Plant asset management
Products for intelligent maintenance

intelligent maintenance
PRODUCTS

SIEMENS
How can the productivity of a plant with a high level of automation be increased even further?

Surveys have indicated that plant operators in all sectors consider increased availability and shorter downtimes to be the most effective lever toward increasing productivity. Investigations have shown that downtimes are frequently the result of insufficient maintenance – despite the fact that maintenance is already a significant portion of the lifecycle costs.

Intelligent maintenance strategies can make a significant contribution toward increasing productivity:

■ Failures can be prevented by monitoring the current plant condition.
■ Maintenance can then be planned. maintenance is not left until a fault has occurred, but already provides appropriate measures in advance for avoiding faults. The timing of maintenance can be planned such that the existing resources can be used optimally.
■ Innovative maintenance strategies pay for themselves twice: planning security and the specific application of methods reduces the direct maintenance costs.
■ Plant availability is increased at the same time. This means that consequential costs resulting from failures, such as quality deficiencies or loss of image, are reduced.

Totally Integrated Automation supports intelligent maintenance strategies. The SIMATIC Maintenance Station is of significant importance, and presents the information relevant to maintenance from all automation components in a uniform and clear manner, thus providing the maintenance engineer with valuable support for making decisions.

Maintenance strategies

There are two maintenance strategies: response to failures or taking preventive measures. In the case of failure-oriented corrective maintenance, measures are only initiated when a fault has occurred, i.e. failures are acceptable in this case and may be minimized by a redundant plant design.

The objective of preventive strategies is to already carry out maintenance measures before faults occur in order to prevent downtimes which may possibly result. This strategy can be satisfied using time-dependent and load-dependent measures. Regular maintenance work is an example of time-dependent measures. The load state is determined from the number of switching operations, operating hours or load peaks.

Benefits of intelligent maintenance

Continuous plant monitoring

■ Reduces the risk of failures, and increases the availability
■ Enables maintenance to be planned

Optimized use of maintenance resources

■ Increases maintenance quality
■ Provides cost savings

Saving potentials result:

■ During maintenance itself and
■ by avoiding consequential costs

Condition Monitoring, that is to say status monitoring, aims to detect imminent errors at an early state. provides information on the remaining duration of use. In the case of condition-based maintenance, the maintenance measures are only initiated when the period of use has expired.

It has been shown in practice that optimum results can be achieved through intelligent combination of the different strategies.

Higher operating expenses for condition-based maintenance will be worthwhile for devices that play a central role for the availability of a plant and have high replacement costs. But mostly there are also devices where failures can be faced without endangering the availability and productivity of the plant.

Maintenance strategies

Increase in productivity through intelligent maintenance
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Plant asset management

General
Various tasks have to be handled during the operating phase of a plant, for which different groups of persons are responsible.

The production personnel operate and monitor the plant, and make sure that the desired products are produced with the appropriate quality, in the defined quantity, at a specified time, and with minimum resources with respect to personnel, raw materials, energy, costs, etc.

Maintenance staff must
- ensure a high availability of the plant,
- ensure this availability in the long term by implementing optimization measures, and
- carry out maintenance measures with minimum use of personnel, material, energy, costs, etc.

As a result of their different tasks, these two groups of persons have different information requirements. The production staff is mainly interested in information concerning the production process, whereas the maintenance engineer requires information on the condition of the production equipment.

The information interfaces for both groups are the SCADA systems of the plant. Only that information is provided to the respective user which is important for his task, without flooding him with information. In the context of intelligent maintenance strategies, SCADA systems play an important role in plant asset management.

Asset management in production
The term “asset management” comes from the economics sector and identifies the handling of the fixed and current assets of a company. These include the production equipment with its plant components such as apparatus, machines, pipelines etc. and the equipment and devices for their automation. All these are referred to as assets. In association with production, asset management covers all activities and measures which serve toward retaining or increasing the value of a plant. This is called plant asset management.

Benefits of plant asset management
Plant asset management enables the maintenance staff
- to unambiguously identify and evaluate the assets, this means the production equipment and its components,
- to carry out the appropriate measures in the case of deviations from the desired or expected state.

As a result of monitoring, i.e. the recording and evaluation of status variables, the condition of a component or device can be determined.

It can be recognized, for example, that no signal is received from the sensor, resulting in the diagnosis "Open circuit". This result triggers a maintenance request, and maintenance must then be carried out to eliminate the open circuit.

This measure – replacement of a faulty line in the example – ensures that the component is returned to the desired condition and closes the maintenance cycle. Thus plant-level asset management is the basis for increased production.
Intelligent maintenance of plant automation

In order to describe the automation of a plant, an appropriate model has been used for a long time already which divides the functions to be executed and the required systems and components into control levels within a pyramid. A different number of levels exists depending on the environment in which the model is used. One common model is based on three levels: ERP (Enterprise Resource Planning), MES (Manufacturing Execution Systems) and Control (process and field level).

Just like the automation functions, maintenance – and thus asset management – can be divided into control levels. In the Control level of the maintenance pyramid, the data relevant to the condition of a component are recorded and preprocessed, permitting determination of the condition of the component. Following this, maintenance requests can be passed on to the higher levels as required. Functions are present in the higher levels which permit planning and coordination of the initiated measures.

Despite the different tasks, it is meaningful and necessary to map the functions of these two pyramids within one visualization system and not to use different systems. There are various reasons for this:

- Uniform visualization for all components and devices.
- The same information sources (plant components) are relevant to both automation and maintenance.
- There is a close link between automation and asset management functions.
- Engineering data for automation can also be used for maintenance.
- Simplified handling of the system, since users need only be acquainted with the engineering and HMI tools of one single system.
- Operators already on site can also monitor the SIMATIC Maintenance Station.
Intelligent maintenance with Totally Integrated Automation

The SIMATIC maintenance station

With Totally Integrated Automation, the same system can be used for automation and maintenance: SIMATIC WinCC, the SCADA system for Totally Integrated Automation.

The resulting information is selectively divided to prevent the operators and maintenance engineers from being flooded with information.

To achieve this, a maintenance station is introduced in addition to the actual SCADA system. The operator can use the SCADA Station to access all of the process-relevant information and can manually intervene in the plant sequence. Maintenance-relevant information is kept away from the SCADA Station. This information is presented for the maintenance engineer on the maintenance station.

It is irrelevant whether the SCADA system and the maintenance station are executed on a common computer or on separate computers. Since the same HMI tools are used, switching of the display between the SCADA system and the maintenance station is possible at any time.

The maintenance station visualizes maintenance information from the complete automation technology of a plant.

This includes:
- The industrial PCs
- The controllers
- The field buses and field devices
- The switching, protective and control devices
- The drives
- The network components

Each component makes its individual functionalities available in the total concept.

If there are many components and devices in a plant, it is particularly important to keep the overhead of the Maintenance Station as low as possible. Therefore the linking of components is based on established standards, and is possible for a large number of devices from many different vendors.

Low-overhead configuring

The SIMATIC Maintenance Station is based on the STEP 7 project or multiproject already created for the plant automation. The maintenance view in the form of hierarchical, completely linked WinCC displays is automatically generated from the existing hardware configuration. This so-called maintenance area is subsequently transferred to the WinCC station, and can be linked as required to the existing HMI displays. Maintenance engineers can adapt the GUI to their own requirements extremely easily.

Automatic functions reduce engineering overhead

Transmission and display are carried out automatically after the data for the maintenance station have been produced by means of a generation procedure on the basis of the existing STEP 7 configuration. This avoids high-cost engineering. Furthermore, the uniform functionality results in consistency.

New hardware components are incorporated into the hardware configuration of STEP 7, and are then automatically available for use by the SIMATIC Maintenance Station. Manual updating is unnecessary, consequential costs are avoided.

Maintenance with Totally Integrated Automation

- Uniformity applies to both automation and maintenance
- The SIMATIC Maintenance Station displays maintenance information about the complete automation technology
- The maintenance view is automatically derived from STEP 7 hardware configuration
- Additionally, any components can be integrated via a proxy concept
- The generation process generates data from the STEP 7 project
- Additional engineering is unnecessary
- Data, visualization and operation of the SIMATIC SCADA system and SIMATIC Maintenance Station are consistent and uniform
Visualization of information for maintenance

In order to recognize the conditions of individual devices or components without doubt, a uniform symbol representation has been implemented. There are symbols for the device status itself and also for the importance of a maintenance request. In addition, the status of a maintenance measure is displayed. The conditions of all devices and equipment of the automation technology are indicated by these standardized symbols.

Uniform symbols for the conditions of components and devices

In addition to the standardized symbols, it is important for the overview to have a hierarchical information structure from which the maintenance engineer can also access all details of the components and devices if necessary starting from an overview display (plant view).

The overview display uses the standardized symbols to visualize the condition of a component itself and also provides group information on the conditions of all devices in the subordinate hierarchies.

The group status message shows the OK condition or the seriousness of a possible problem by displaying a traffic light with the colors red, yellow and green. A button can be used to access all of the subordinate hierarchy levels step-by-step all the way down to the bottom device level.

Further views of the maintenance information are available in addition so that the maintenance engineer has a complete overview of all current information of the component relevant to maintenance. This permits assessment of the plant status at a glance.

The information is consistently structured and hierarchically organized. The quantity of information displayed on each individual screen always remains manageable for the maintenance engineer, who nevertheless has easy access at any time to the complete information.
SIMATIC Maintenance Station – User interface for maintenance

The option package SIMATIC Maintenance Station is available for SIMATIC STEP 7 and SIMATIC WinCC to permit plant-level asset management. This software permits expansion of a SCADA system into a maintenance station. Information related to plant maintenance for the connected control components, switching devices, drives etc. are displayed on the maintenance station.

The SIMATIC Maintenance Station is of modular design. With small plants it is possible to install the SCADA system and the maintenance station on the same PC. Just like the SCADA system, the Maintenance Station can be expanded into a client/server application with multi-client operation. The signals and messages from the components and devices which are relevant to maintenance are collected and saved on the server of a client/server application. They are displayed on the client.

The SIMATIC Maintenance Station is based on standard SIMATIC products:
- SIMATIC STEP 7 for configuration
- SIMATIC WinCC for operator control and monitoring and
- SIMATIC SNMP OPC Server for interfacing of network components and industrial PCs

Configuring a maintenance station
In order to set up a maintenance station, the user need only select the automation systems to be mapped.

The components configured in the STEP 7 project/multiproject are mapped. It is additionally possible to incorporate further components into the maintenance station using proxy blocks. The automatically generated diagnostics screens can additionally be supplemented with project-specific contents and connected with any available operating and monitoring screens.

Visualization in the maintenance station
In the operating state, the maintenance station’s client requests cyclic data from the associated server. Various components with highly different diagnostics capabilities are used in a plant. However, from the viewpoint of maintenance, all components are displayed in the same manner. Therefore the maintenance and diagnostics states of the components are represented by standardized symbols.

The symbols indicate the maintenance status
- of a component (maintenance state display)
- of subordinate devices (maintenance group display)
- and, if applicable, the status of maintenance work (operator state display).
Symbol displays and component faceplates

The conditions of the components or also of subordinate components are visualized using standardized symbol displays in the diagnostics displays.

The symbol displays of the components contain:

- Graphical representation of the component type
- Configured name of the component
- Maintenance state display
- Group display for maintenance messages from subordinate components

Clicking an element in the symbol display either opens the subordinate hierarchy level or a component faceplate. This faceplate contains various views of the respective component in which further device-specific information can be output.

There are three standard views:

Identification

Depending on the component, the identification view displays all of the information available from the configuration or as so-called Identification & Maintenance (I&M) data available directly in the component.

The I&M data for PROFINET were standardized by PROFINET International to ensure that they apply for all vendors. They contain, for example, information on the device manufacturer, the order number, the hardware and firmware versions, etc. The maintenance engineer does not have to search for and copy data that are difficult to access, and accessing of plant documentation which may not even be up-to-date can be omitted. Electronic device identification thus saves resources.
SIMATIC Maintenance Station –
User interface for maintenance

**Messages**

The messages view displays diagnostics error messages and maintenance requests for the selected component. The view can be switched between current or archived messages.

The messages are particularly important since they ensure the comprehensibility of the events and operations. An important database for subsequent analyses is thus produced. This database can be analyzed using the tools known from WinCC. Client/server applications are possible, as are WinCC Web applications.

**Maintenance**

The maintenance view is used for the response of the operator to a maintenance request of a component. Maintenance work can be requested.

The status of the work can also be specified. This is recorded, and signaled in the symbols. A work instruction number and a comment can be entered for each work request. The instruction number is included in the report. This can be used for transfer to maintenance planning.

On the basis of the information present in the SIMATIC Maintenance Station per message and status display, comprehensible actions can be initiated by the user and documented by means of WinCC operator input messages.

This supports the maintenance workflow on the one hand, and generates a comprehensive database for subsequent plant optimization to reduce maintenance costs on the other hand.
Monitoring and diagnostics for industrial PCs

SIMATIC PCs are rugged industrial PCs for professional automation solutions in 24-h operation. Because of their high system availability, they are used in production automation in the field and operation management levels.

The following are monitored and signaled:

- Exceeding or falling below the permissible operating temperature range by measuring at various points in the device, e.g. on the processor and motherboard
- Fan speeds/failure (including open-circuit)
- Hard disk condition/problems
- Program interruption (watchdog)
- Maintenance interval (freely selectable) by means of parameterizable elapsed time counter

It is then possible, for example, for the user to replace hard disks as a preventive measure before a loss of data occurs. In the event of an alarm, the DiagMonitor also starts autonomous programs such as special PC tools or user-specific applications for individual response to alarms.

Advantages at a glance

Increase in productivity through avoidance of potential failures

- Diagnostics and signaling functions for PC temperature, fan, hard disks (SMART), system status (watchdog)
- Operating hours counter for preventive maintenance
- Recording and evaluation of operating data
- Integral recording function, comprehensive text messages and online help in German and English

Reduced costs thanks to minimization of downtimes

- Fast information to service personnel using communication by e-mail, SMS
- Fast response through communication to application using OPC and SNMP

The SIMATIC PC/PG DiagMonitor supports fast detection and efficient avoidance of potential system failures.
Diagnostics of the communications equipment

With a powerful production automation system, users not only expect the coordination of complex and dynamic processes but also support towards increasing plant availability. Powerful networking of the automation components present in the plant is decisive for maintenance.

All communications equipment and field buses used must uniformly support the maintenance functions. The uniform communication of Totally Integrated Automation provides the prerequisites for this.

In addition to reliable communication, the network components of SIMATIC NET also offer the facility for network diagnostics during runtime. This permits early detection of weak points and rapid locating in the event of a fault.

PROFINET, the open Industrial Ethernet standard

PROFINET is used for the direct connection of distributed field devices to Industrial Ethernet and allows distributed automation with the support of the component technology, as well as vertical integration and the solution of safety-related applications.

Through importing of the device model of PROFIBUS, the same diagnostics information is available with PROFINET.

To establish optical network topologies, glass fiber optic cables (glass FOC) or plastic fiber optic cables made of light-conducting plastics such as polymer optic fiber (POF), or plastic covered glass fibers such as polymer cladded fiber (PCF) are used.

The uniform system solution comprises passive and active network components, as well as distributed field devices with integral POF/PCF interfaces. The cables are monitored during startup and runtime for attenuation resulting from material aging.

PROFINET maintenance functionalities

In addition to the communication of conventional diagnostics events, PROFINET also permits standardized signaling of information relevant to maintenance. A standardized device status model has been defined for this by PROFIBUS International.

This possibility is used, for example, to signal an increased attenuation on optical transmission links (POF) at an early point in time. The associated cable can then be replaced in the context of a planned maintenance measure. This avoids unplanned downtimes.

Network components for PROFINET

SCALANCE X is the new product range of Industrial Ethernet switches from SIMATIC NET. Switches are active network components that specifically distribute data to the relevant addresses. The SCALANCE X product group comprises several product lines that complement each other and are carefully tuned to the specific automation task.

- SCALANCE X005 unmanaged: entry level switch for designing small star or line structures with switching functionality in machine and plant islands.
- SCALANCE X-100 unmanaged: Industrial Ethernet switches for use in applications at machine level with local diagnostics.
- SCALANCE X-200 managed: universally implementable in applications at machine level up to networked subsystems.
- SIMATIC NET with SCALANCE 200IRT: the first Industrial Ethernet real-time switch with innovated housing concept and integral ERTEC (Enhanced Real-Time Ethernet Controller). Response times can be achieved using standard components which correspond to the performance of current fieldbus systems. High-performance, isochronous motion control applications can be implemented with IRT. In addition to the proven industrial features of the SCALANCE X-200 product range, the SCALANCE X204IRT switch includes an integral redundancy manager.
- SCALANCE X-400 modular: for implementation in high-performance plant networks that will also satisfy future requirements (e.g. high-speed redundancy).
The integral network management with the standard SNMP (Simple Network Management Protocol) in the SCALANCE X products (except X-005, X-100) provides diagnostics information which can be displayed on the SIMATIC Maintenance Station.

**PROFIBUS - Online diagnostics of the bus cables using the diagnostics repeater**

Under normal operating conditions, the bus cables are also subjected to external forces that can cause damage. Particularly in the case of exceptional stress, e.g. trailing cables or strong vibrations, frequent inspection of the cables is recommended to reduce failures to a minimum.

The diagnostics repeater is available for cable diagnostics during normal operating conditions. It is integrated as an RS485 repeater into the PROFIBUS network, and additionally has powerful functions for diagnostics of the following cable faults:

- Open circuit in conductor A or B
- Short-circuit between signal lines and the shield
- Absent or too many bus terminating resistors

**Maintenance functionality of the diagnostics repeater**

The diagnostics repeater determines the bus system topology. If a fault occurs, the repeater – as a PROFIBUS slave – automatically sends a standard diagnostics message to the master. The message contains information on:

- The affected bus segment
- The fault location (e.g. between stations X and Y), i.e. the distance of the fault location from the repeater or from the stations in meters
- The possible cause, e.g. short-circuit between signal cable A and shield.

The diagnostics functions mentioned also permit maintenance engineers without PROFIBUS experience to rapidly and reliably locate and correct faults in the bus cables. The exact and simple diagnostics can increase plant productivity.

The diagnostics repeater is visualized on the SIMATIC Maintenance Station as a PROFIBUS device, and represents the diagnostics condition in the associated bus system. Further detailed diagnostics information is available from the SIMATIC Maintenance Station using the Engineering System. STEP 7 must be installed on the maintenance station for this purpose.

**SNMP OPC server**

Using the SNMP OPC server, which can be integrated in the SIMATIC Maintenance Station, the latter can access diagnostics information (e.g. from SCALANCE network components, OSM and ESM or the SIMATIC PC/PG DiagMonitor).

The SNMP OPC server offers the following functions:

- Condition monitoring, device identification and network management of SNMP-compatible devices
- Devices without SNMP agents can also be monitored
- Automatic incorporation of SNMP-compatible devices by means of the SNMP mapper within STEP 7; i.e. generation of OPC tags, interrupt messages and faceplates for SNMP devices
- Parallel use of SNMP with other communications protocols.

The network and process can be monitored and diagnosed in one system using the SNMP OPC server. Configuration is incorporated into the STEP 7 engineering environment. This means that even sporadic cable faults, which are usually very difficult to find, can also be detected and signaled.
Diagnostics of the communications equipment

AS-Interface – the actuator/sensor interface

Below the PROFINET and PROFIBUS bus systems the AS-Interface, an open and vendor-independent bus system, connects the sensors and actuators in the field. Actuators and sensors are connected with programmable logic controls via a 2-wire cable and this permits simultaneous transferring of data and energy. AS-Interface is therefore positioned at the border to the automation world and in the transition area to the machine. As an industrial bus system, AS-Interface can transmit safety-relevant data in addition to operating data.

To connect binary and analog signals in this machine-level environment, AS-Interface satisfies further requirements, e.g. power supply to the interfaces and the sensor electronics over the data line, and suitability for field applications up to IP65/67.

Maintenance functionality with AS-Interface

AS-Interface is seamlessly integrated in the SIMATIC system diagnostics. Using object managers, the system diagnostics is simple, secure and uniform by means of the existing SIMATIC tools. AS-Interface is therefore fit for a variety of maintenance tasks.

For hardware components AS-Interface also supports high-speed signaling of maintenance-relevant data at any time. The DPI/AS-i LINK Advanced is a PROFIBUS DPV1 slave and an AS-Interface master. This allows transparent data access to AS-Interface from PROFIBUS DP.

The DPI/AS-i LINK Advanced is thus ideally suited for distributed configuration and for linking an underlying AS-Interface network:

- Integral Ethernet port permits Web interface diagnostics, and reduces the number of external switch ports.
- Complete startup and diagnostics on site without additional tools and with low time requirements.

Thanks to the new IE/AS-i LINK PN IO, AS-i is also optimally suited for PROFINET. Data can be recorded via the AS-Interface integrated in sensors or actuators, or via modern, rugged and compact modules such as the new K20 compact module. The new AS-Interface specification also permits joint transmission of binary and analog data – without loading the PLC with coordination tasks. With the aid of pre-fabricated WinCC flexible diagnostics displays, the status displays of all AS-i slaves (and ASIsafe slaves) can be visualized centrally in the control room.

The prerequisites for comprehensive provision of data are therefore satisfied as the basis for different maintenance strategies.
Diagnostics of protective and switching components and distributed I/Os

**Contactor with remaining-life-time signal RLT**

Contactor main contacts are parts subject to wear, and must be replaced before they reach the end of their service life. The erosion of the contact material, and therefore the electric service life (= number of switching operations) is larger or smaller depending on the load, category of use, operating mode etc. Routine checks/visible inspections by the maintenance personnel provide information on the status of the main contacts.

The *remaining life time message* function of the SIRIUS contactors with RLT handles this task and makes on-site visual inspections unnecessary. It not only counts the switching operations – which do not provide information on the contact wear – but, more importantly, the actual advancement of the erosion of each of the three main contacts is electronically recorded, evaluated, saved and signaled when defined limits are reached.

These saved data are not lost even if the control supply voltage fails. State-oriented maintenance permits optimum utilization of the contact material. This results in a reduction in operating costs with a simultaneous increase in plant availability. The message is output via a relay contact or AS-Interface when a remaining service life of 20% is reached.

The SIRIUS contactor with RLT can be integrated in the SIMATIC Maintenance Station via a proxy module.

**Selective protection of load feeders**

Automation components are usually supplied with 24 V DC. Each 24-V load is reliably monitored for overload and short-circuit by the SITOP select diagnostics module, and switched off in the event of a fault. A diagnostics module monitors up to 4 load feeders which can be switched in sequence following defined periods in order to offload the power supply.

The monitoring currents can be set between 2 A and 10 A. The SITOP select electronics permits brief current peaks such as peak inrush currents - longer overload/short-circuits are switched off.

When one of the four outputs is switched off, a common signaling contact picks up, and this can be evaluated by the host automation system. The service technician recognizes on site which 24-V feeder is concerned, since each output has a multicolor LED to indicate the current operating status.

In addition to fast fault recognition and locating, this results in reduced downtimes.

SITOP select can be integrated in the SIMATIC Maintenance Station via a proxy module.
Diagnostics of protective and switching components and distributed I/Os

Distributed I/O
Modern automation can no longer be imagined without flexible, distributed solutions, since these result in significant cost savings. The modular SIMATIC ET 200 range permits distributed solutions for every sector. Whether compact or modular, purely digital I/O interfaces or complete distributed systems with drive technology, installed in the control cabinet or directly in harsh industrial environments.

Integrated engineering and diagnostics
The SIMATIC ET 200 I/O systems offer powerful, multi-level diagnostic systems within the framework of Totally Integrated Automation for faults that occur in the control system (system diagnostics). System faults are automatically detected and are caught by programmable exception handling routines. Furthermore, such system faults are signaled to the connected HMI system, and displayed there in an appropriate manner.

During startup and runtime, the automation system topology with the ET 200 stations is offered as overview diagnostics. Module diagnostics provides more detailed information on the individual modules, and includes, for example, short-circuit testing of sensor power supply and outputs.

Modules with diagnostic capability monitor each channel for short-circuit and wire-break. This makes it possible to react immediately to every irregularity and process event. The response of the controller can easily be programmed with STEP 7.

Utilization of the system diagnostics functions of the SIMATIC ET 200 I/O systems is easy and user-friendly thanks to the SIMATIC Maintenance Station. The modular ET 200 stations can be displayed in a detailed representation with their diagnostics conditions, where station, module and channel diagnostics are visualized.

Solutions in the control cabinet

SIMATIC ET 200S – the all-rounder with a comprehensive range of functions
- Scaleable design with multi-conductor connection
- Multifunctional thanks to a wide range of modules: Motor starters, frequency converters, safety technology, distributed intelligence, IQ-Sense sensor modules.
- 8-channel 8 DI 24 V DC and 8 DO 24 V DC/0.5 A compact modules.
- For use in hazardous areas (Zone 2)
- Also available as expandable block version with integral DI/DO: SIMATIC ET 200S COMPACT

SIMATIC ET 200M – the multi-channel S7-300
- Modular design using standard SIMATIC S7-300 modules, redundant design also possible
- Fail-safe I/O modules
- For use in hazardous areas up to Zone 2, sensors and actuators up to Zone 1
- High plant availability thanks to redundancy, hot swapping, and configuration changes during operation (CIR)
- Available for PROFIBUS and PROFINET

Solutions without a control cabinet

SIMATIC ET 200pro – modular and multi-functional
- Modular design with an extremely compact casing (small footprint)
- IM 154-8 CPU on-site intelligence (Scope as for CPU 315-2 PN/DP)
- Easy installation
- Multi-functional thanks to a wide range of modules – from simple inputs and outputs through safety systems, motor starters, all to way to MOBY identification systems
- High plant availability thanks to hot swapping and permanent wiring
- Comprehensive diagnostics (e.g. transmission of current value)
SIRIUS motor starter
SIRIUS motor starters with communications capability are available for all customer requirements:
- For centralized drives: ET 200S motor starters in IP20 and ET 200pro motor starters in IP65
- For distributed drives: ECOFAST motor starters in IP65

The communication-capable SIRIUS motor starters are completely incorporated in Totally Integrated Automation, and can therefore be incorporated and visualized in the automation systems simply and rapidly using standard mechanisms.

They also provide important benefits for plant owners with respect to maintenance (see page 18).

ET 200pro motor starters
SIMATIC ET 200pro is the distributed I/O system with a modular design for complete solutions with high degree of protection. Motors and loads up to 5.5 kW can be directly connected to PROFIBUS DP/PROFINET by means of the intelligent motor starter generation ET200pro Standard and High Feature. The motor starters are parameterized in a simple manner using the SIMATIC Manager.

The motor starters permit integration of conventional switchgear technology into uniform automation with Totally Integrated Automation and thus a simple connection to the host control system. The motor starters are available as direct-on-line or reversing starters with optional 400 V brake control.

The High Feature motor starter differs from the Standard motor starter in that it has more parameters and thus four integrated, freely-parameterizable digital inputs. The motor starters for ET 200pro are preferably used for plants with a larger number of drives within a small area.
Diagnostics of protective and switching components and distributed I/Os

ET 200S motor starters
The SIMATIC ET 200S High Feature motor starter for the central control cabinet (or control box) rounds off the ET 200S module range at the top end. It handles switching and protection for three-phase loads up to a power of 7.5 kW with two power versions. This results in extremely economical stock keeping and increased availability through maximum reliability and early diagnostics.

ET 200S with motor starters

ECOFAST motor starter
The ECOFAST motor starters are components of a distributed system solution for a comprehensive modular design of the installation with standardized interfaces and comprehensive diagnostics at the component level. They are the ideal solution for conveyor technology applications. Many different applications can be optimally covered by the complete product range comprising electromechanical and electronic motor starters and soft starters as well as a speed adjuster.

Maintainance features of the SIRIUS motor starters
The motor starters of the ET 200pro distributed I/O and ECOFAST support the most important functions for providing preventive maintenance, short downtimes and optimum monitoring of the plant processes. The ET 200S motor starters can be optimally used in small control cabinets with distributed designs, and provide a wide range of maintenance data thanks to the cyclic data transfer on the bus systems.

Preventive maintenance:
The ET 200pro and ECOFAST motor starters provide information such as the actual phase current and monitoring of the upper and lower current limits. Additional information such as switching frequencies, duty cycle of motor starter, motor operating life, tripping frequency, or last tripping current can be read out via the usual communication paths of the bus systems or reported automatically. The motor starters of the ET 200S offer comprehensive diagnostics, and transmit the largest actual phase current by means of the cyclic data transfer of the PROFIBUS/PROFINET. Additional maintenance information can be read out over the serial device interface using the software motor starter ES.

Short downtimes
Faults can be diagnosed simply and rapidly by means of bus or LEDs. If a motor starter has to be replaced, the new device is parameterized automatically. The plug-in system for 400 V or permanent wiring and simple assembly ensure rapid device replacement.

Optimized monitoring of plant processes:
During operation parameters of the motor starters of the ET200pro and ECOFAST family can additionally be adjusting by the user. This enables ideal adaptation of the parameters to the plant processes.
Diagnostics of drive components

Hardly any other group of products influences plant availability as much as drive engineering: production stops if these products fail. Such unplanned plant downtimes are associated with expensive production outages, unplanned repairs, and frequently consequential damage.

The drive systems and frequency converters of the SINAMICS, MASTERDRIVES and MICROMASTER ranges with the downstream motors are integrated into the SIMATIC Maintenance Station. This results in the common, uniform presentation of maintenance-relevant information which permits preventive and predictive maintenance strategies.

The drive systems are incorporated into the maintenance station using the engineering system DriveES SIMATIC, an add-on package for SIMATIC STEP 7. DriveES SIMATIC permits that Siemens drives are controlled, operated, monitored, and diagnosed using SIMATIC STEP 7 with standard function blocks.

Condition monitoring
The frequency converters offer multiple monitoring possibilities such as speed monitoring, motor current monitoring, motor overload, torque monitoring by means of tolerance band checks and thermal motor monitoring.

Maintenance functionality
SINAMICS permits simple plant diagnostics, even via TeleService. For this purpose, all of the drive parameters including motor data are available.

The uncomplicated connection system allows simple replacement of components during maintenance, and a programming device is not required. The Control Unit is replaced extremely easily by replacing the CF card. Diagnostics with an operator panel is possible on site.

Identical meanings of the parameters simplifies the maintenance of different types of drive. Many identical parts facilitate the simple stocking of spare parts, e.g. use of the CU 320 for SINAMICS S120, G130/G150, S150, GM150, SM150. PROFIBUS/PROFINET are global standards, and the established transmission protocols are used (Ethernet/TCP/IP).

Drives are integrated into the maintenance station concept using a DriveES SIMATIC proxy block which provides the maintenance condition and links the drive with respect to the operating condition and maintenance requirements to the signaling system.

Products
Together with the proven frequency converters MICROMASTER and MASTERDRIVES, the SINAMICS drive family covers the complete range of applications, power and performance levels. Conveyors, pumps, fans, extruders and mixers, packaging and plastics machines, machines for production of food and beverages, presses and punches, printing and paper machines etc. All drives can be managed using DriveES.
Diagnostics of drive components

Maintenance using example of a conveyor belt
A gear motor drives a conveyor belt, and is controlled by a frequency converter. The frequency converter records the runtime of the gear motor using an operating hours counter. In addition, the utilization is recorded through evaluation of the temperature and torque of the gear motor. The company can then define the maintenance intervals based on the utilization. If the temperature and torque limits are not exceeded, the geared motor can then be serviced at larger intervals. If there are frequent torque peaks/changes or overtemperatures on the geared motor, the maintenance intervals can be shorter.

Special procedures for assessing the condition of high-voltage machines
An established procedure for assessing the condition of high-voltage machines is partial-discharge diagnostics (PD) which is carried out as an offline or online measurement depending on the application. This is an important measure within reliability-based maintenance strategies for large drives.

In order to measure the PD signals, as an option the patented Siemens Insulator Integrated Coupling Units can be installed in high-voltage motors at the factory.

The post insulators in the terminal box are simply replaced by the Insulator Integrated Coupling Units. This results in decisive benefits:

- Simple, low-cost installation
- No change in terminal box necessary
- Rugged mechanical design
- Maximum and tested safety of insulation distances
- Direct interface to condition diagnostics

The frequency converters for controlling the speed, which are compatible with the high-voltage motors, also offer intelligent maintenance functions: Their components report autonomously that maintenance is required. For instance, by means of a differential pressure procedure the degree of contamination of the dust filters is determined. For liquid-cooled devices the analog conductivity measurement continuously monitors the operation of the ion exchanger and outputs an early-warning message when the exchange capacity decreases. This ensures that components are exchanged in good time (e.g. during a routine inspection).
Diagnostics of drive trains

Although designers and plant engineers attach utmost importance to a long service life of power train elements, sporadic disturbances during daily operation may occur as well as damages due to wear after many years of operation. Unscheduled downtimes and sometimes serious consequential damages can occur in many cases if the disturbances and damages are not detected in time.

Use of Condition Monitoring technologies and services

For this reason Flender Service International offers and uses various Condition Monitoring tools and services for machine status acquisition:

- Gear control diagnostics systems
- Drive analyzers
- Torque measuring technique
- Oil analyzing systems
- Thermography
- Laser alignment systems
- Video endoscopy

Remote diagnostics systems are used for online monitoring of power trains. They automatically record the rolling resistance characteristics and send warnings, alarm and measurement results by e-mail to the diagnostics experts in the remote diagnostics service center. Tailored remote diagnostics services are provided for detailed analyses and reporting.

Measurement of torques on the power train

Many problems in electromechanical drive systems can be solved by using the torque measuring technique.

As a primary process variable, the torque best describes the loads on the components of a drive train. It is usually the highly dynamic vibration components in the torque signal which permit statements on impermissible resonant torsional vibrations or overload peaks.

To carry out the measurement, an appropriate part of the drive train, for example a shaft or coupling bush, is turned into a torque sensor by adhering foil strain gauges to the surface of shafts and connecting them as a Wheatstone bridge. The torsion-dependent surface expansion is transmitted to the strain gauge without loss. Flender Service has optimized the practical aspects through numerous applications such that the design of the complete measuring chain of a torque channel, from preparation of the shafts up to data recording, can usually be completed within one working shift.

Flender Service International is a subsidiary of Siemens AG. www.flender-service.com
Solutions for machine tools

The target of IT solutions for machine tools is to increase the productivity and availability of machines and to optimize servicing and maintenance processes worldwide. Siemens software supports the two main processes representing the supporting pillars in modern and efficient production.

Total Productive Maintenance (TPM) to increase the machine service life

The TPM software informs the machine operator directly about preventive maintenance activities. A traffic light signalizes pending maintenance jobs in time. Brief instructions in the form of PDFs and HTML documents support the maintenance operator during execution. This can be implemented direct on the controller or PC in the technician’s office.

Based on the TPM (Total Productivity Maintenance) philosophy, production and maintenance are both integrated in the maintenance and servicing activities.

The results:
- Relief of the maintenance department from simple routine jobs
- Less machine documentation is required
- Increase of overall plant effectiveness due to optimally maintained machines

Condition Monitoring to prevent unscheduled machine failures

Software-supported, automated test routines regularly record and archive the actual machine status. By comparing the actual status to previous status measurements, changes in the machine can be identified. Based on these trends component failures can be predicted. This enables the machine manufacturer, maintenance staff or service provider to schedule maintenance activities such that they will be implemented during periods with no production. This reduces unscheduled downtimes to a minimum and increases the productive time of plants significantly.

A virtual team, consisting of machine manufacturers, maintenance staff and service providers has online access to the machines and trend analyses. Thus a platform is made available for uncomplicated cooperation.

The results:
- Safe communication between company networks
- Reduced inspection and maintenance overhead
- Reduced maintenance costs
- Reduction of the life cycle costs

Further information can be found in the Internet at: www.siemens.com/sinumerik ➔ HMI software
Diagnostics of sensors

IQ-Sense enables the intelligent integration of sensors into automation technology. This consequently leads to system-wide availability of parameter and diagnostic data for various sensors, which greatly increases system availability.

Available sensor components

Optical sensors for IQ-Sense
Currently the following optical sensors with IQ-Sense functionality are available: energetic sensors, sensors with background suppression or retroreflective sensors in K80 and C40 types.

Ultrasonic sensors for IQ-Sense
Type M18 retroreflective sensors (without blind zone) or diffuse scanners (with foreground or background suppression) as well as analog mode to directly transfer the distance information via IQ-Sense can be selected.

RF identification system for IQ-Sense
The SIMATIC RF310R is a cost-effective SLG read/write device with IQ-Sense interface. Thanks to its extremely compact dimensions, it is particularly suited to small assembly lines with low amounts of data on the transponder.

Intelligent interface modules

The SIMATIC ET 200S 4 IQ-Sense sensor module
The 4 IQ-Sense sensor module is an intelligent 4-channel electronics module for SIMATIC ET 200S and is used to connect optical IQ-Sense sensors. The ET 200S provides all of the functions to any PROFIBUS DP Master modules.

Sensor module 8 x IQ-Sense for S7-300/ET 200M
The 8 x IQ-Sense sensor module is an intelligent 8-channel I/O module for SIMATIC S7-300 and ET 200M, and is used to connect optical sensors, ultrasonic sensors and RF identification systems with IQ-Sense technology.

Various sensor types can be combined in a module.

Extensive diagnostic options
Sensor diagnostics accurate to one channel means automatic signaling of wire breakage, short circuit, misalignment or module/sensor failure. No additional hardware is required to transfer diagnostics information. This is achieved event-controlled using a two-wire cable. The signals are embedded in the S7 system diagnostics as well as in the PROFIBUS DP standard diagnostics.

Preventive maintenance
For optical sensors, the gradual accumulation of dirt, which occurs with optical sensors, is reliably detected and signaled using a two-stage monitoring of the surplus light emission before a failure occurs. This means that plant downtimes can be significantly reduced.
Further information is available in the Internet

For further details, see SIMATIC Guide
Technical Documentation:
www.siemens.com/simatic-docu

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