With the STEP 7 Safety Advanced or Basic option packages, users benefit from an extremely high level of convenience and integration when developing safety-related programs: All the necessary configuration and programming tools are integrated into the STEP 7 operator interface and utilize a common project structure.

With STEP 7 Safety Advanced or Basic, all the advantages of the TIA Portal can also be used for fail-safe automation:

- Intuitive user interface; operating concept is identical to that used for creating standard programs for getting started
- Smart library concept simplifies validation of safety-related applications
- No separate programming of system diagnostics
- Checking and testing of the entire project, incl. safety before commissioning, by means of PLCSIM
- Trace functionality for safety-related signals, too

**Further highlights:**

- Certified function block library
- Change log
- Standard-compliant documentation

Testing the TIA Portal

Curious? Just try the TIA Portal. For more information go to: siemens.com/tia-portal
Machine with variable quantity structure and flexible requirements regarding safety functions

Basic Controller with Safety Integrated: SIMATIC S7-1200
SIMATIC S7-1200 Basic Controllers features an impressive array of technological functions and integrated IOs, as well as a compact, space-saving design.

These controllers are the intelligent choice for everyday automation tasks in small projects.

The fail-safe S7-1200 CPUs with Safety Integrated can also perform monitoring of safety functions, such as protective door with lock. The fail-safe sensors and actuators are connected via fail-safe signal modules.

Further information is available at: siemens.com/s7-1200

In addition to the “normal” control tasks, the fail-safe CPUs of the S7-1200 also perform monitoring of the safety functions (e.g. protective door). For this purpose, the sensors and actuators are read in and controlled via fail-safe I/O modules. (Connection via PROFINET/PROFIsafe is available soon.)
**Advanced Controller with Safety Integrated: SIMATIC S7-1500**

The flagship of the Advanced Controllers is the SIMATIC S7-1500. It is the current standard for the entire factory automation complex, including sophisticated safety-oriented applications. Thanks to its unrestricted scalability, SIMATIC S7-1500 is the perfect controller solution for automating everything from an individual machine to an entire plant. The fail-safe sensors and actuators can be connected as a centralized or distributed configuration via SIMATIC ET200 fail-safe signal modules. It is also possible to connect them directly via PROFINET or PROFIBUS.

- This makes flexible implementation of the safety-related functions of the SINAMICS converters (G120 and S120) possible without additional hardware costs, for example.
- This also applies to other types of devices, such as laser scanners, HMI panels with emergency stop functionality, etc.
- It is possible to use Industrial Wireless LAN (PROFINET) for driverless systems (charging trucks), for example.

Further information is available at: siemens.com/s7-1500

**Distributed Controller with Safety Integrated: SIMATIC ET 200SP**

The SIMATIC ET 200 CPU distributed controllers combine compact design with versatility. The perfect solution in the mid-performance range for machines with distributed intelligence or series machines where little space is available. The fail-safe CPUs with Safety Integrated can also perform monitoring of safety functions, such as protective door with lock.

The fail-safe sensors and actuators are connected via fail-safe signal modules either in a centralized or in a distributed manner. The Distributed Controllers make it possible to integrate devices both via PROFINET/PROFIBUS and AS-Interface.

Further information is available at: siemens.com/et200sp
Machine with variable quantity structure and flexible requirements regarding safety functions

I/O systems with Safety Integrated: SIMATIC ET 200

The fail-safe I/Os from the SIMATIC ET 200 spectrum are available for cabinet mounting and for cabinet-free use – in both modular and block design.

The I/O is connected by means of PROFIsafe via PROFIBUS and/or PROFINET. Within an ET 200 station, both standard and fail-safe modules can be operated. All Safety modules are designed for safety-related use up to SIL 3 according to EN 62061 and PL e according to ISO 13849.

SIMATIC HMI Mobile Panels 2nd Generation – Power and Safety in your hands

The second generation of SIMATIC HMI Mobile Panels now offers more power, flexibility, convenience, and quality. This makes mobile operator control and monitoring even more efficient and safer.
Machines have to be **safe**. 
But can safety be **economical**?

**Safety Integrated** with Totally Integrated Automation combines **safety** with **productivity**.

Safe, fault-tolerant applications compliant with **current international guidelines** ensure **maximum process safety**.

The **safety functions** are integrated into the automation components.

**Safety-related communication** is achieved using standard buses and even via WLAN.

And the **seamless integration into the TIA Portal** ensures efficient engineering.

**Perfect protection** of personnel, machinery, and the environment

Further information is available at: [siemens.com/tia-si](https://siemens.com/tia-si)
Fail-safe communication

First choice for maximum efficiency: PROFINET, PROFIBUS and AS-Interface

The safety-relevant data are transferred via the already existing standard bus. This facilitates significant savings in terms of installation and engineering. Safe I/O modules can be combined with standard modules and safe data can be reused for diagnostics purposes on the standard level. Furthermore, safe components by third-party suppliers can be effortlessly connected.

Reliable compliance with high requirements: PROFIsafe

PROFIsafe® was the first communication standard defined in accordance with IEC 61508 to allow for standard and safety-related communication on a single bus cable. PROFIsafe can be easily retrofitted as the existing wiring can be used. PROFIsafe uses the PROFINET and PROFIBUS services. This ensures compliance with maximum requirements up to PL e in accordance with ISO 13849 and SIL 3 in accordance with IEC 61508.

The advantages of AS-i can also be utilized in complex safety applications. The DP/AS-i F-Link facilitates the application of AS-Interface under fail-safe SIMATIC or SINUMERIK controllers. Acting as a link in bus-based safety technology, it supports the transfer of ASIsafe telegrams to the PROFIsafe protocol. As usual, the detection of safe signals is realized by means of rugged ASIsafe slaves.

Evaluation is carried out by the available F-PLC. Actuator response is realized on the PROFIsafe level, optionally via F-DO/F-RO modules in the central rack or with the help of the fail-safe distributed I/O.

Security note:

The assurance of safe system or machine operation necessitates the implementation of additional suitable protective measures and the integration of all automation and drive components in a holistic state-of-the-art industrial security concept.

Further information is available: www.siemens.com/industrialsecurity

Safety-related and standard data are transferred via the same bus with PROFIsafe. The term black channel implies that safety-related communication is independent of the bus system and the subordinate network components.
At a glance

**AS-i master for SIMATIC ET 200SP**
(CM / F-CM AS-i Safety ST for SIMATIC ET 200SP)

- AS-i as the feeder for higher-level bus systems
- Simple integration
  - of AS-Interface devices into the SIMATIC and SINUMERIK
  - of fail-safe AS-Interface networks via PROFINet into SIMATIC F controllers (PROFINET / PROFIBUS)
  - into the TIA Portal / STEP 7: just one engineering framework for configuration of the controller, AS-i Master, and Safety
- Fast diagnostics: on the slave, centrally via Web server, HMI, or TIA Portal
Drives with integrated safety functions

Electrically driven power units and machine components frequently bear enormous risk potentials. Rotating units such as saws, rollers and spindles may lead to severe or even fatal injuries. The same applies to linearly moved machine units such as handling axes and machine slides.

**Easier and faster realization of standard-compliant, powerful safety concepts**

Drives with integrated safety functions facilitate the easy realization of safety concepts. Previously required electromechanical components and corresponding wiring are done away with. The transfer of safety-relevant signals can be realized via standard field buses, which additionally minimizes wiring complexity and expenditures.

Furthermore, drives with integrated safety functions support the implementation of way more powerful safety concepts – both in terms of functionality and response times. In many cases, this even results in increased productivity.
Depending on the required motion profile, the most varying components are employed for moving the motors in practice.

Siemens offers a comprehensive product portfolio for the efficient realization of powerful safety concepts for all application profiles.

The table below provides an overview of the recommended products for the respective application cases.

<table>
<thead>
<tr>
<th>Application class</th>
<th>Fixed-speed applications</th>
<th>Variable-speed applications</th>
<th>High-performance and motion control applications</th>
<th>Numeric control in processing machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application areas</td>
<td>Conveyor technology, pumps, power units</td>
<td>Conveyor technology, handling, pumps, extruders, agitators, mills, power units</td>
<td>Production machines, handling devices, converting applications (winding, ...), mounting equipment</td>
<td>Machine tools, processing machines (wood, plastic, ...)</td>
</tr>
<tr>
<td>Operating mode</td>
<td>ON/OFF operation or continuous operation with fixed speed</td>
<td>ON/OFF operation with acceleration/brake ramp, continuous operation with variable speed</td>
<td>Continuous operation with high speed accuracy or fixed-cycle operation with frequent acceleration/delay: Positioning, motion control, interpolating operation of drive axes</td>
<td>Interpolating operation of multiple feed axes, speed control of spindles</td>
</tr>
<tr>
<td>Product groups</td>
<td>SIRIUS motor starters, SIMOCODE pro motor management system</td>
<td>SINAMICS G General Performance drives</td>
<td>SINAMICS S High-performance drives</td>
<td>SINUMERIK CNC systems</td>
</tr>
<tr>
<td></td>
<td>• SINAMICS G110D, G110M, SINAMICS G120, SINAMICS G120C, D, SINAMICS G130/G150</td>
<td>• SINAMICS S110, SINAMICS S120, S120M, SINAMICS S150, SINAMICS SM150</td>
<td>• SINAMICS S110, SINAMICS S120, S120M, SINAMICS S150, SINAMICS SM150</td>
<td>• SINUMERIK 828D, SINUMERIK 840D sl</td>
</tr>
</tbody>
</table>
**Drive-integrated safety functions can be roughly divided into three classes:**

<table>
<thead>
<tr>
<th>Class</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe drive shutdown</td>
<td><strong>STO</strong></td>
<td>Safe torque off (STO): This function prevents any further release of a torque on the motor shaft.</td>
</tr>
<tr>
<td>Reliable drive motion monitoring</td>
<td><strong>SLS</strong></td>
<td>Safely limited speed (SLS): This function monitors the drive for exceedance of one or several specified maximum speeds.</td>
</tr>
<tr>
<td>Reliable drive position monitoring</td>
<td><strong>SSM</strong></td>
<td>Safe speed monitor (SSM): This function signals the shortfall of a specified speed. No drive-autonomous response is effected.</td>
</tr>
<tr>
<td></td>
<td><strong>SP</strong></td>
<td>Safe position (SP): This function transfers the drive’s safe position values to the superior control (F-PLC), where the safe cam (SCA) function can for example be realized. SCA outputs a safe signal when the drive is positioned within a specified position range.</td>
</tr>
</tbody>
</table>

**STO**

![Diagram of STO](image1)

**SLS**

![Diagram of SLS](image2)

**SSM**

![Diagram of SSM](image3)

**SP**

![Diagram of SP](image4)
**SS2**

**Safe stop 2 (SS2):**
Like the SS1 function, this function actively brakes a drive. However, the SOS function is activated upon standstill instead of the STO function. As with SS1, drives with high kinetic energy are quickly brought to standstill in case of danger.

**SOS**

**Safe operating stop (SOS):**
This function can be used alternatively to STO. As opposed to STO, the motor is not switched to a torque-free state, but the drive remains in position control, retains its position and is monitored for standstill.

**SBC / SBT**

**Safe brake management:**
This function consists of safe brake control (SBC) and a safe brake test (SBT). The safely controlled and tested brake in connection with the safely monitored drive results in a safe holding system for anti-fall guards on vertical axes.

**SDI**

**Safe direction (SDI):**
This function monitors compliance with the selected direction of motion/rotation.

**SP**

**Safe programmable logics**

This function can be used to implement a reliable range recognition for specific axes. Using SP, also multi-axis safety concepts can be realized in the F-control.

Further safety functions are available particularly for safety solutions in machine tools in connection with the SINUMERIK CNC control:

**Safe programmable logics**

With the help of safe programmable logics, safety-related sensors and actuators can be directly connected to the control's I/O and evaluated by means of software without external evaluation units.

Further information is available at: [siemens.com/safety-drives](http://siemens.com/safety-drives)
Competent support throughout the entire lifecycle

With our innovative and comprehensive safety technology product portfolio as well as competent support services, we offer substantial advantages throughout all phases of the product lifecycle.

Our services*

* These services can be rendered directly by Siemens or by certified Siemens Solution Partners.

- Support throughout the entire lifecycle:
  - Planning and conceptual design (e.g. with functional examples)
  - Preparation, right down to machine acceptance and transfer
  - Installation and commissioning
- Comprehensive training
- Consulting on the application/interpretation of safety-relevant directives and standards
- Safety Evaluation Tool for support with safety integrity determination and standard-compliant report generation
- Quick on-site service due to global presence
- Fast spare parts delivery for low capital commitment
- TÜV-compliant user manuals
- Regular renewal of safety-relevant components
- Modernization concepts and implementation in accordance with your requirements and state-of-the-art technology

Design and engineering

Requirements
Prior to designing a machine, the machine manufacturer is required to perform a risk analysis in consideration of all relevant standards. This shows the hazards posed by the machine and the respectively required protection measures.

Siemens system advantages
Modular solutions, tailored to various machines and systems

- Innovative technologies
- Globally applicable products and systems with the required approvals and compliance with the EU directives
Modernization and optimization

Requirements
For upgrading existing systems to state-of-the-art safety technology, expansion or modernization measures are required. We help you to optimally comply with all current safety requirements by means of tests, documentation, consulting and the definition of rectification measures.

Siemens system advantages
- Easy expandability through integration in the Totally Integrated Automation architecture
- Long-term product availability

Mounting and commissioning

Requirements
The risk analysis shows which components are required for the protection of hazardous areas. A proof of safety is required for the machine’s CE marking.

Siemens system advantages
- Space-, time- and cost-saving assembly due to the integration of safety technology in standard automation
- Faster commissioning due to comprehensive diagnostics as well as prewired and certified components

Maintenance

Requirements
Maintenance measures must be carried out quickly to keep downtimes at a minimum. Fault rectification must be accomplished as fast as possible as production must not be interrupted – or only interrupted for minimum periods – for reasons of competitiveness.

Siemens system advantages
- Quick fault diagnostics and rectification due to the Safety Integrated concept
- Long-term availability of components

Operation and servicing

Requirements
The operator must observe the framework directive on industrial safety as well as the documentation on compliance with the machinery directive to be prepared by the machine manufacturer.

Siemens system advantages
- Faster fault diagnostics and rectification for increased productivity
- Easier handling due to uniform operating concept
- Minimized downtimes and accelerated workflows due to integrated safety functions

Support

Siemens system advantages
- Easy expandability through integration in the Totally Integrated Automation architecture
- Long-term product availability
## Products for safe machines and plants

### Detecting

<table>
<thead>
<tr>
<th>Products</th>
<th>SIRIUS position switches with separate actuator, without and with interlocks, hinge switches, non-contact safety switches (RFID) and magnetically-operated switches</th>
<th>SIRIUS ACT emergency stop</th>
<th>SIMATIC AS-i F-Link safety-related AS-i Link for PROFINET and PROFIBUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval (max.)</td>
<td>IEC 62061 (IEC 61508) Up to SIL 3</td>
<td>Up to SIL 3</td>
<td>Up to SIL 3</td>
</tr>
<tr>
<td></td>
<td>ISO 13849-1 Up to PL e</td>
<td>Up to PL e</td>
<td>Up to PL e</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
<td>NFPA 79, NRTL-listed</td>
</tr>
<tr>
<td>Fail-safe communication options</td>
<td>AS-Interface (ASIsafe)</td>
<td>AS-Interface (ASIsafe)</td>
<td>AS-Interface (ASIsafe) and PROFIBUS or PROFINET with PROFIsafe</td>
</tr>
</tbody>
</table>

### Evaluating

<table>
<thead>
<tr>
<th>Products</th>
<th>SIRIUS 3SK safety relays</th>
<th>SIMOCODE pro 3UF7 motor management system with fail-safe DM-F local or PROFIsafe expansion modules</th>
<th>Safe ASIsafe I/O modules</th>
</tr>
</thead>
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<tr>
<td>Approval (max.)</td>
<td>IEC 62061 (IEC 61508) Up to SIL 3</td>
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<td>• Safe input modules</td>
</tr>
<tr>
<td></td>
<td>ISO 13849-1 Up to PL e</td>
<td>Up to PL e</td>
<td>• MSS ASIsafe</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>Up to PL e</td>
<td>• Safe as-i outputs</td>
</tr>
<tr>
<td></td>
<td>NFPA 79, NRTL-listed</td>
<td>NFPA 79, NRTL-listed, IEC 61511</td>
<td></td>
</tr>
<tr>
<td>Fail-safe communication options</td>
<td>PROFIBUS and PROFINET with PROFIsafe profile</td>
<td>AS-Interface (ASIsafe)</td>
<td></td>
</tr>
</tbody>
</table>
Detecting Products

SIRIUS position switches with separate actuator, without and with interlocks, hinge switches, non-contact safety switches (RFID) and magnetically-operated switches

SIRIUS ACT emergency stop SIMATIC AS-i F-Link

Safety-related AS-i Link for PROFINET and PROFIBUS

• SIMATIC HMI mobile panel 277F IWLAN
• SIMATIC HMI key panel

www.siemens.com/sirius-detecting
www.siemens.com/sirius-act
www.siemens.com/simatic-safety-integrated

Approval (max.)
IEC 62061 (IEC 61508) Up to SIL 3 Up to SIL 3 Up to SIL 3 Up to SIL 3
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Fail-safe communication options
AS-Interface (ASIsafe) AS-Interface (ASIsafe) AS-Interface (ASIsafe) and PROFIBUS or PROFINET with PROFIsafe

Evaluating Products

SIRIUS 3SK safety relays SIMOCODE pro 3UF7 motor management system with fail-safe DM-F local or PROFIsafe expansion modules

Safe ASIsafe I/O modules
• Safe input modules
• MSS ASIsafe
• Safe AS-i outputs

SIRIUS 3RK3 modular safety system SIMATIC fail-safe controllers with Safety Integrated Highly available controllers with Safety Integrated SIMATIC I/O systems with Safety Integrated


Up to SIL 3 Up to SIL 3 Up to SIL 3 Up to SIL 3
Up to PL e Up to PL e Up to PL e Up to PL e
NFPA 79, NRTL-listed NFPA 79, NFPA 85, NRTL-listed, IEC 61511 NFPA 79, NFPA 85, NRTL-listed, IEC 61511 NFPA 79, NFPA 85, NRTL-listed, IEC 61511
Diagnoses via PROFINET with PROFIsafe
AS-Interface (ASIsafe) PROFINET with PROFIsafe IWLAN with PROFIsafe

Interactive animation: Make a filling plant safe step by step – at siemens.com/safety-integrated

Diagnostics via PROFINET, PROFIsafe profile: All systems PROFINET with PROFIsafe profile: ET 2005, ET 200M, ET 200SP, ET 200pro (IWLAN interface module available)
### Products

<table>
<thead>
<tr>
<th>Products</th>
<th>Motor starters for:</th>
<th>Frequency converters</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIRIUS 3RM1 motor starters</td>
<td>ET 200S (IP20) ET 200pro (IP65)</td>
<td>SINAMICS G120C SINAMICS G120 SINAMICS G120D SINAMICS G110M</td>
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<tr>
<td></td>
<td></td>
<td>SINAMICS G130 SINAMICS G150</td>
</tr>
</tbody>
</table>

### Approval (max.)

<table>
<thead>
<tr>
<th>Standard</th>
<th>Safety Level</th>
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<td></td>
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</tr>
</tbody>
</table>

### Fail-safe communication options

- Solution PROFIsafe: PROFINET with PROFIsafe profile
- Solution Local: On-site safety application

### Functional examples

Application-oriented functional examples covering typical requirements in the field of industrial safety technology are available online. They comprise safety functions with product examples, including wiring plan, programming code and assessment in accordance with IEC 62061 and ISO 13849.

www.siemens.com/safety-functional-examples

Examples of some common applications:

www.siemens.com/safety-applications

---

¹⁾ Integrated safety functions can be realized without sensors

²⁾ Integrated safety functions can be realized with or without sensors

---

### SERVICE & SUPPORT

- **Functional examples**
  - Application-oriented functional examples covering typical requirements in the field of industrial safety technology are available online. They comprise safety functions with product examples, including wiring plan, programming code and assessment in accordance with IEC 62061 and ISO 13849.
  - Examples of some common applications:
| SINAMICS S110 positioning drive | • SINAMICS S120 drive system  
• SINAMICS S120M distributed servo drive  
• SINAMICS S150 cabinet unit | SIMOTION D motion control system | Machine tool control  
• SINUMERIK 840D sl  
• SINUMERIK 828D | SIDOOR ATD401W door management |

<table>
<thead>
<tr>
<th>SINAMICS S120M</th>
<th>PROFIBUS / PROFINET with PROFIsafe profile</th>
<th>PROFIBUS / PROFINET with PROFIsafe profile</th>
<th>PROFIBUS / PROFINET with PROFIsafe profile</th>
<th>PROFIBUS / PROFINET with PROFIsafe profile</th>
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</thead>
<tbody>
<tr>
<td>SITRAIN training program is available on the Internet at: <a href="http://www.siemens.com/sitrain-safetyintegrated">www.siemens.com/sitrain-safetyintegrated</a></td>
<td>Our various configurators, including the TIA Selection Tool, can be called up via: <a href="http://www.siemens.com/tia-selection-tool">www.siemens.com/tia-selection-tool</a></td>
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</tr>
<tr>
<td>Our A&amp;D mall has got it all covered: <a href="http://www.siemens.com/industrymall">www.siemens.com/industrymall</a></td>
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<tr>
<td>Safety Integrated in the application: <a href="http://www.siemens.com/automation/references">www.siemens.com/automation/references</a></td>
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</tr>
</tbody>
</table>
Find out more:
siemens.com/safety-integrated

Systematic industrial safety technology:

▷ Find the right safety solution
▷ Learn everything about machine safety
▷ Experience safety in production and process automation

Safety Integrated – at a glance!

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