Plant asset management

Products for intelligent maintenance in the process industry

Brochure · April 2006

maintenance intelligent

PRODUCTS

SIEMENS

Introduction
Increase in productivity through intelligent maintenance

How can the productivity of a plant with a high level of automation be increased even further?
Surveys indicate that plant operators in all sectors consider increased availability and shorter downtimes to be the most effective catalist toward increasing productivity. Investigations have shown that downtimes are frequently the result of insufficient maintenance – despite the fact that maintenance costs are already a significant portion of lifecycle costs. In addition, subsequent costs can also occur due to substandard quality or damage to one's image wich are often not taken into consideration.

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

Maintenance strategies

Different maintenance strategies exist depending on whether a response to failures or preventive actions are required. In the case of corrective maintenance, measures are only initiated when a fault has occurred, i.e. failures are risked in this case or minimized by a redundant plant design.

The objective of preventive strategies is to complete maintenance measures before faults occur, preventing downtimes which may otherwise result.

This strategy can be carried out using time-based measures such as regular maintenance activities, or condition-based measures which are initiated depending on the degree of wear.

In addition, predictive measures can recognize problems at an early point in time and provide the user with information on the remaining service life.

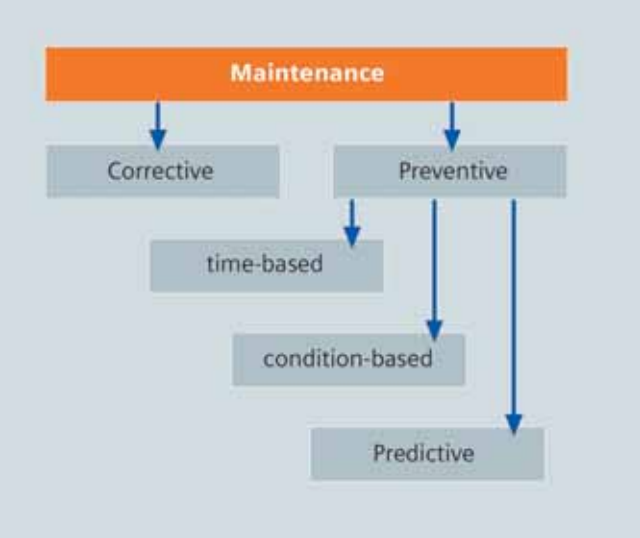
Intelligent maintenance strategies with SIMATIC PCS 7

The SIMATIC PCS 7 process control system together with the automation and drive components of Totally Integrated Automation offer integral system functionalities which permit the implementation of effective maintenance strategies.

The following objectives are achieved using plant asset management:

- Recording and assessment of the plant status and its components, e.g. field devices,
- Initiation of the appropriate measures to eliminate or avoid problems,
- Support in the implementation of preventive measures.

In the context of Business Based Maintenance, we support you in finding your optimum maintenance strategy. The service packages for preventive and predictive maintenance extend from consulting and implementation up to the complete taking over of maintenance processes.
www.siemens-com/simain



Maintenance strategies

Content

Plant asset management

Operation of a plant and availability

Various tasks have to be handled during the operating phase of a plant. The actual plant operation is the task of the operators. They 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 engineers or plant engineers are responsible for guaranteeing a high plant availability for a certain period of time.

Maintenance measures must also be carried out 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 plant operator is mainly interested in information concerning the process, whereas the maintenance engineer requires information on the state of the production equipment.

Information is available for the plant operator concerning the measured process variables. In addition to the measured value itself and its status, this information could also indicate whether the measured value is still valid.

Maintenance engineers are focused on the current and projected status of the production equipment – particularly the field devices. This status is typically represented as "Component OK", "Maintenance required", "Failure" or "Functional check".

SIMATIC PCS 7 permits a clear division of information between plant operators and maintenance engineers as the user groups.

This so-called plant asset management reduces the scope of information for each of these user groups to the amount required for the respective task. At the same time, the availability and reliability of the information for the plant operator and the quality of operator interventions is improved. This increases the availability of the production equipment.

Different information requirements associated with the plant

Plant operators

Information on the process, e.g.:

- Recipe parameters
- Temperature characteristic
- Pressure values
- Supply of raw material
- Output

Maintenance engineers

Information on status of production equipment, e.g.:

- Component OK
- Maintenance requirement
- Failure
- Functional check

Plant asset management

General

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.
For a production facility, plant asset management includes the maintenance activities that retain or increase the value of the plant.

An important focal point of the tasks in addition to plant management or process optimization is the so-called asset management, understood as maintenance which retains and increases value (recommendation of the association representing the interests of process control engineering in the chemical and pharmaceutical industries, NAMUR, NE 91).

It is emphasized that maintenance measures are necessary to retain availability of production equipment at a high level, but that these must also stand up to critical economical consideration at any time. Specific measures include maintenance, inspection, repair and elimination of weak points.

These terms and measures are described in DIN 31051. Optimization of the measures with respect to cost/benefit consideration is an integral task of plant asset management.

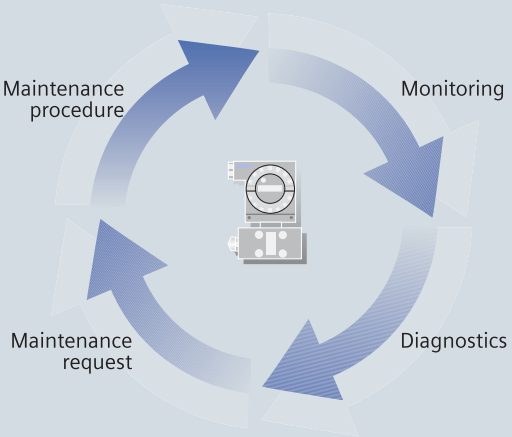
Benefits of plant asset management

Plant asset management permits maintenance engineers to unambiguously identify and assess the assets, i.e. the production equipment and its components, so that appropriate measures can be initiated in the case of deviations from a desired or expected status.

As a result of monitoring, i.e. the recording and evaluation of process values and status variables, the status can be determined for a component or device, e.g. a field device.

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 maintenance procedure – replacement of a faulty sensor in the example – ensures that the component is returned to the desired status and closes the maintenance cycle.



Maintenance cycle

Plant asset management in process engineering

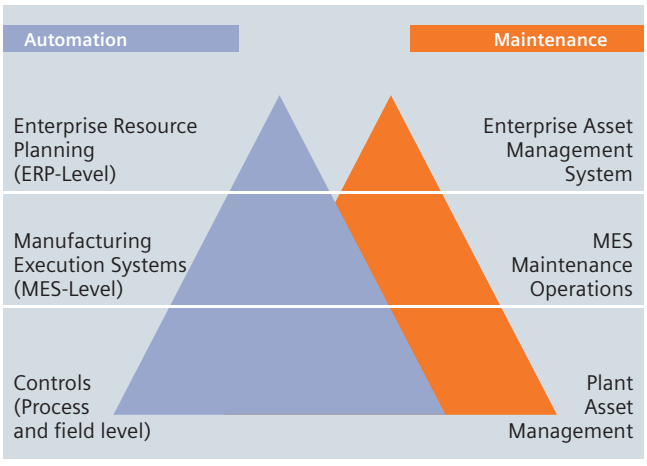
In order to describe the automation of a plant, an appropriate model divides the functions to be executed, the required systems, and the components into control levels within a pyramid. A different number of levels exist depending on the environment in which the model is used. One common model uses three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

Just like the automation functions, maintenance functions – and thus plant asset management – can be divided into control levels. In the maintenance pyramid, the data relevant to the status of a component is recorded and preprocessed in the Control level, permitting determination of the status 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 process control system and not to use different systems.

There are various reasons for this:

- Uniform visualization for all components and devices
- No limitation in selection of field devices
- The same information sources (field devices) are relevant to both automation and maintenance
- There is a close link between automation and asset management functions because e.g. the current operating mode of the plant is important for assessing the status of a component
- 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



Plant automation and maintenance in one system

The process control standards committee for the chemical and pharmaceutical industries (NAMUR) has formulated the important requirements (NE 91) from the user side. It considers that special importance must be applied to the integration of plant asset management into the process control system including:

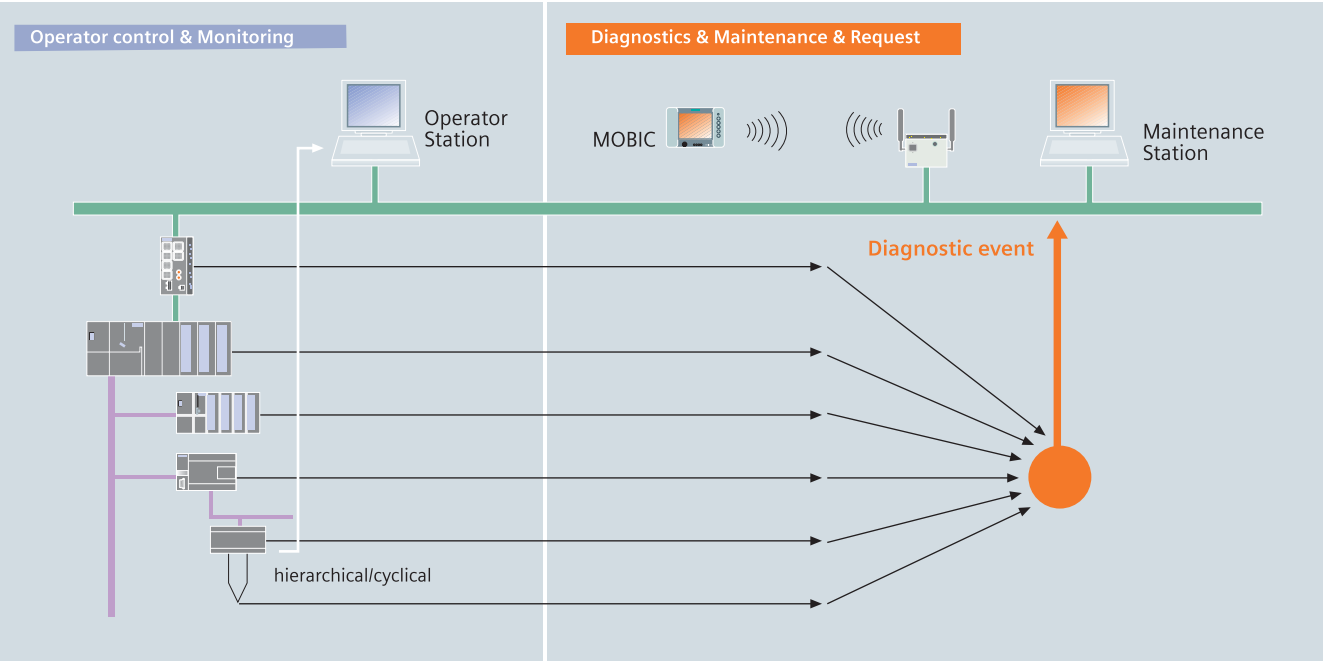
- Plant asset management is a component of the process control system
- Recording and assessment of the asset status
- Incorporation of all assets (process control devices and plant components)
- Separation of maintenance-relevant information and process information
- Uniform visualization for all assets
- No limitation in selection of field devices

The requirement additionally exists (NE 107) that all field devices should provide uniform status messages of type:

- Good
  No limitation of functions known
- Out of specification
  Operation outside the specified range
- Device failure
  Maintenance requirement
- Maintenance required
  Function check (process value manipulated)
- Function check, local operation
  Failure (process value invalid)

Plant asset management with PCS 7

- Process plants which can be controlled using SIMATIC PCS 7 and components of Totally Integrated Automation satisfy the requirements formulated by NAMUR.
- Automation and plant asset management are executed on the same system.
- The information for the plant or maintenance engineer is presented on the operator station or the maintenance station.
- Common configuring and uniform user interfaces help to keep the overhead for plant asset management at a minimum.



Separation of maintenance-relevant information and process information

Implementation with SIMATIC PCS 7
Process automation for Totally Integrated Automation

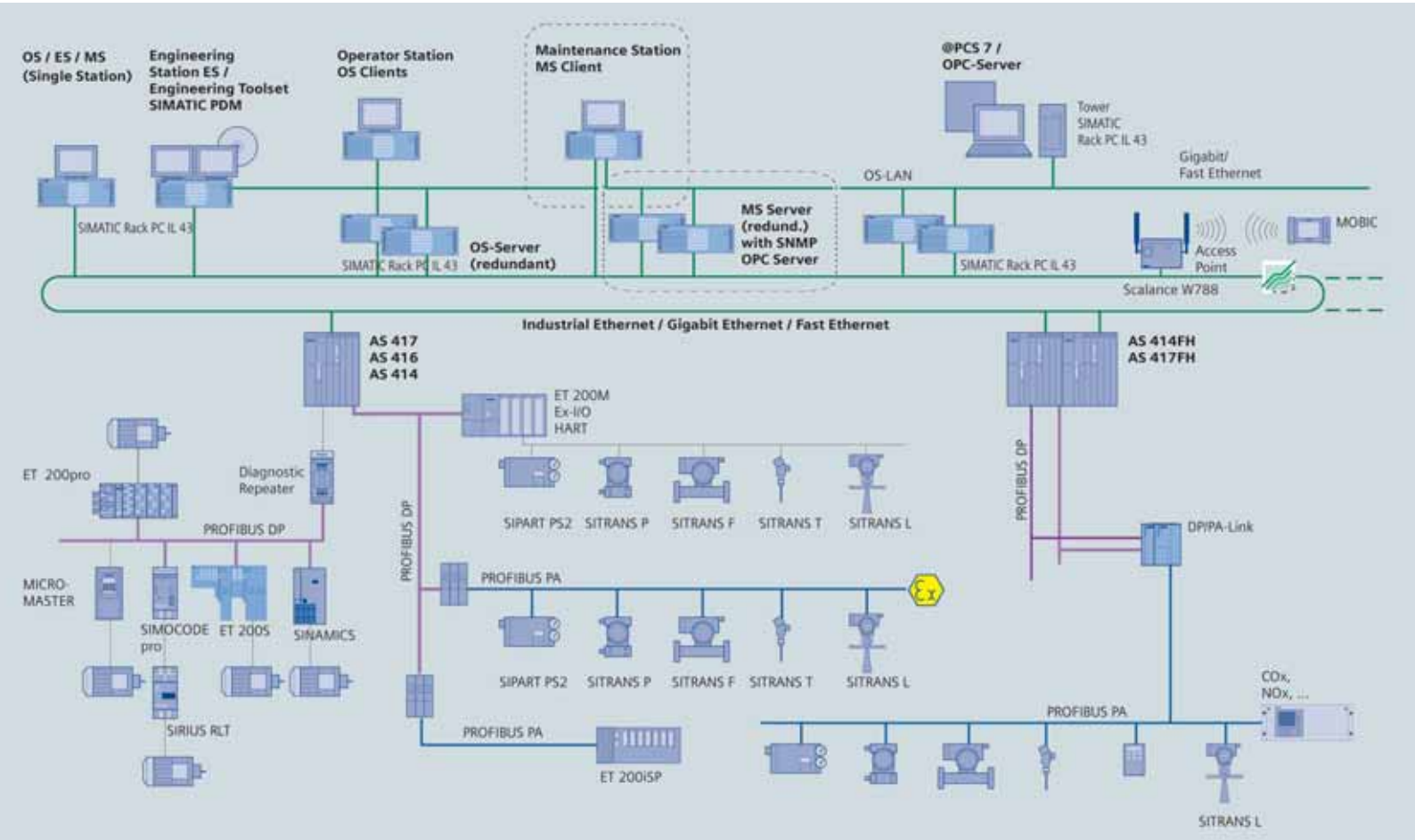
The process control system that ties together your plant and your business

SIMATIC PCS 7 is the integrated and homogeneous automation solution for all industrial applications, whether process, production or hybrid applications, and regardless of whether manufacturing or process automation production is involved. Its design and architecture make it possible to operate a plant cost-effectively and efficiently over the entire life cycle, from planning, engineering, commissioning and training through ongoing operation, up to maintenance.
SIMATIC PCS 7 handles not only process engineering tasks in the primary production process, but also the integration of all secondary, upstream and downstream processes, such as wastewater treatment or the distribution of power at a production location.

- The flexible and user-friendly engineering system is a universal tool for all configuration tasks and for all components of the process control system
- The HMI system is the window to the process: operating personnel and plant personnel can track the process, modify recipes or batch sequences and change current values
- SIMATIC PCS 7 automation systems provide all the functions required to solve automation and control tasks – at different performance and safety levels to meet your requirements
- Recipe-controlled batch processes can be implemented easily and quickly with SIMATIC BATCH, making a flexible solution possible for virtually any task from simple single-line/single-product processes to complex multi-line/multi-product processes
- SIMATIC PCS 7 utilizes the Industrial Ethernet and PROFIBUS standards for communication

Diagnostics of the automation systems

All diagnostics functions present in the process control system and its components are provided by the PCS 7 Maintenance Station and are visualized there.

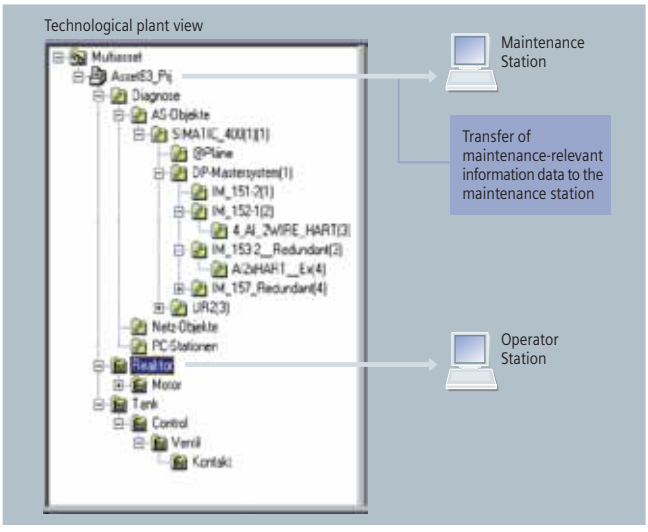


Plant asset management with PCS 7 Maintenance Station

Process plants which can be controlled using SIMATIC PCS 7 and components of Totally Integrated Automation satisfy the requirements formulated by NAMUR. Automation and plant asset management are executed on the same system. The resulting information is selectively divided to prevent the plant operators and maintenance engineers from being flooded with information.

To achieve this, a maintenance station (MS) is introduced in addition to the operator station (OS). The plant operator can use the operator station to access all process-relevant information and can manually intervene in the process. Maintenance-relevant information is kept away from the operator station. This information is presented for the maintenance engineer on the maintenance station.

The same HMI tools are used for the operator and maintenance stations, and the HMI philosophy is completely identical. The only difference is that the information contents are provided appropriate to the tasks of the plant operators and maintenance engineers.



During configuration of PCS 7, the technological plant view automatically produces a separate maintenance area

Asset Management with PCS 7

The advantages of plant asset management are effective for field devices, switchgears, protective equipment, control devices and drives which can be incorporated into the SIMATIC PCS 7 process control system, and for the process control system itself. With the large number of components and devices in a plant, it is particularly important to keep the overhead for configuration of the plant asset management as low as possible.

Configuring

During the configuring of PCS 7, a separate maintenance display is produced in addition to the technological plant view, which maps the plant from the maintenance viewpoint.

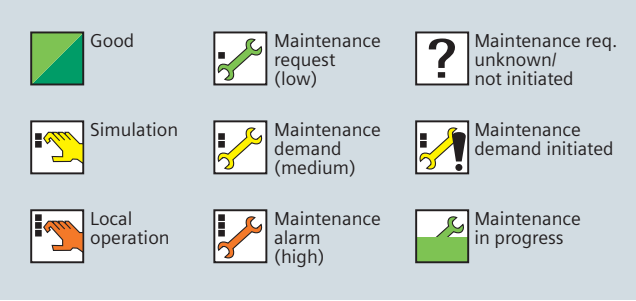
This display is automatically generated from the existing hardware configuration so that no manual steps are required to configure this display. If required, maintenance engineers can adapt the user interface to their own requirements extremely easily.

The two areas are transferred to the two user stations according to the division of information for the different user groups, where the technological view is assigned to the operator station and the maintenance display to the maintenance station.

Visualization of information for maintenance

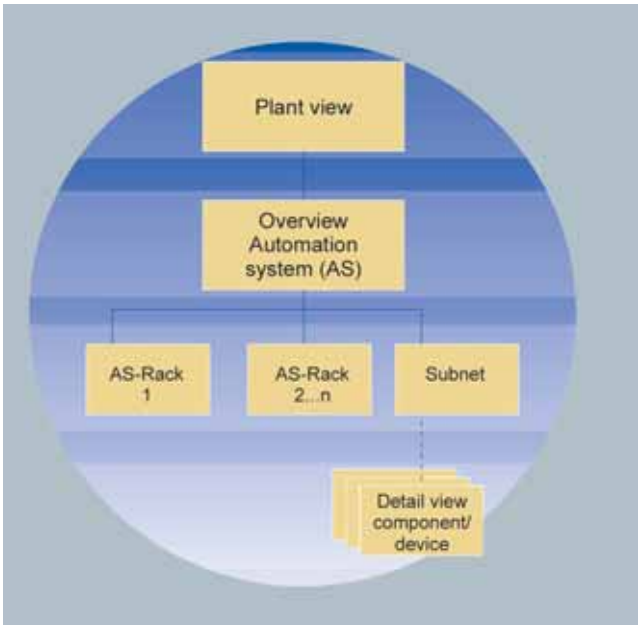
In order to assess the status of individual devices or components without doubt, a uniform symbol representation has been implemented.

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 status of all devices and equipment of the automation technology and of the plant components are indicated by these standardized symbols.



Uniform symbols for the status of components and devices

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

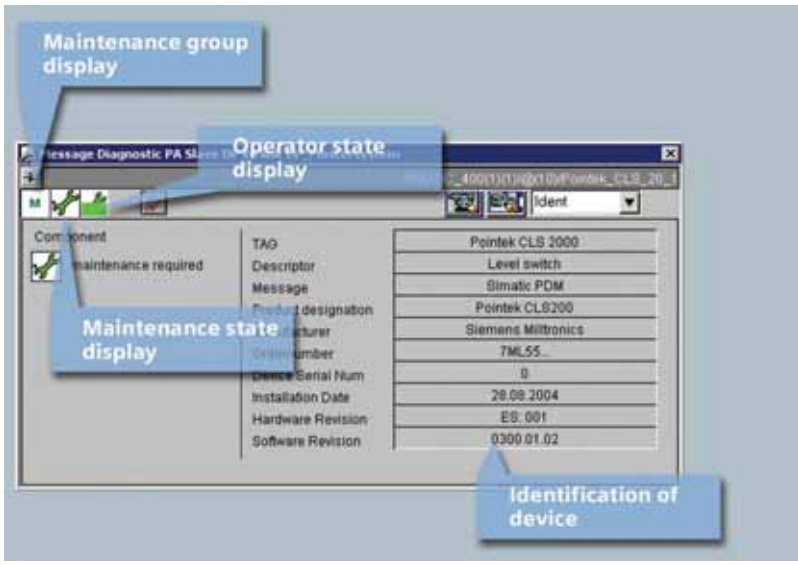


Extract of the hierarchically structured visualization of maintenance information

In the overview display, the standardized symbols are used to represent the status of components and also provide collective information on the status of all devices in the subordinate hierarchies.

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

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



Detailed view of a component

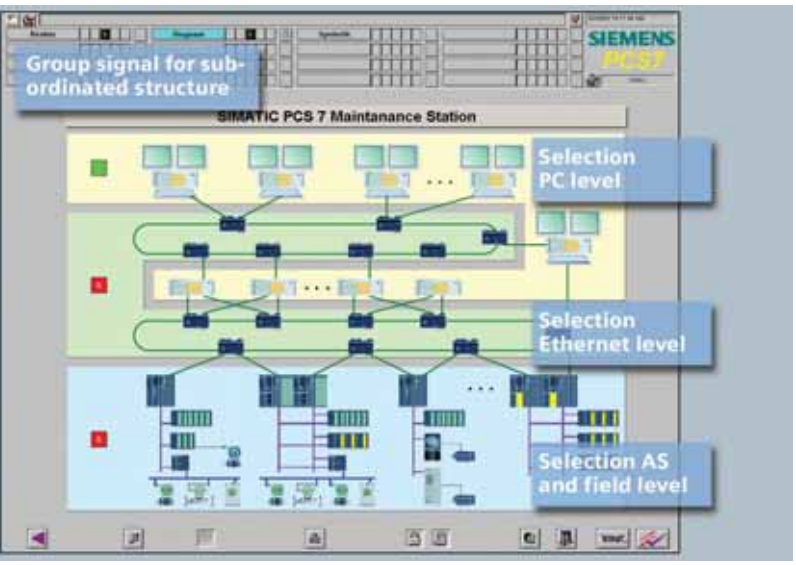
The information is consistently structured and hierarchically organized. The quantity of information displayed on each individual screen always remains manageable for the maintenance engineer, who nevertheless has simple access to the complete information at any time.

Maintenance Station – User interface for maintenance

The software package "SIMATIC PCS 7 Maintenance Station" is available as a SIMATIC PCS 7 option for implementing plant asset management. This software permits expansion of an operator station into a maintenance station. The maintenance station displays information on the connected field devices, switchgears, drives and control system components which is relevant to maintenance.

The SIMATIC PCS 7 Maintenance Station is of modular design. With small plants it is possible to install the operator station and maintenance station on the same PC. Just like the operator station, 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, and are displayed on the client.



Plant overview with block icons for components

The SIMATIC PCS 7 Maintenance Station is based on standard SIMATIC products:

- SIMATIC PCS 7 ES/OS
  for configuration and operator control and monitoring,
- SIMATIC PDM
  for interfacing of field devices and
- SIMATIC SNMP OPC Server
  for interfacing of network components.

Configuring a maintenance station

In order to set up a maintenance station, the user need only assign the corresponding attribute once when configuring. The technological hierarchy for the diagnostics displays is then generated automatically. The diagnostics displays can be subsequently expanded by project-specific contents.

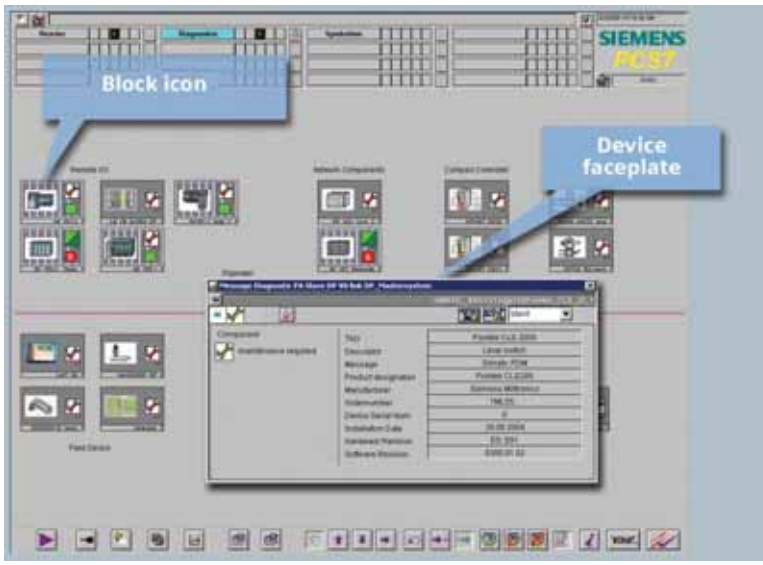
Visualization in the maintenance station

In the operating state, the maintenance station's client requests cyclic data from the associated server. The client can additionally access hardware components and field devices directly via an online connection, so that the maintenance engineer is provided with all relevant information at all times.

Various components with highly different diagnostics capabilities are used with SIMATIC PCS 7. However, from the viewpoint of maintenance, all components are displayed in the same manner. Therefore the maintenance and diagnostics status 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)



Overview display for components on one PROFIBUS segment with block icons

Maintenance Station – User interface for maintenance

Block icons and component faceplates

The status of components and subordinate components are visualized using standardized symbols in the diagnostics displays.

Block icon of a component

The block icons of the components contain:

- Bitmap of the component
- Tag name of the component
- Maintenance status display
- Collective display for maintenance message from subordinate components

Clicking an element in the block icons either opens the subordinate hierarchy level or a component faceplate. This faceplate contains views in which further device-specific information can be output.

There are three standard views.

Identification:
The identification view displays all information available from the hardware configuration or via SIMATIC PDM depending on the components. Also displayed are the maintenance status and, if present, the status of a redundant component.

Messages:
The messages view displays diagnostics error messages, operator inputs and maintenance requests.

Maintenance:
The maintenance view is used for the response of the operator to a maintenance request of a component. 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.

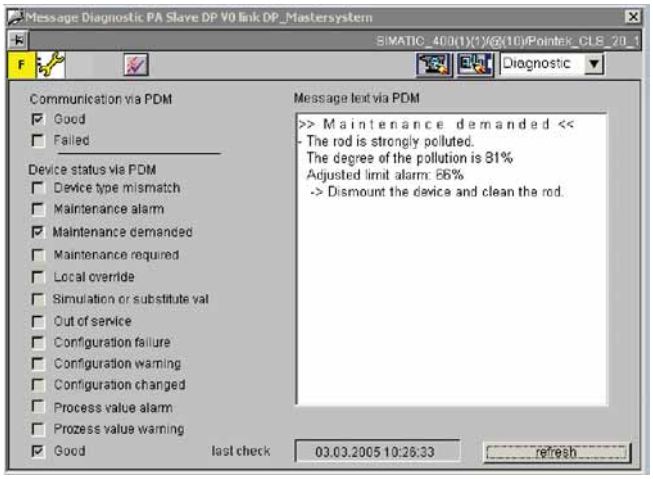
The work instruction number has no effect within the maintenance station and is only included in the report. It is available for use as transfer information to ERP (Enterprise Resource Planning).

Faceplate for maintenance view

Process Device Management

There are additional views depending on the diagnostics capability of a device. For example, information made available by the process device management (PDM) is output in the component faceplate for intelligent field devices (DP, PA, HART). Changes in parameter settings are recorded in a modification logbook and can be reviewed by the maintenance station. The time and the responsible operator are also recorded.

Modifications to the configuration can also be displayed. Diagnostics information from intelligent field devices is accessed using the PDM by means of the EDD of a field device. In the EDD, the device vendor also specifies which supplementary information is provided in the event of faults.
The cause, a trend statement, as well as troubleshooting information can all be displayed. In addition, PDM can be directly accessed from the faceplate. This makes all vendor-specific information available for intelligent field devices.



Faceplate for detail view of a component

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 PCS 7 systems as operator stations or maintenance stations and also as engineering stations or OPC servers.

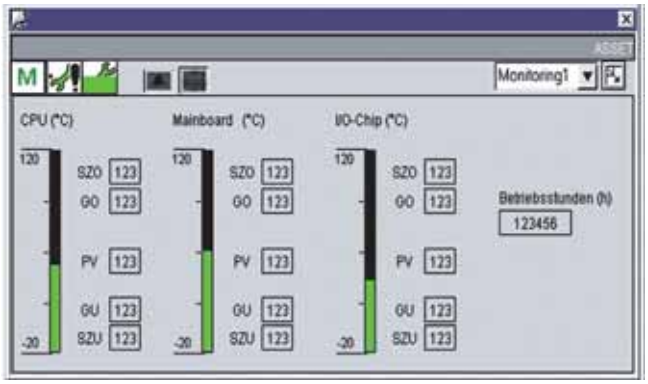
The SIMATIC PC DiagMonitor monitoring and signaling software recognizes possible hardware and software faults at an early point in time, and provides corresponding messages for the maintenance station. Client/server network architectures can be designed over a LAN with several SIMATIC PCs, and all SIMATIC PCs of a production plant can be centrally monitored using the DiagMonitor.

Efficient service structures can be established by integrating automated communications facilities, e.g. using Ethernet, e-mail or SMS (phone).

DiagMonitor supplements the operating data of the monitored PCs by text messages, transmits them to the SNMP OPC server, and outputs them in the associated asset faceplate:

- The view "Monitoring 1" indicates the operating hours of the SIMATIC PC as well as the internal device temperatures at various points, e.g. on the processor or motherboard.
- Two further views display the fan speeds or diagnostics data and information on the drive statuses. It is then possible, for example, to replace hard disks before a data loss can occur (*preventive maintenance*). Furthermore, early warnings can be provided for fan or hard disk failures (*predictive maintenance*).

In the event of an alarm, the DiagMonitor can also start standalone programs such as special PC tools or user-specific applications for individual reactions to the alarm messages.



Operating hours and internal device temperatures in the view "Monitoring 1"

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 logging function, comprehensive text messages, online help in German and English.

Further facilities for minimization of PC downtimes:

- Poduct Equipment Data: online service tool for simple and fast information on the device equipment in the delivered state. This information supports e.g. the purchasing of spare parts (**www.siemens.de/ped**).
- The After Sales Information System for SIMATIC PC/PG provides product and contact information on the Internet at a central point (**www.siemens.com/asis**).

Monitoring	Reporting	Visualizing	Alarming	Responding and recording
• PC hardware functions • Internal device temperature • Fan • Disk status • System states • Operating hours counter meter	• Violation of permissible operating temperature • Fan failure/fault • Hard disk problems • Program interruption in case of watchdog timeout • Maintenance intervals (user-selectable)	• Diagnostic LEDs on each device • Locally on the monitor of the device • Via LAN on the central server • Graphic measured data display	• LAN • Text message on mobile phone • E-Mail to relevant person • OPC and/or SNMP to user software	• Activates reset (watchdog) • Executes programs automatically (batch/executable files) • Records events (log file)

The SIMATIC PC DiagMonitor supports fast detection and efficient avoidance of potential system failures

Diagnostics for communications equipment

SIMATIC PCS 7 communicates with the subordinate components of Totally Integrated Automation using Industrial Ethernet and PROFIBUS, with application of the SIMATIC NET network components. In addition to reliable communication, these 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. 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 addressees. The SCALANCE X product group comprises several product lines that complement each other and are carefully tuned to the specific automation task.

- *SCALANCE X-100 unmanaged:*
  Industrial Ethernet switches for application at machine level with on-site diagnostics.
- *SCALANCE X-200 managed:*
  universally implementable in applications at machine level to networked subsystems.
- *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-100) provides diagnostics information.

SCALANCE network components

Industrial Mobile Communication

Mobile systems interconnected via fast wireless data networks (Wireless LAN) can provide maintenance measures with significantly greater efficiency.

With Industrial Mobile Communication (IMC), SIMATIC NET provides industrial mobile communication products with wireless communication:

SCALANCE W

SCALANCE W is a product range for producing radio networks according to WLAN standard IEEE 802.11. The products additionally offer expansions for supporting deterministics and redundancy.
They are characterized by the reliability of the radio channel as well as their dustproof and waterproof design. Standard mechanisms for user ID and data encryption protect against unauthorized access. Existing safety concepts can be integrated without problem.

MOBIC T8

The mobile, industry-compatible Internet pad permits location-independent access to central information.
The data of the PCS 7 Maintenance Station are accessed via a Thin-Client with a so-called 1:1 connection. During on-site maintenance of machines, MOBIC can be used to call diagnostics data and modify parameters. This results in a significant reduction of the time required for maintenance work.

SNMP OPC Server

Using the SNMP OPC server present in the PCS 7/Maintenance Station, the diagnostics information provided by the SNMP (e.g. with SCALANCE network components, OSM and ESM or the SIMATIC PC DiagMonitor) can be accessed.

The SNMP OPC server offers the following functions:

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

The network and process can be monitored and diagnosed in one system using the SNMP OPC server. Configuration is incorporated into the PCS 7 engineering environment.

C-PLUG for the simple replacement of network components

The optional C-PLUG can be used with the SCALANCE X400, X200 and SCALANCE W network components to make a further contribution toward minimization of downtimes within the PCS 7 control system. The C-PLUG is a swap medium for saving configuration data. It is used when it is necessary for SCALANCE network components to be replaced quickly and easily without reconfiguring the replacement part and without special training.

Online diagnostics of the bus cable using the PROFIBUS 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 RS 485 repeater into the PROFIBUS network, and 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

Diagnostics functionality

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:

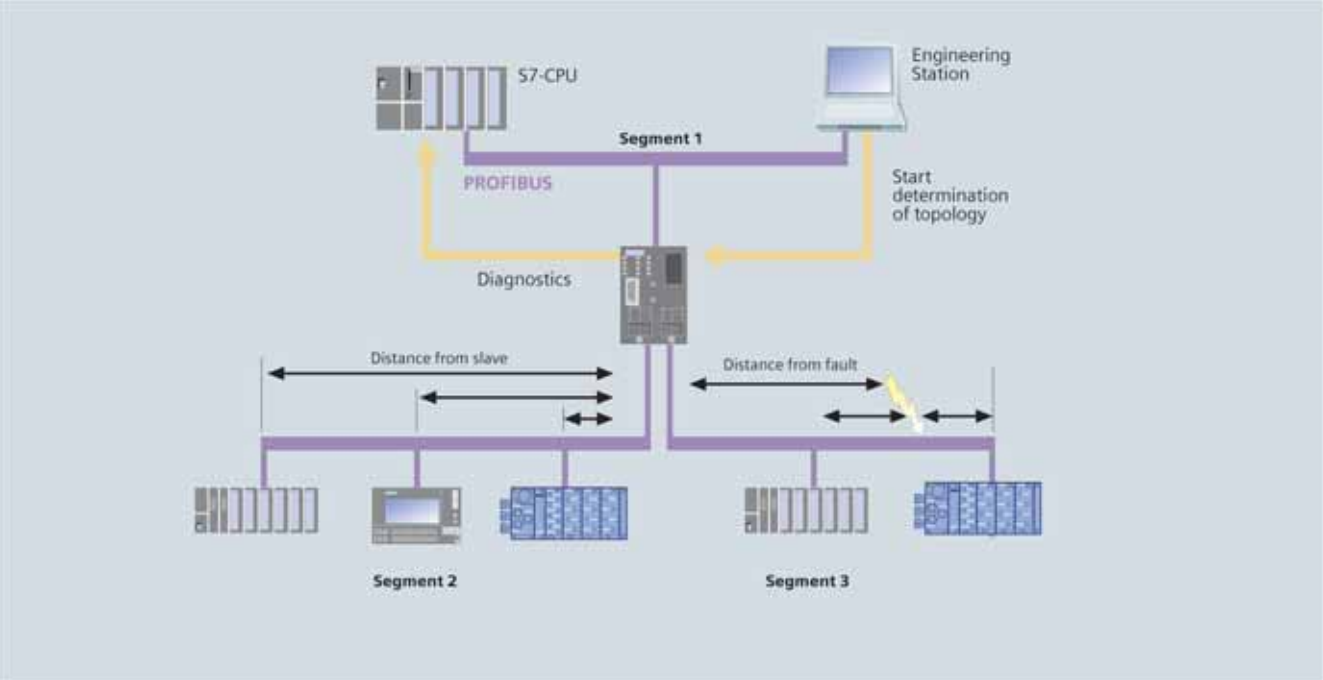
- The affected bus segment
- The fault location (e.g. between stations X and Y), i.e. the distance of the fault location from the repeater or from the stations in meters
- The possible cause, e.g. short-circuit between signal cable A and shield

This means that sporadic cable faults can also be detected and signaled. The diagnostics functions also permit maintenance engineers without PROFIBUS experience to rapidly and reliably locate faults in the bus cable.

Integration in SIMATIC PCS 7

- SIMATIC PCS 7 driver blocks are available for the diagnostics repeater

Detailed information is available from the PCS 7 Maintenance Station using the engineering system.



Topology recording and fault detection with the PROFIBUS diagnostics repeater

Diagnostics for process instrumentation
Process sensors and process analyzers

Pressure, absolute pressure, differential pressure, flow and hydrostatic level measurements

SITRANS P is a range of pressure transmitters. The SITRANS P DS III digital pressure transmitter is universally suitable for measurement of gauge pressures, absolute pressures and differential pressures, and also for flow and hydrostatic level measurements.

It has a number of integral diagnostics and simulation functions which permit users to specifically assess the status of a device during commissioning, servicing and maintenance.

Preventive maintenance is supported by functions such as:

- Operating hours counters for measuring capsule and electronics module
- Event counters for limit violations
- Minimum/Maximum pointers for pressure, sensor temperature and electronics temperature to record process extremes
- Two freely-configurable timers which can generate a warning or an alarm when a set value has been reached.

The device diagnostics effectively support troubleshooting in the context of *corrective maintenance*. The following are monitored cyclically:

- Memory integrity of RAM, ROM and EEPROM using the checksum method
- Program execution by means of monitoring certain checkpoints (watchdog)
- Sensor break and linearization calculation function.

Simulation functions are additionally available for checking the configuration of the transmitter and the controller input for intended functionality. These also contribute toward fast and specific troubleshooting and thus toward an increase in the efficiency of maintenance.

Measures can be derived from combination of the above-mentioned functions which make a contribution towards *predictive maintenance* and thus increase the plant availability and help increase productivity.

SITRANS P DS III

SITRANS P 300, digital display

Temperature measurement

SITRANS TW is a universal four-wire temperature transmitter for rail mounting. The device is suitable for connecting resistance thermometers, thermocouples and resistance-type sensors, but can also process DC voltage or direct current signals.

In addition to the usual monitoring functions such as open-circuit or short-circuit, the SITRANS TW temperature transmitter contains advanced monitoring functions which significantly simplify maintenance work. For example, cyclic diagnostics functions are available for device diagnostics and troubleshooting in the sense of corrective maintenance, and monitor the EEPROM, ROM and RAM storage functionality as well as program execution.

In this manner, imminent faulty measurements or internal device faults can be recognized at an early point in time, and the device replaced in good time. In addition, the device has four pairs of trailing pointers with which variables can be monitored for negative and positive peak values.

- Pair of trailing pointers for absolute temperature measurements at the signal input, e.g. for resistance thermometers or resistance-type sensors, or for a temperature measurement in a differential circuit
- Pair of trailing pointers for temperature of electronics

Furthermore:

- Operating hours counter for the electronics

Imminent faulty measurements can then be analyzed for possible causes. Simulation functions are present in addition which facilitate troubleshooting:

- Fixed value or ramp function at signal input
- Fixed value or ramp function referred to electronics
- Fixed value at signal output

These functions permit a full loop check as well as checking of device functions and a function check of the diagnostics settings.

The diagnostics concept is designed such that the maintenance request is sent over HART, and additionally locally when maintenance is required:

- LEDs (flashing at 1 Hz or 5 Hz depending on type of fault),
- floating signaling contacts
- adjustable current output value
  (maximum value > 20.5 mA or minimum value < 3.84 mA).

SITRANS TW

Diagnostics for process instrumentation
Process sensors and process analyzers

Flow measurements

Siemens offers flow meters with different types of contactless measuring technologies:

- SITRANS F M MAGFLO electromagnetic flowmeters
- SITRANS F C MASSFLO coriolis mass flowmeters

The devices permit flexible use, and can be positioned at any point in the installation.

MAGFLO flowmeters are used for applications with conductive liquids, and MASSFLO flowmeters e.g. for non-conducting liquids, high accuracy requirements, or processes where the parameters are subject to large variations.

MAGFLO flowmeters are insensitive to variations in pressure, temperature, viscosity and electrical conductivity (min. 5 µS/cm guaranteed).

The device is equipped with a variety of diagnostics functions which are displayed in plain text and saved in a logbook. Periodically occurring faults can then also be located. These faults can be divided into the following categories: operational faults, warnings, permanent faults and fatal faults.

The transmitter including the outputs is monitored and the sensor is continuously checked.

Also empty pipe detection is carried out. It is additionally possible with the MAGFLO flowmeter to check the complete measuring system using an external verifier.

MASSFLO flowmeters is insensitive to variations in pressure, temperature, density, electrical conductivity and viscosity. An ASIC ensures improved response to discontinuities. The devices are practically insensitive to external noise – an important prerequisite for increasing the dynamic range.

MASS 6000 monitors both application-dependent faults as well as the device settings selected by the user:

- Too much air in the metering pipe
- Detection of empty pipe
- Unstable flow signal
- Zero-point error
- Density of liquid and temperature limits
- Measuring range limits

The user-specific settings are compared with the actual values in order to achieve as optimum a setting as possible. Faults caused by mechanical vibrations, cavitation or pump noise can influence the measurement.

To identify this, expanded diagnostics functions in the MASS 6000 transmitter for the natural resonance of the sensor, pickup amplitudes and signal phase are available.

The device additionally contains a fault and status logbook system with four groups of information

- General Information: no faults
- Warnings which may cause malfunction in the application
- Permanent errors which can cause malfunction in the application
- Fatal error which is essential for the operation of the flowmeter.

The comprehensive diagnostics functions facilitate trouble-shooting. The user can draw conclusions based on this information (type and frequency of messages) which indicate an imminent failure. Steps can then be taken to increase the quality of the measurement or to prevent a production failure.

SITRANS F M MAGFLO

SITRANS F C MASSFLO

Level measurements

Three different technologies are available for level measurements: radar technology, capacitive level measurements, and ultrasonic technology.

Level measurements using non contacting radar technology:

- SITRANS LR400 with FMCW Radar (Frequency Modulated Continuous Wave)
- SITRANS LR200, pulse radar
- SITRANS LR300, pulse radar
- SITRANS Probe LR, pulse radar

Level measurements using non contacting ultrasonic technology:

- SITRANS Probe LU with ultrasonic compact echo-sounding

Capacitive level measurements and point level detection

- POINTEK CLS 200/300/500
- SITRANS LC 300/500

Siemens level meters have a range of internal and external monitoring functions. The Pointek CLS 200/300/500 limit switches offer the facility for detecting external influences such as deposits or contamination, with derivation of maintenance requirements.

In addition to the typical electric and electronic components, device diagnostics also includes assessment of the signal quality with respect to trustworthiness and strength. The maintenance station signals that maintenance demanded when a limit is reached.

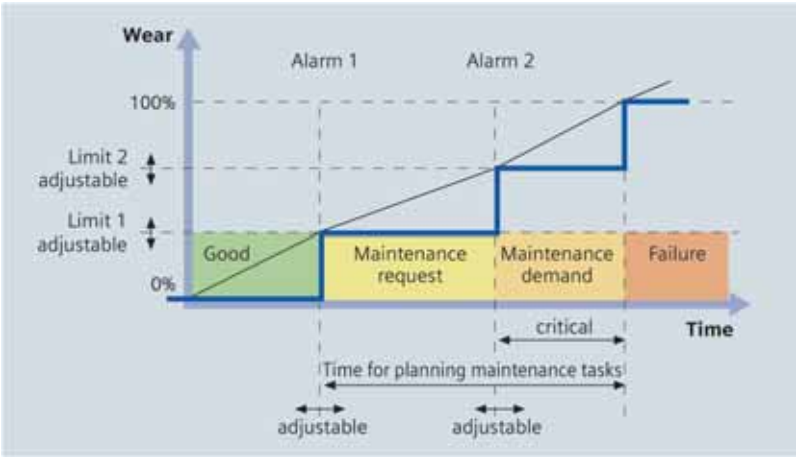
SITRANS LR400 adds up the operating data, and then calculates the remaining service life in the sense of *preventive maintenance*.

SITRANS LR400

SITRANS LR, LC and LU for level monitoring

POINTEK CLS200/300 detects the degree of contamination. The current status of the device is used to predict the remaining service life. This makes *predictive maintenance* possible. Maintenance measures can be optimally planned. The result of implemented maintenance is included into the current trend calculation.

As a result of their design and the patented active shield technology, the SITRANS LC300/LC500 are suitable for difficult applications which require reliable and accurate measurements practically uninfluenced by material deposits or contamination. They have a higher availability than comparable devices, and thus the maintenance demands are reduced to a minimum.



Adjustable limits for the various warning stages permit optimum adaptation to the physical conditions

Diagnostics for process instrumentation
Process sensors and process analyzers

Pump diagnostics for monitoring positive displacement pumps

SITRANS DA400 is a diagnostics unit for continuously monitoring the status of oscillating positive displacement pumps. The device detects extremely small leaks at the valves in oscillating pumps, making additional troubleshooting unnecessary.

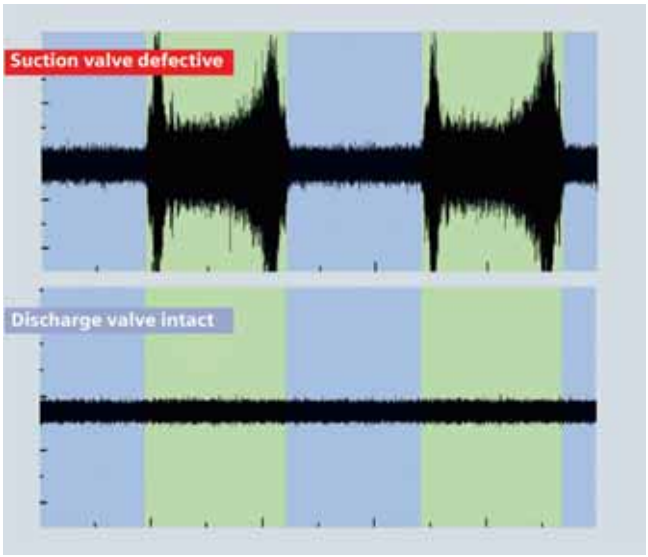
The principle is based on the measurement of structure-borne noise caused by the production of cavitation produces by leaks. It is optionally possible to monitor further pump variables such as pressure or temperature. Reaching safety limits is signaled to host control systems via digital outputs or PROFIBUS PA. In addition to local setting of the device, the parameters can also be set via PROFIBUS.

SITRANS DA 400 increases plant availability through:

- Significantly reduced downtimes
- Maintenance intervals are extended since pumps need only be serviced when necessary.
- Consequential damage resulting from failures can be avoided since faulty parts can be replaced or repaired long before the complete unit fails. Furthermore, the early detection of faults permits optimum planning of maintenance measures. The operating mode of a plant can also be adapted, thus improving the availability.

Condition-based maintenance also makes a contribution to energy-saving: a premature drop in performance is recognized at an early point in time, and can be corrected by replacing or repairing the affected parts.

SITRANS DA400 makes a significant contribution to reducing the cost of ownership and increasing plant productivity.



Large amplitudes caused by a leakage in the suction valve indicate the defect

SITRANS DA400

Gas analysis

Siemens offers a wide range of gas analyzers.

- *CALOMAT 6*
  Thermal conductivity gas analyzers for quantitative determination of hydrogen or helium in binary gas mixtures
- *FIDAMAT 6*
  Gas analyzers for the quantitative determination of the total hydrocarbon concentration based on the flame ionization principle
- *OXYMAT 6/61*
  Gas analyzers for the measurement of oxygen based on the paramagnetic principle
- *ULTRAMAT 6*
  Single-channel and dual-channel gas analyzers for the measurement of infrared sensitive components
- *ULTRAMAT/OXYMAT 6*
  Combination of OXYMAT 6 and ULTRAMAT 6 in one analyzer
- *ULTRAMAT 23*
  Gas analyzers for the measurement of up to three infrared sensitive components plus oxygen

The gas analyzers have comprehensive functions for device diagnostics, and thus for corrective maintenance. Furthermore, they are also able to detect functional irregularities. These appear as a maintenance request or failure message on the maintenance station display, or are present at the signal output, or are signaled to host systems via PROFIBUS PA/DP. The messages are recorded in a logbook.

Possible reasons for maintenance requests include:

- Calibration tolerance violated as result of contamination in measuring chamber, drift or replacement of calibration gas
- Zero-point or calibration gas contains too much oxygen (OXYMAT 6 only)
- Incorrect calibration gas used
- Detector faulty or calibration gas failed
- Maximum measuring chamber or measuring head temperature
- exceeded (OXYMAT 6), or heater faulty
- Combustion gas failure or flame extinguished (FIDAMAT 6)

Maintenance request may also result from:

- Monitoring of chopper motor (ULTRAMAT 6)
- Monitoring of magnetic field (OXYMAT 6)
- Monitoring of external interference signals (sample preparation)
- Flow monitoring (ULTRAMAT 23)
- Monitoring of external interference signals (sample preparation)

These monitoring functions ensure reliable operation for the gas analyzers, and support effective corrective maintenance.

ULTRAMAT 6 19" unit

OXYMAT 6 field unit

Diagnostics for process instrumentation
Diagnostics for positioners and valves

SIPART PS2 is an electro-pneumatic positioner for control valves. The device is suitable for highly exact control of valves and dampers in many different applications.

In addition to numerous basic functions for self-monitoring, the positioner features the following online diagnostics functions which have a direct relationship to the current maintenance requirements:

- Pneumatic leak (e.g. torn diaphragm)
- General fault in fitting (tight fitting)
- Valve cone torn off
- Deposits in pipeline or fitting
- Wear of valve seat or plug
- Static friction of stuffing box

These faults are signaled according to a three-stage rating scale depending on their seriousness and the associated maintenance urgency (see spanner symbols on page 10).

These faults are also be indicated gradually on the local display. Faults can then be recognized long before they lead to failures or even a plant standstill.

Furthermore, the following variables are monitored to derive *preventive maintenance strategies*, where gradual signaling (see above) can be made in some cases:

- Operating hours (also differentiated according to temperature ranges)
- Current temperature of use and min./max.
- Operating hours according to valve positioning ranges
- Number of switching operations of pneumatic output stage
- Stroke counter (travel integral)
- Number of changes in direction

The benefit of *predictive maintenance strategies* is that the service life of the corresponding components can be fully utilized without the risk of failures or damage. The degree of loading can provide information for optimization of the plant's mode of operation and thus for increasing the availability.

SIPART PS2 positioners

Diagnostics for protective, switching and drive components

Selective protection of load feeders

In the process industry, the automation components are usually provided with 24 V DC.
With the electronic SITOP select diagnostics module, every 24-V load is reliably monitored for overloading and short-circuit, and switched off in the event of a fault.

A diagnostics module can monitor up to 4 consumer circuits, and these can be switched off sequentially after defined periods in order to relieve the power supply.

The monitoring currents can be set between 2 and 10 A. The electronics of SITOP select recognizes whether brief, high inrush currents are involved, or an overload/short-circuit.

If one of the 4 outputs is switched off, a group signaling contact is tripped which can be evaluated by the host automation system. The service technician immediately recognizes on site which 24-V feeder is involved, since each output has a multi-color LED to indicate the current operating status. In addition to fast fault detection and locating, this leads to a reduction in downtimes.

Contactor with remaining life time (RLT) message

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/visual 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, making local visual inspections unnecessary. Not only the switching operations are counted – 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. The saved data is not lost even if the control supply voltage fails.

Condition-based 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 messages reach the SIMATIC PCS 7 maintenance station via a digital input of SIMOCODE pro and thus via PROFIBUS.

SITOP select

SIRIUS contactor with RLT

Diagnostics for protective, switching and drive components

SIRIUS motor management system SIMOCODE pro

SIMOCODE pro is the flexible, modular motor management system for motors with constant speeds in the low-voltage performance range. It optimizes the connection between control technology and motor feeder and thus increases plant availability. SIMOCODE pro has been specially designed for use in motor control centers (MCC) of the process industry and power plants, and is applied here for the protection and control of motors/pumps etc., e.g. in hazardous areas, in sectors with heavy start-up procedures (paper, cement and metal industries) and in fault-tolerant plants.

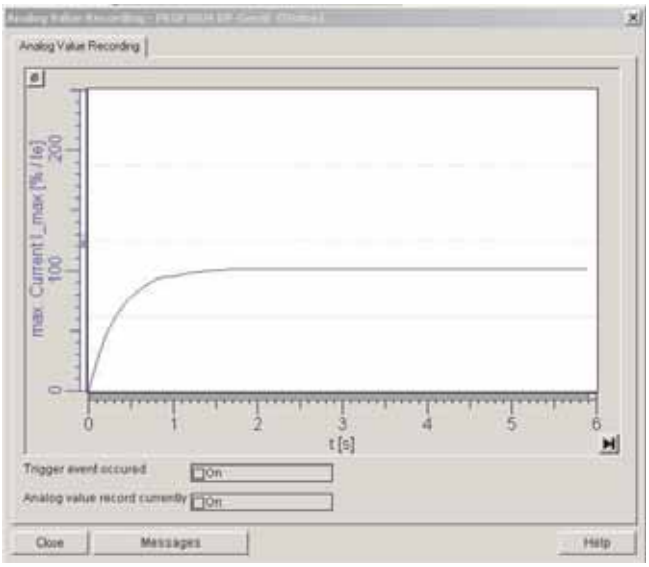
Special features:

- Multifunctional, solid-state full motor protection which is independent of the automation system
- Flexible software instead of hardware for the motor control
- Detailed operational, service and diagnostics data
- Energy management capability
- Communication via PROFIBUS DP

SIMOCODE pro can be flexibly expanded by the following function modules to achieve the optimum solution for each application: digital, analog, ground fault and temperature modules. A PCS 7 block library permits diagnostics data to be displayed on the maintenance station. Faults can then be prevented, or rapidly located and eliminated as necessary.

The extremely detailed diagnostics message is provided via PROFIBUS and also by LEDs directly on the control cabinet. If a device or a complete control cabinet module has to be replaced in motor control centers (MCC), the addressing plug permits rapid, uncomplicated assignment of the new PROFIBUS address to the replacement unit. Use of a memory submodule also permits direct transfer of the parameter settings of the replaced units to the new SIMOCODE pro – simply by plugging into the system interface.

SIRIUS motor management SIMOCODE pro



SIMOCODE pro analog-value recording in SIMATIC PDM

A further important feature of SIMOCODE pro is the autonomous design of all protection and control functions, even if communication with the control system is interrupted. The full feeder functionality is ensured even if the bus system or automation system fails. A defined response to a fault can be parameterized, e.g. specific shutdown of the feeder or execution of certain control mechanisms (e.g. reversal of direction of rotation).

Operating and statistics data which permit *condition-based maintenance*:

- Motor operating hours
- Motor downtimes
- Number of motor startups
- Number of overload trips
- Internal comments stored in the device
- Number of operating hours of device

Diagnostics data for *corrective maintenance*:

- Numerous detailed early warning and fault messages (can also be used for further processing in the device or I&C system)
- Internal device fault logging with time stamp
- Time stamping of freely selectable status, alarm and fault messages
- Value of the previous tripping current
- Checkback error (e.g. no current flow in the main circuit following ON control command) etc.

Diagnostics of drives

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

Therefore all drive systems and frequency converters of the SINAMICS and MICROMASTER ranges with their associated motors are integrated into the SIMATIC PCS 7 maintenance station. This results in the common, uniform presentation of maintenance-relevant information which permits preventive and predictive maintenance strategies.

The components automatically signal when maintenance is required. An example is a medium-voltage converter such as SINAMICS GM150. In this case, a differential pressure procedure also determines the degree of contamination of the dust filters.

In the water-cooled version, the analog conductivity measurement continuously checks the mode of operation of the ion exchanger, and provides an early signal when its capacity is diminishing. The filters for air cooling and the pumps for water cooling are equipped with operating hours counters which recommend that components be checked when a certain number of hours has been reached.

The drive systems are incorporated into the maintenance station using Drive ES SIMATIC PCS 7, an add-on package for SIMATIC PCS 7. Drive ES PCS 7 allows Siemens drives to be controlled using SIMATIC PCS 7 with standard function blocks, and operation and monitoring using faceplates in the operator station.

Assessing the status of high-voltage machines

An established procedure for assessing the status of high-voltage machines is the partial-discharge test which is carried out as an offline or online measurement depending on the application. This is an important measure in the reliability-based maintenance strategies of large drives.

In order to measure the partial-discharge signals, the patented "Siemens Insulator Integrated Coupling Units" can be fitted in high-voltage motors as options ex-works.

It is only necessary to replace the post insulators in the terminal box by the Insulator Integrated Coupling Units.

This results in decisive advantages:

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

The SINAMICS range

IEC motors

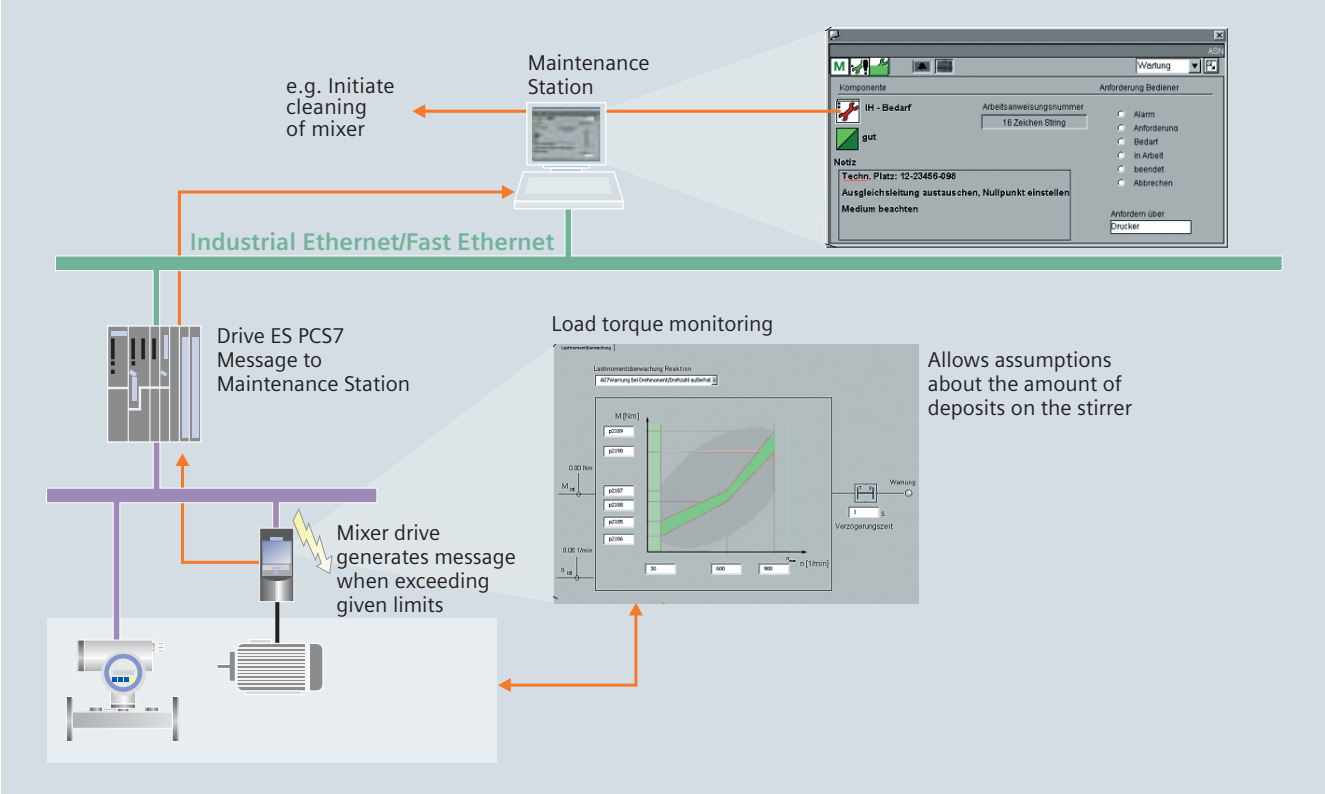
Diagnostics for protective, switching and drive components

Maintenance with Drive ES SIMATIC PCS 7 can be shown using the example of a mixer drive: the material to be mixed slowly deposits on the stirrer. The stirrer was previously cleaned at predefined intervals to ensure its availability. Using the new functions in the maintenance station, cleaning can be carried out only when required.

To accomplish this the converter provides the facility for load torque monitoring with adjustable torque limits, and different types of response in the event of a violation. The mixer functions without problems within the load limits. It is known for the mixer that the amount of deposits has an indirect effect on the torque response of the converter. If the limit is violated, a message is sent to the control system.

From this converter warning, Drive ES SIMATIC PCS 7 generates a corresponding maintenance display for the maintenance station. The mixer can then be cleaned as required. It is also possible to record the frequency of cleaning requests to derive process optimization or predictive maintenance scenarios.

Maintenance can therefore also be optimized for moving plant components, with associated increases in plant availability and productivity.



Schematic flow of information using example of mixer drive

Plant asset management with the components of Totally Integrated Automation

- Plant-wide and uniform display of diagnostics and maintenance status
- Integrated support of condition-based maintenance
- Optimization of the complete workflow from diagnostics to completing the maintenance task
- Maintenance functionality integrated in the system – no additional engineering overhead

Further information on the topic:

SIMATIC PCS 7:
www.siemens.com/pcs7

SIMATIC PC DiagMonitor:
www.siemens.com/diag-monitor

SIMATIC NET:
www.siemens.com/simaticnet

Process instrumentation:
www.siemens.com/processinstrumentation

Process analytics:
www.siemens.com/processanalytics

Motor management system:
www.siemens.com/simocode

ET200pro Motorstarter:
www.siemens.com/sirius-motorstarter

Low voltage switchgear:
www.siemens.com/lowvoltage

Drive systems:
www.siemens.com/drives

Maintenance services range:
www.siemens.com/simain

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

You can order more publications on the subject of SIMATIC at:
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