APPLICATION EXAMPLE

Enhanced system availability through condition monitoring

A safe and reliable low-voltage supply for infrastructure or industry begins at the grid infeed. A demand-oriented safety power supply across several consumer levels supports the secure supply of the consumer circuits within the application.

With this application example, we want to support you in selecting the most important components for high-availability and cost-optimized power distribution for your infrastructure.

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Application example – Hospital

Simplified network planning for a 400 V network fed from the medium voltage side
Technically relevant data such as operational currents and short-circuit currents were determined on the basis of the defined operating modes using the SIMARIS Design planning tool. The consistent implementation of the functions integrated in SIMARIS Design, including selectivity assessment, ensures the electrical protection functions of the protection devices and the connected equipment.

The figure below (Fig. 1) shows an exemplary network diagram of a hospital application with several low-voltage main distribution boards with sub-distribution boards to supply various low-voltage loads in different areas.

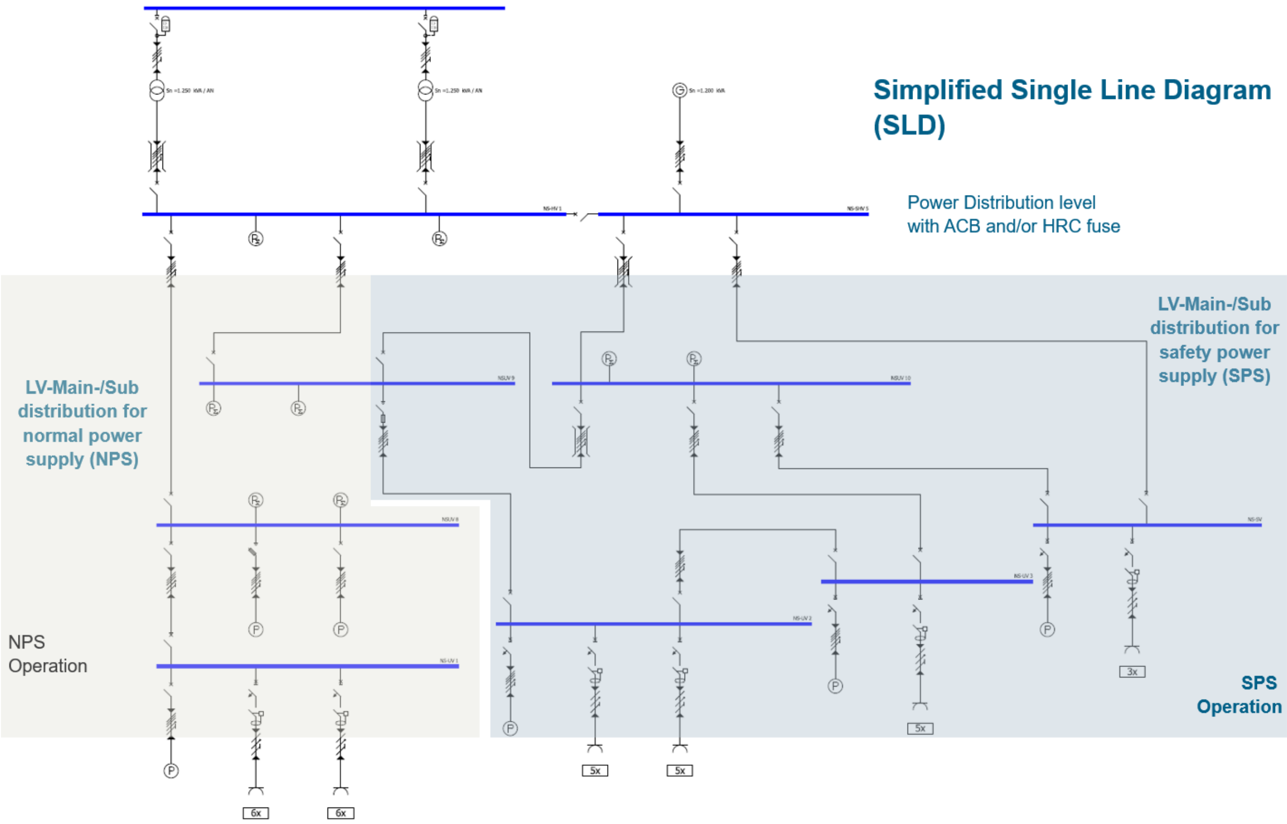


Fig. 1: Network diagram of a hospital application. The dark gray area marks the power supply's current safety power supply (SPS) distribution.

The infeed in normal operation is provided by a network supply with two power transformers with 1250 kVA each. The supply in the event of line-side supply problems or faults on the grid side is ensured via a safety power source, e.g. in the form of a generator. A longitudinal busbar coupling allows separation of the network supply from the part of the safety power supply that is supplied by the generator. The load levels are functionally divided into a group of general loads (GL) and loads with a secured power supply (PS).

This constellation ensures a reliable supply of the different load areas via parallel operation of the generator, even in case of failure of a grid-connected infeed. If both network supplies fail, the generator can maintain the function of the main loads.

The main distribution levels in the upper left part of the graphic are primarily used for normal power supply (NPS). The upper right part supplies the part of the safety loads (SPS) via the longitudinal coupler, which is closed during normal operation.

Parallel operation and network backup operation or safe operation during maintenance and service of the system equipment are possible via different operating modes. The single line diagram shows the SPS load supply via busbar trunking systems or wired connections between the main distribution board and sub-distribution board.

Permanent and continuous monitoring of all supply-relevant power distribution boards is usually not integrated for economic reasons. There is therefore a risk of failures in the power supply, resulting in economic or reputational damage. The likelihood of these failures depends on a variety of factors, such as operating periods, ambient conditions, number of operating faults, or load changes. The requirements for reliability and availability of the electrical power supply should be considered right from the planning phase and integrated into the planning concept.

This document is designed to assist in the economic selection of safe and highly reliable power supplies in the general section and the safety power supply, and includes the following main points:

- Identification of the main supply-related low-voltage protection devices in the power and main distribution board to ensure the safety power supply. This application example identifies the key requirements for air circuit breakers (ACBs) commonly used in power distribution, using the example of the SENTRON 3WA device series.
- Approaches for integrated condition monitoring of SENTRON 3WA air circuit breakers from an economic point of view
- Support for the selection of the cross-functional communication devices including auxiliary power supplies for integration of the SENTRON 3WA ACBs into the system structure.
- Condition monitoring for additional protection devices such as MCCBs and LV HRC fuses in the main distribution boards
- Condition monitoring for protection devices in load distribution boards for supplying the load circuits with modular installation devices.
- Ideas for cross-plant condition monitoring and energy monitoring in accordance with the energy management standard ISO 50001 by means of communication via Ethernet/Modbus TCP.
- Interaction of communication-capable components with recording of operating data and operating states for efficient and economical condition monitoring via the 7KN Powercenter 3000.
- Condition monitoring summary: Prevent failures in electrical power distribution systems and avoid high economic or reputational damage.

Identification of the supply-relevant functions from the network plan example

In the selected example, a TN-S network, 400 V/50 Hz is assumed. The network-specific data for network planning was entered in SIMARIS Design.

The parameters for the desired functionality and operational reliability were carefully selected for this example and entered into the SIMARIS Design planning tool. The technically relevant data was determined and checked via SIMARIS Design on the basis of the load structure and operating modes, and the critical paths were identified. The operator may desire for the highest possible supply including oversizing of the infeed transformers, or generators or other redundant energy sources.

In addition to the expected operational currents, the data obtained from SIMARIS Design also identifies the short-circuit currents in the event of a fault. The tool determines the technically required protection devices with the associated protection parameters and protective characteristics. SIMARIS Design supports the proof of selectivity in the event of a fault based on the load structure, load flow, short-circuit load and the protection characteristics of the protection devices integrated in the planning tool.

In this example, we evaluated the supply-critical functional units based on the planning data. The highly reliable air circuit breakers (ACB) of the type SENTRON 3WA in withdrawable design (Fig. 2) are provided for the function of the network supply and the safety power supply, including the couplings for the secure supply of the power and main distribution level. The blue triangles in Figure 3 indicate these ACBs and at the same time show the energy flow direction.

Fig. 2: Air circuit breaker (ACB) in withdrawable design

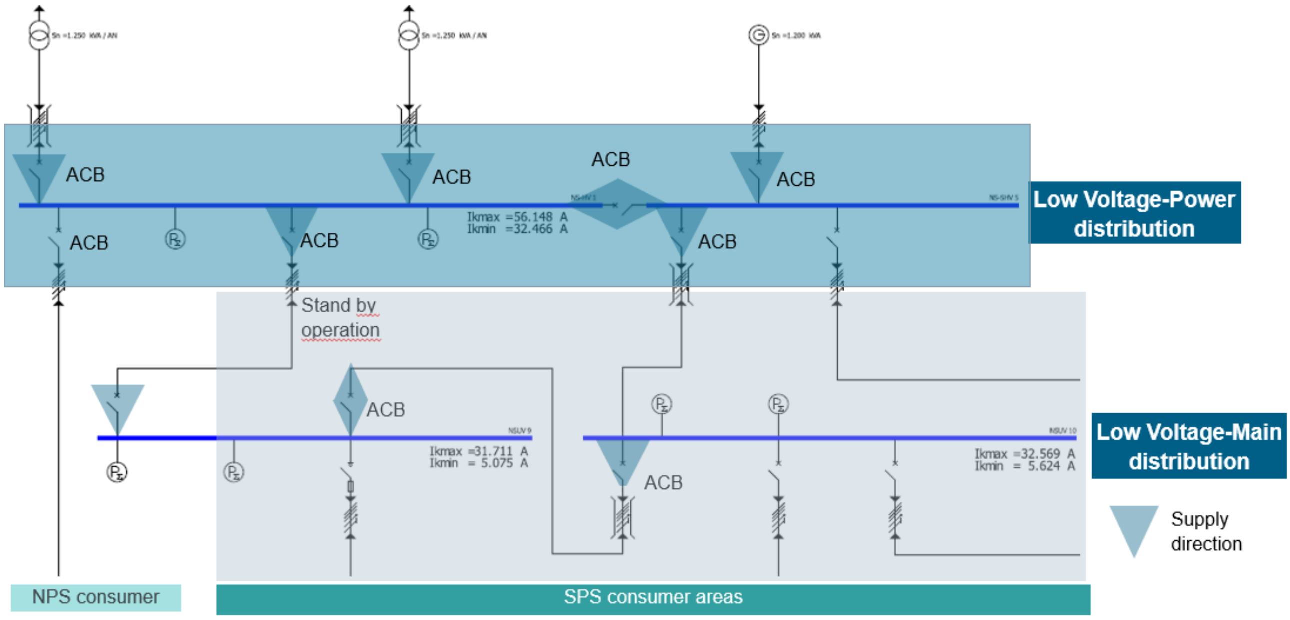


Fig. 3: Supply-critical functional units

ACBs can also be used to supply and protect directly connected loads which require high power ratings or high operating cycles. In this application, loads are protected from the main distribution board using Molded Case Circuit Breakers (MCCBs) or Low Voltage HRC fuses, which are considered in the next section.
The SENTRON 3WA ACB series offers three different sizes and safely switches off rated currents up to 6300 A, as well as residual currents up to a short-circuit breaking capacity I_{cu} of max. 150 kA.
Aging tests were carried out and failure rates determined across several generations of SENTRON 3W ACBs.

Thanks to continuous aging tests in development laboratories, they impress in terms of:

- Proven robustness of all mechanical and electronic components through long-term testing at high temperatures
- Potential service life of the electronics of more than 90 years
- High MTBF* (3 389 years) and $MTTF_D$** (6 778 years)

*MTBF = Mean Time Between Failure ** $MTTF_D$ = Mean Time to dangerous failure

The technical requirements for the application example are met by the size 1 ACBs with a required short-circuit current strength I_{cu} of at least 56 kA and a nominal current of 2000 A.

This size 1 ACBs offer exceptional service conditions for rated currents of up to 2500 A and provide long service life with up to 30 000 operating cycles for switching capacity type N and S.

Rated current		630 A	up to	2500 A
Service life (operating cycles)				
Mechanical	Without maintenance		15000	
	With maintenance		30 000	
Electrical	Without maintenance ≤ 690 V		10 000	
	With maintenance		30 000	
Switching frequency				
Electrical	3-pole	1/h	45/60	
	4-pole	1/h	60/60	

The withdrawable ACB's, type S, with a short-circuit breaking capacity I_{cu} of 66 kA at 400 V, still offer power reserves for later expansion. Thus, the ACBs technically necessary for the application with an operational current of max. 2000 A are suitable for subsequent retrofitting to operational currents of up to 2500 A without changing the overall size.
The decision to use withdrawable ACBs and a standardization of the size means that the protection devices can be replaced on site whenever required. This option allows significantly increased availability in the event of a fault without time-consuming service or repair work.

The air circuit breakers of type SENTRON 3WA offer the highest level of technical functionality and consistent protective functionality with simple configuration selection. The ETU600 electronic trip unit used for this purpose allows all the usual protection functions to be set.
The protection functions shown in Figure 4 apply to many applications up to rated AC voltages of 1150 V.

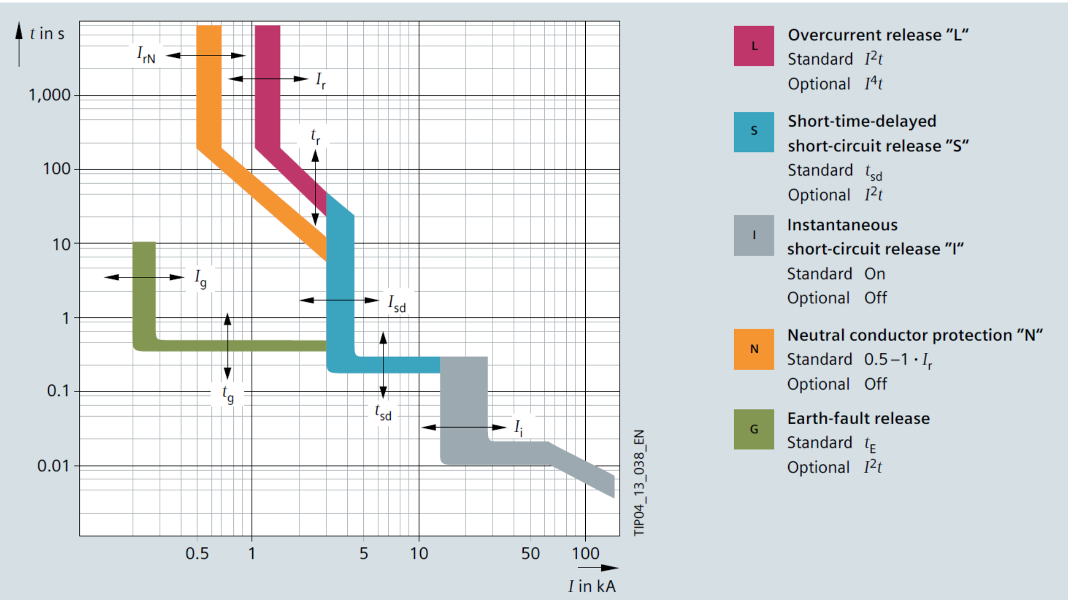


Fig. 4: Variants of the tripping characteristics

The requirement for LSI protection is fulfilled without additional measures, e.g. current transformers or other equipment. In addition, the voltage tap integrated in the air circuit breaker means that no external voltage transformers are required for the acquisition of measuring functions via the ETU600 up to 690 V AC.

The functionality of the ETU600 can grow over its entire service life in line with the customer's requirements. Functions can be quickly retrofitted as required by means of updates/upgrades via the SENTRON powerconfig software.

Should the operator request energy metering, or if it is subsequently necessary due to legal regulations, the 3WA air circuit breakers (ACB) allow the recording and output of energy monitoring, provided that this requirement was taken into account during the planning phase. If necessary, any required energy monitoring functions can be supplemented.

The functions listed in the table below can be expanded under license from the energy monitoring function (PMF-I).

	PMF-I	PMF-II	PMF-III
	Energy efficiency	Basic Power Monitoring	Advanced Power Monitoring
Directional short-time dST	optional functions *	•	•
Reverse-power RP		•	•
Unbalance (voltages, currents)		•	•
Voltage (overvoltage/undervoltage)		•	•
Power (forward, backward)		•	•
Frequency (over-/underfrequency)		•	•
Direction of rotation		•	•
THD total harmonics distortion (voltage, currents)			•

In addition are the EPF enhanced protective functions, marked with “optional functions*” in the table, expandable under license. The following functions are also available:

- Ground fault alarm (GF alarm)
- Second protection parameter set

Recording and evaluation of essential operating and service data in the circuit breaker panel

With the ETU600, the 3WA air circuit breakers have an integrated, self-monitored electronic trip unit with color display for visualizing the operating data and service parameters. The picture below shows a function package with energy monitoring. The following operating and service data are permanently recorded and visualized via the display or the LEDs below it:

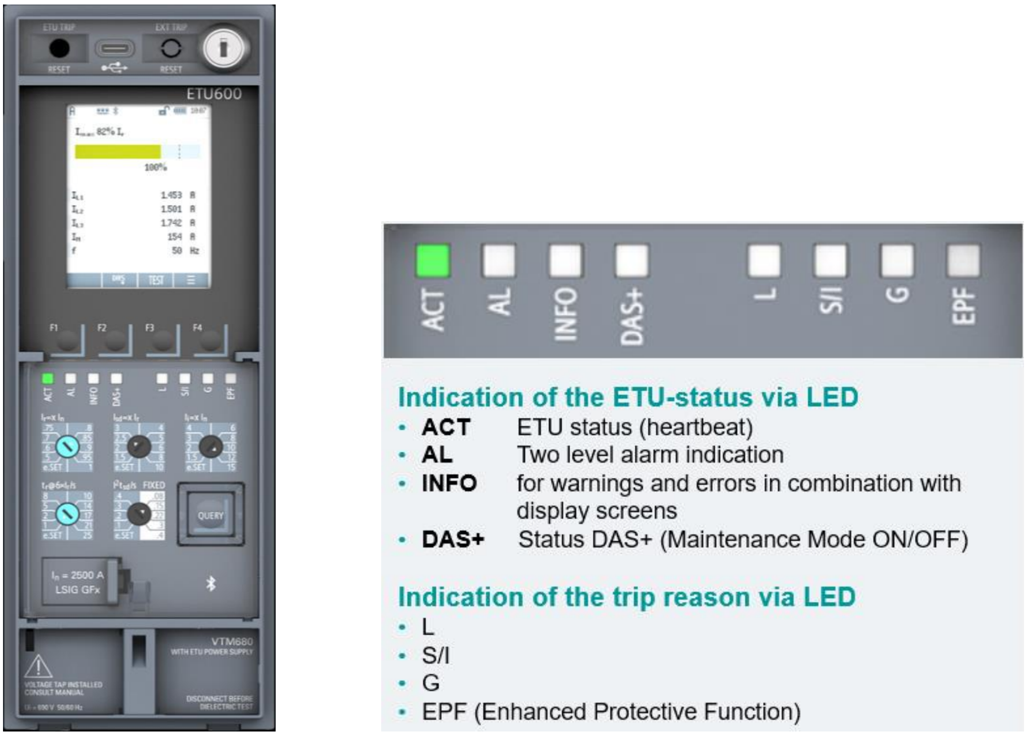


Fig. 5: Display of operating and service data

In addition to the display, this data can be read out on site via the integrated CubicleBus[2] and the integrated USB-C and Bluetooth interface by the powerconfig software or powerconfig app.

The 3WA ACBs, provided they were specified as communication-capable versions (ready4Com) during the planning phase, can be easily retrofitted with an Ethernet/Modbus TCP-capable communication interface (COM190).

Fig. 6: Communication via COM190 PROFINET/Modbus TCP and separate I/O

The COM190 is the basis for further intelligent solutions, including data collection for condition monitoring, and can be used flexibly in the immediate vicinity of the ACB. The COM190 can be placed via adapters either directly on the ACB or close to the ACB by means of DIN rail mounting. The following functions and information can also be called up via the communication interface:

- Read out circuit breaker data and measured values
- Read out circuit breaker status
- Transmit alarms and warnings
- Set parameters
- Switch the circuit breaker on/off via the communication link
- Read out status and maintenance information
- Testing/switching/commissioning/setting of parameters via SENTRON powerconfig
- Monitoring:
  - ETU and current sensor status (watchdog)
  - Circuit breaker status (condition & maintenance)
- Documentation, for example test reports
- Upgrade capability ETU
- Power supply and activation ETU

Order number system

The extended functionality with measurement and communication can be easily added via the order number extensions.

For condition monitoring, at least the current measurement, ready4COM feature must be selected, to provide a BSS200 breaker status sensor within the switch.

Via the order number extension (-Z) F19, the above mentioned, including condition and maintenance information, are available for Condition Monitoring via the PROFINET/Modbus TCP communication interface COM 190.

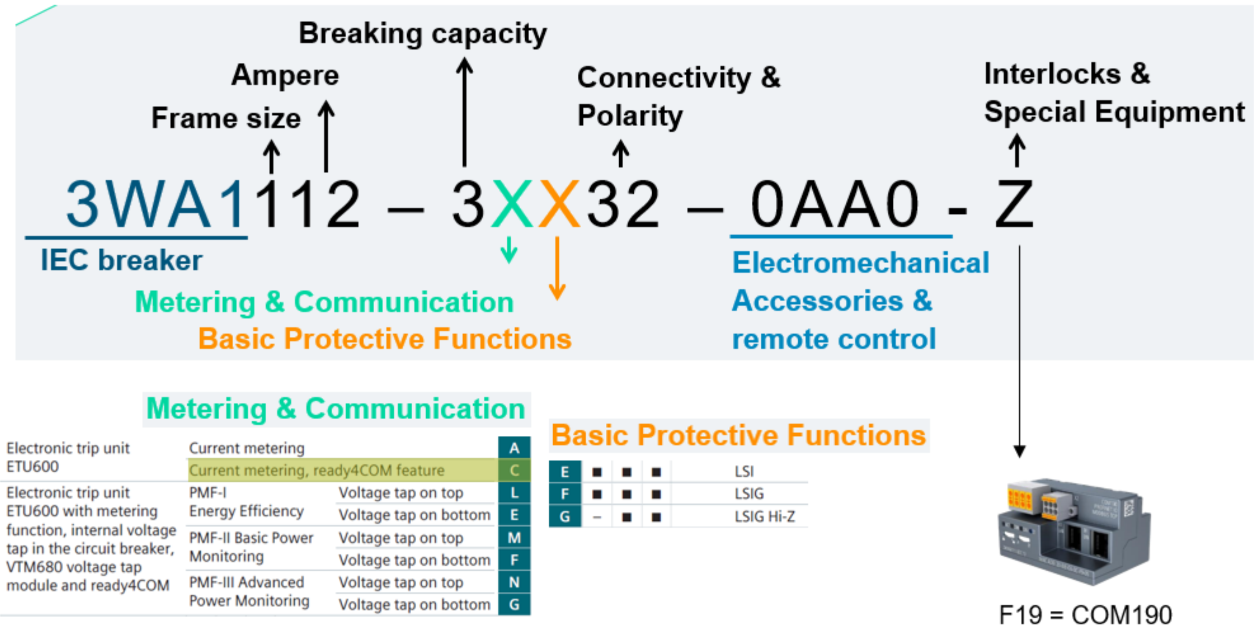


Fig. 8: Order number system

Interaction of ACB components including acquisition of operating data

The status detection of the ACB-internal status sensors provides the following information via the BSS200 breaker status sensor:

- Circuit breaker state OPEN/CLOSED
- Operating cycles
- Spring energy store compressed *
- Ready-to-close condition *
- Circuit breaker tripped
- Temperature values in the circuit breaker
- TEST and CONNECT positions of the circuit breaker in withdrawable design

* incl. monitoring for defects (watchdog)

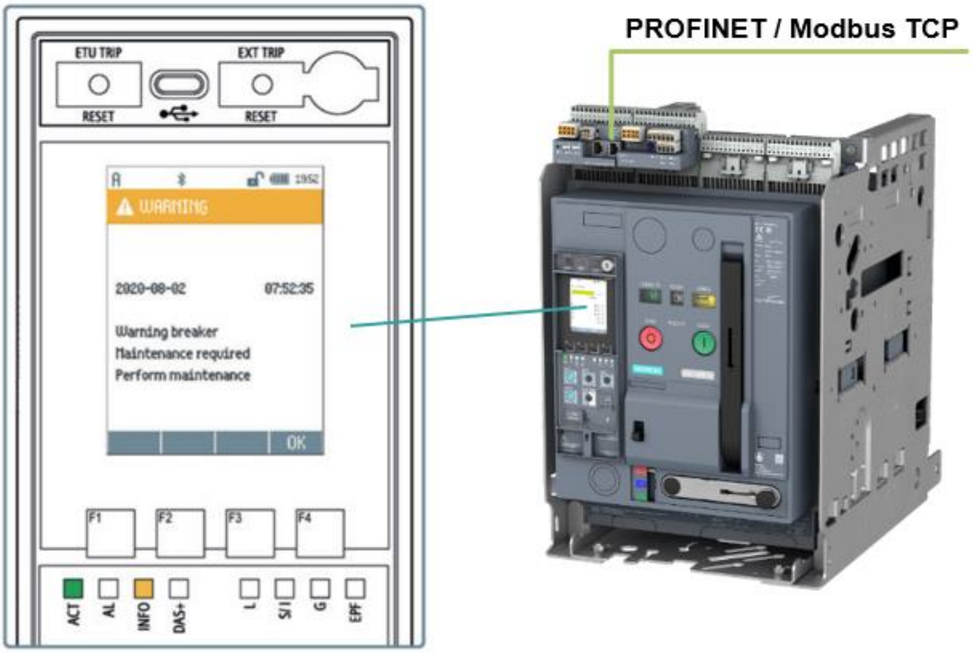


Fig. 9: Status display

In addition, the cost-neutral integrated CubicleBus[2] of the 3WA ACB permits the output of the following information via the display integrated in the ETU600:

- Maintenance information
- Statuses
- Events and parameters of the ACB

The maintenance intervals are specified based on the operating conditions, taking the following factors into account:

- the condition of the contact system
- the condition of the arc chutes or arc chute covers
- the end of the electrical and mechanical service life

By adding the COM190 communication module for Ethernet communication, the status acquisition via the output of the BSS200 additionally offers:

- Circuit breaker data and electrical measured values (from PMF-I)
- Alarms and warnings
- Setting of parameter data
- Alarms, warnings, condition/maintenance information
- Switching the circuit breaker on/off via the COM190
- Temperature values at the circuit breaker or in the environment of the COM190

Selection of cross-functional communication devices for the integration of the open circuit breakers 3WA (ACB)

The 3WA air circuit breakers (ACB) perform protection tasks and core functions for the circuit breaker panel, i.e. the functional safety of the application. The scope of planning allows for the addition of further functions, such as energy transparency or Condition Monitoring, as used in this example (cf. Fig. 10).

A 24 V DC supply serves as a simple and safe interface for the supply and control of the motor drive of the selected 2000 A circuit breaker in withdrawable design. In addition, this 24 V supply is used to control the trip units and for signal processing and transfer via the auxiliary and signaling switches to the higher-level control and automation level.

Since many equipment manufacturers require a safety extra-low voltage 24 V DC, we have provided a SELV (Safety Extra Low Voltage) supply via a SITOP PSU 300S in this example. At the same time, these serve to supply optional equipment, relays, measuring instruments or modules by means of Ethernet or Modbus communication.

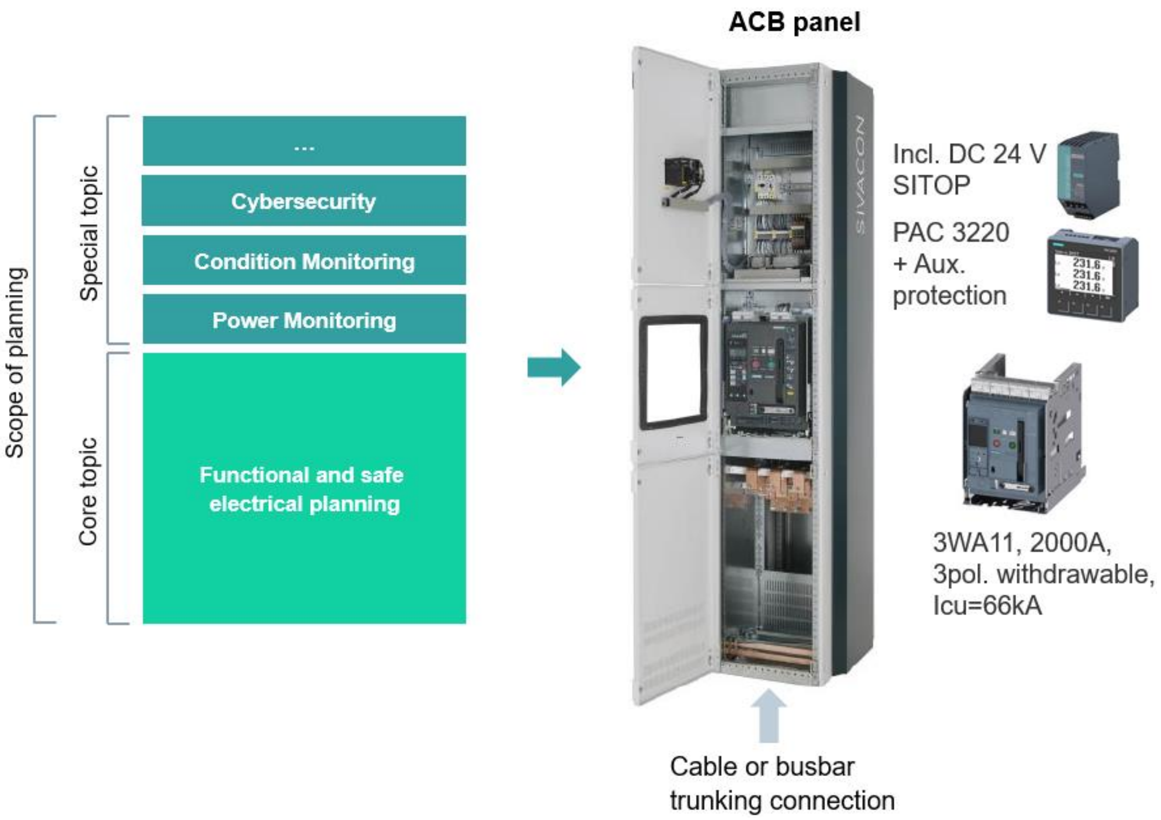


Fig. 10: Scope of planning for circuit breaker panel

With the integration for metering function and the extension of the COM190 module, communication of measured value and energy management data for energy transparency is possible without integrating further components such as current and voltage transformers or measuring instruments. The function is integrated in the 3WA air circuit breaker and in the ETU600.

COM190 module

- PROFINET IO and Modbus TPC in parallel operation possible → "in-switch" mounting or DIN rail mounting
- Two COM modules in parallel → redundancy
- Two Ethernet ports for easy cabling
- Ambient temperature range from -40 °C to +70 °C
- Communication system together with 3VA molded case circuit breakers and 7KM PAC measuring instruments
- Safety functions: write hardware parameters and protection against remote switching, Modbus TCP whitelist

An additional switch, e.g. SCALANCE, enables IT-secure transmission outside the enclosure of the switchgear assembly.

The expected additional costs (see figure) for condition monitoring in the application example with the ACB circuit breaker in the field are based – in simplified terms – on two requirements.
The CubicleBus[2] integrated in the 3WA air circuit breaker in combination with the breaker status sensor allows the data required for condition monitoring to be read out from the ETU600 electronic trigger unit, including the integrated sensor data, on site. The data can be read out via the integrated display and by means of the integrated Bluetooth and USB-C communication interface with SENTRON powerconfig.
By integrating the PMF-II power monitoring function in conjunction with the COM190 communication interface, it is possible to evaluate the power management data and the condition monitoring data via Ethernet/Modbus TCP. With this solution approach, the data can be visualized and evaluated on site, or by integrating a router for remote diagnostics and evaluation. Through the integration of power monitoring with PMF-II or higher, further functional advantages are integrated at no extra cost.

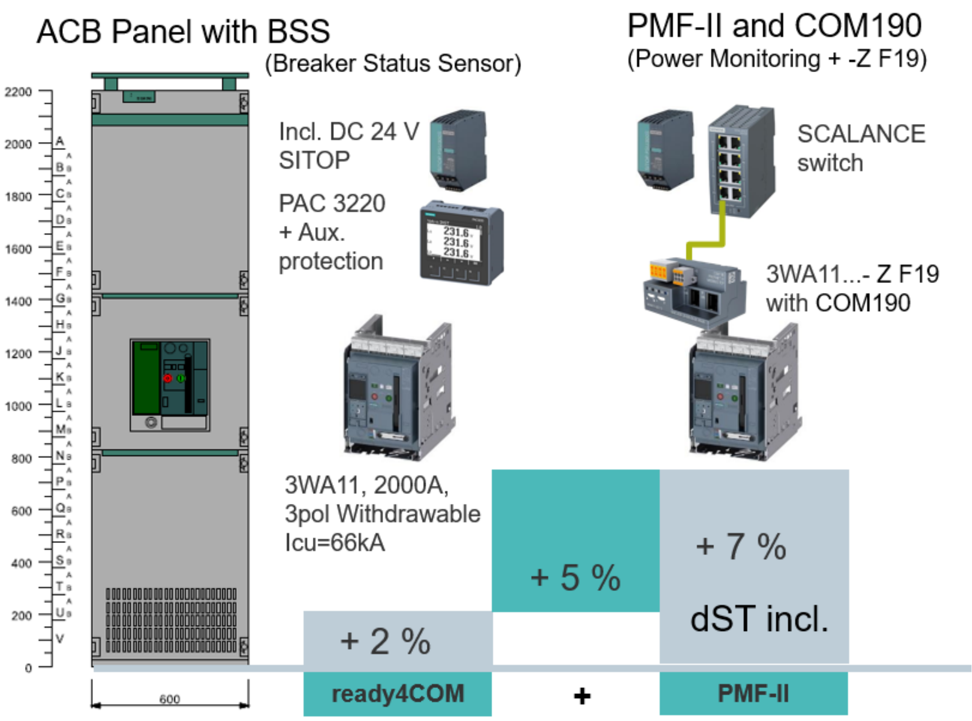


Fig. 11: Additional costs per ACB field in %

The free SENTRON powerconfig software is generally used for parameterization and commissioning. It is used to set all protection and device parameters, as well as all warnings and messages.

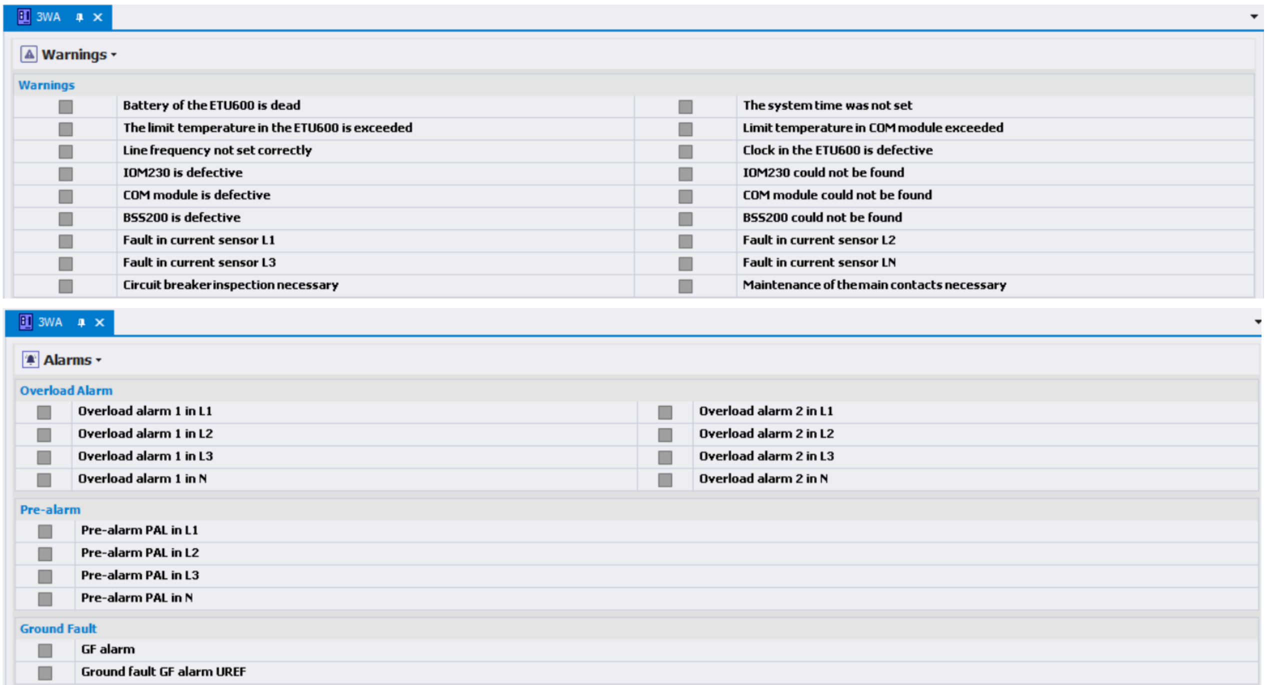


Fig. 12: Overview of warnings and alarms for the 3WA ACB which can be activated in SENTRON powerconfig

Condition monitoring for individual load feeders in the SPS area

The benefits of the added value of condition monitoring are available not only for the air circuit breakers (ACBs), but also for the protection device portfolio in the main and sub-distribution boards. The SENTRON series of 3VA molded case circuit breakers (MCCBs) or the LV HRC fuses of type 3NA COM offer the decisive advantages regarding increased availability.

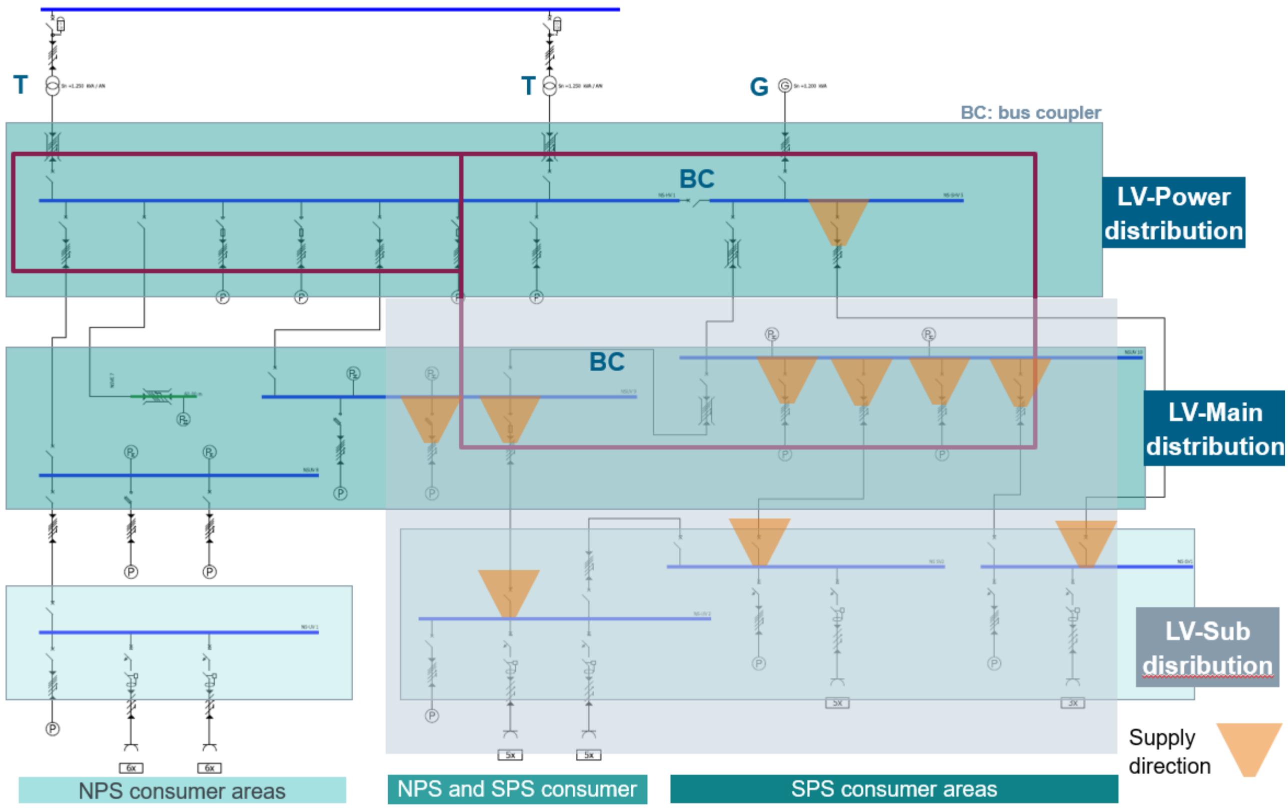


Fig. 13: Network diagram with main and sub-distribution boards and color coding of MCCB or LV HRC fuse outlets

Since the use of low-voltage high-rupturing capacity fuses (LV HRC fuses) depends on country-specific installation conditions, the planning concept of MCCBs or of LV HRC fuses is implemented differently depending on the country or application. The graphic therefore shows both techniques combined.

MCCBs or LV HRC fuses are used to protect loads or to supply sub-distribution boards. For reasons of economy, they are usually used as fixed-mounted versions. In rare cases, the tried-and-tested withdrawable or plug-in technology is used when planning to increase failure safety and supply reliability.

Condition monitoring increases availability in the withdrawable design, but even more so in fixed-mounted versions, since here, significantly longer downtimes usually lead to higher economic damage in the event of a fault.
We recommend monitoring all supply-relevant loads or the supply of safety-relevant energy distribution systems with regard to their availability.
In this way, possible overloads that may lead to supply failures can be identified at an early stage and scheduled promptly via the maintenance or service requirement function.

3VA molded case circuit breaker – an MCCB that becomes transparent

Molded case circuit breakers are suitable for the protection and condition monitoring of systems and generators, as well as the protection of load feeders.

The 3VA molded case circuit breakers (MCCBs) with electronic trip units offer optimum protection for applications up to a rated current of 1250 A. They meet the requirement for LSI protection without additional measures such as current transformers or other equipment.

Condition monitoring is possible on all 3VA2 molded case circuit breakers (MCCBs) with ETU5 or ETU8 and integrated display.

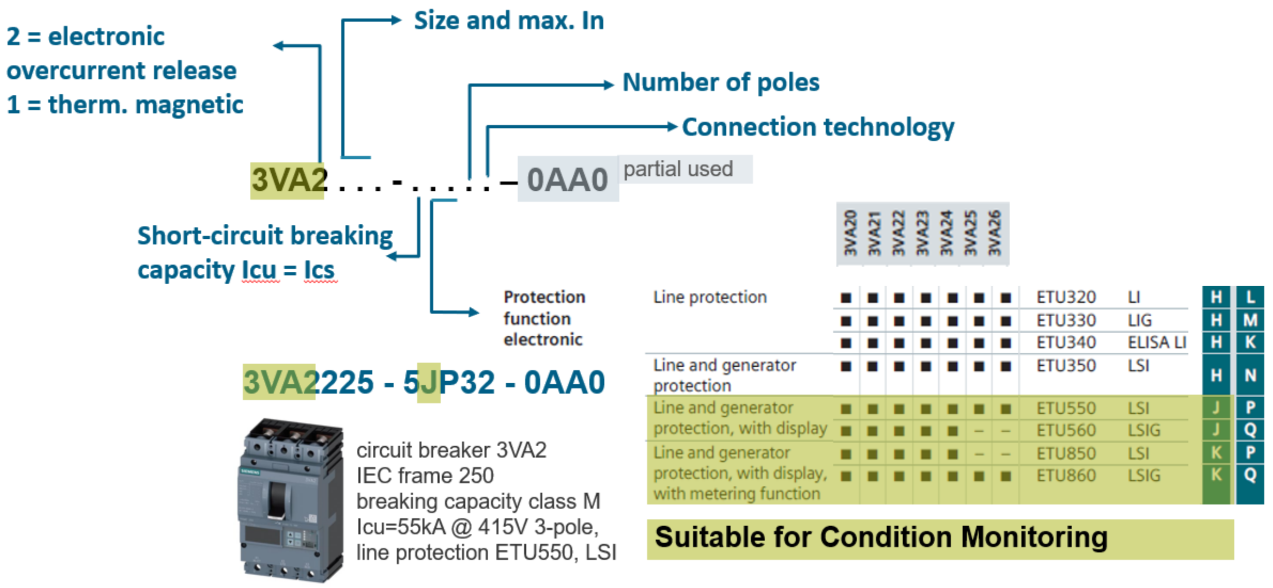


Fig. 14: Order number system for 3VA molded case circuit breakers

The order number system provides a quick overview of the planning-relevant characteristics for 3VA2 molded case circuit breakers (MCCB) with condition monitoring and their visualization.

The intelligent ETU documents all operational and operation messages and system alarms, including limit or threshold violations set by the user, during operation and stores them in a power-independent manner.

Like any protection device, the 3VA molded case circuit breaker requires regular inspection, depending on the operating conditions. This period can be extended to 4 years under certain operating conditions. Apart from external cleaning, the devices are completely maintenance-free!

Since it is not possible to determine from the outside of a molded case circuit breaker which shutdown conditions it has already had to cope with and what technical condition it is in, the 3VA molded case circuit breaker features an intelligent self-monitoring function with integrated remaining life time evaluation.

The status display of the 3VA molded case circuit breaker is determined based on an analysis of the openings and tripping operations. Every time a circuit breaker is opened and triggered, it changes the state of the main contacts. The status display is determined anew with each new switching cycle (on/off or on/off tripping). Tripping operations for test purposes do not affect the health indicator.

The remaining lifetime is calculated with a patented algorithm using the change in health indicator and an analysis of previous usage behavior.

The health indicator is shown in % in the display of the ETU5 and ETU8 series, as shown in the following example. The display indicates the expected service life, taking into account the existing operating conditions, on a scale from 100% to 0%. If 0% is indicated, the operational capability of the circuit breaker is no longer ensured, and the switch should be replaced immediately.

Fig. 15: Display on the ETU550 electronic trip unit

With the optional COM060 communication module in the circuit breaker and the separate COM100 or COM800 breaker data server for up to eight 3VA2 molded case circuit breakers, the following information can also be communicated externally via Ethernet/Modbus TCP:

- Maintenance information
- Statuses
- Remaining life time indicator
- Events and parameters of the circuit breaker

Additionally, when using the ETU8 series:

- Current and voltage measured values, energy data as well as recording of the load profile of the power variables over 40 days. External voltage transformers are not necessary up to 690 V.

The following graphic provides an overview of the necessary components and the basic design of a 3VA molded case circuit breaker with communication connection.

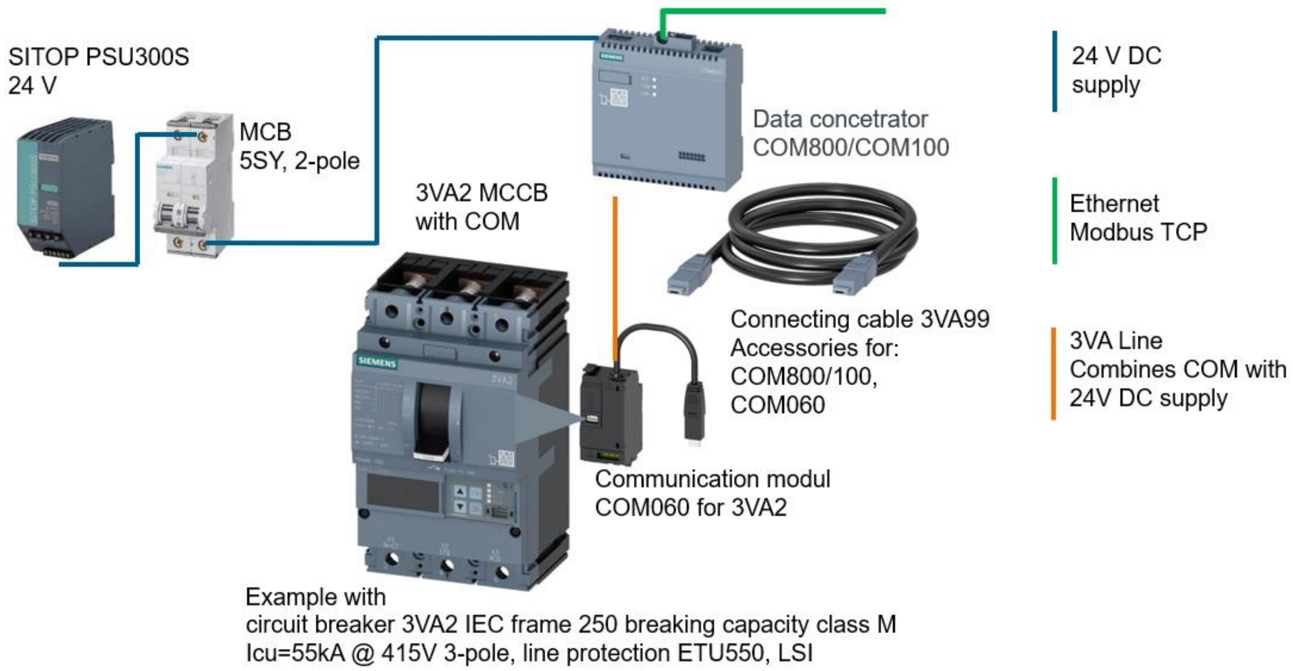
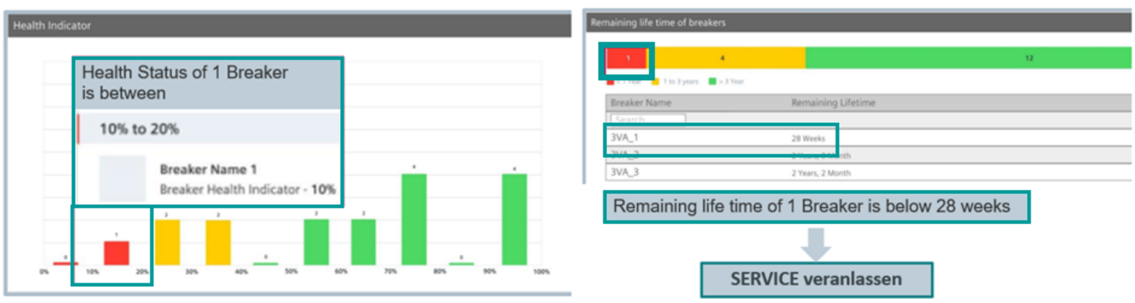


Fig. 16: Components and basic design of a 3VA molded case circuit breaker with communication connection

For communication, an internal COM060 communication module and a COM100 or COM800 breaker data server for up to eight 3VA molded case circuit breakers are required. The entire commissioning is also carried out here with the SENTRON powerconfig configuration software.

The following screenshots from SENTRON powerconfig show the overall states evaluated by the circuit breaker, including the expected remaining life time. Furthermore, there is also a complete overview of all molded case circuit breakers in use, including all



the necessary information for effective maintenance planning.

Fig. 17: Sample displays from the SENTRON powerconfig app

3NA COM – a fuse that likes to communicate about its load

Thanks to their high short-circuit strength, LV HRC fuses provide reliable protection for lines, systems or load feeders. Probably the only disadvantage compared with electromechanical protection devices is that they require replacement in the event of an overload trip. Simple reclosing is therefore not possible. This technology is often said to be subject to an aging process, with fuses therefore only having a limited service life. This statement is only partially correct, however. As long as the fuse is not overloaded, there are also no "micro injuries" and thus no false tripping.

Figure 18 shows an example of what happens in an LV HRC fuse with I_n = 63 A in the event of an overload. With a current of I = 126 A, the fusible element breaks by fusing at the central constriction at approx. 170 °C.
High current loads do not immediately lead to a power supply interruption by the fusible element. However, the existing overcurrent can result in permanent changes in the fuse characteristics that negatively affect the service life.

High pulse loads with alternating heating and cooling can lead to "micro-injuries" (see detail aR fuse element in Fig. 18).

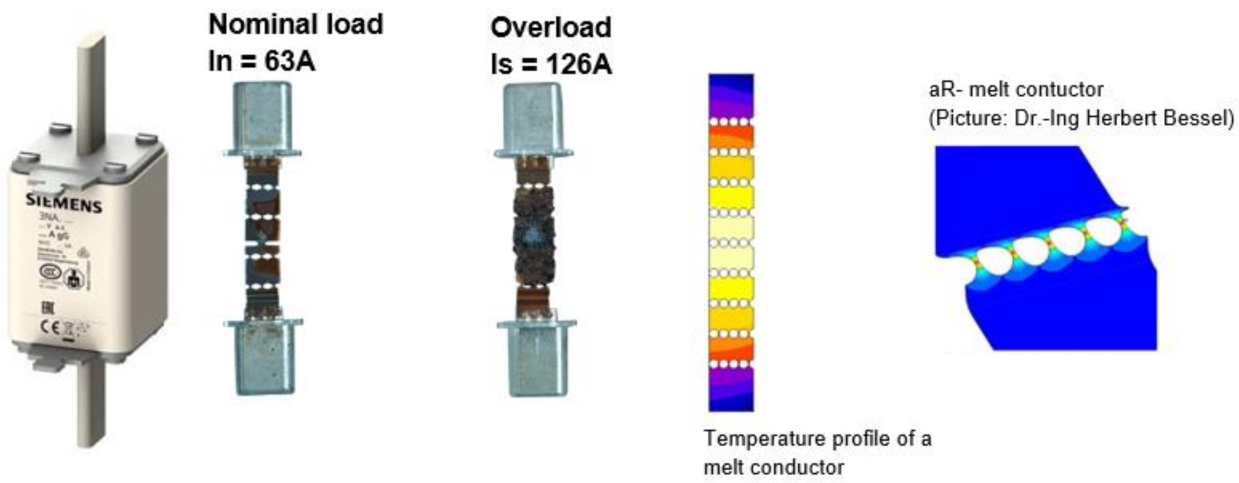


Fig. 18: Temperature profile of a fuse element (backup fuse without solder)
Source: Prof. Adrian Plesca, TU lasi, Romania (Figure: Adrian Piesca, TU lasi, Romania)

With correct fuse selection based on careful system planning, fuses thus provide reliable overcurrent protection over the entire service life. However, stressors and external influencing factors must also be taken into account. Since these can change during the operating phase, additive current and temperature monitoring is the best way to anticipate a fuse failure.
The remedy for this problem is permanent current and temperature measurement inside the fuse.

With the 3NA COM fuses and a rated voltage of 400 V, the following parameters can be set:

- Temperature (incl. mean value)
- Current (incl. average and maximum)
- Upper temperature limits
- Overcurrent alarm 1 and 2
- Undercurrent alarm 1 and 2
- Operating hours
- Operating hours with load current

3NA COM fuses are currently available for 400 V as well as up to a rated current of 315 A and for operational class gG or gFF.

The integrated current transformer (electronic module) supplies the integrated electronics during operation and is used to acquire the operating data and messages. This means that no external equipment is required to supply the 3NA COM fuses.

The order number system below allows a quick selection of communication-capable full-range fuses with flange-mounted electronic modules.

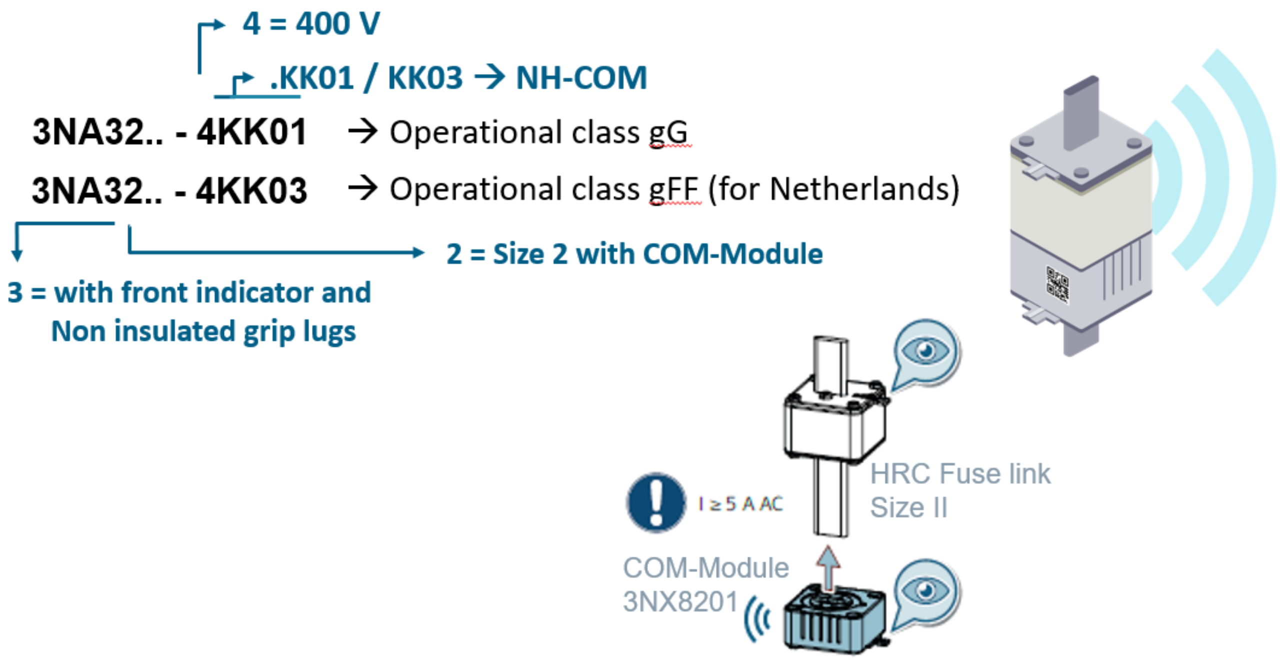


Fig. 18: Order number system for the 3NA COM

Wireless communication with the 7KN Powercenter 1000 can detect the possible risk of aging processes and operation with overload currents through continuous monitoring. In addition, undetected fuse tripping or asymmetrical operation of loads can be monitored by individual alarm messages.

The following diagram provides an overview of the necessary components and the basic structure of a 3NA COM fuse with communication connection.

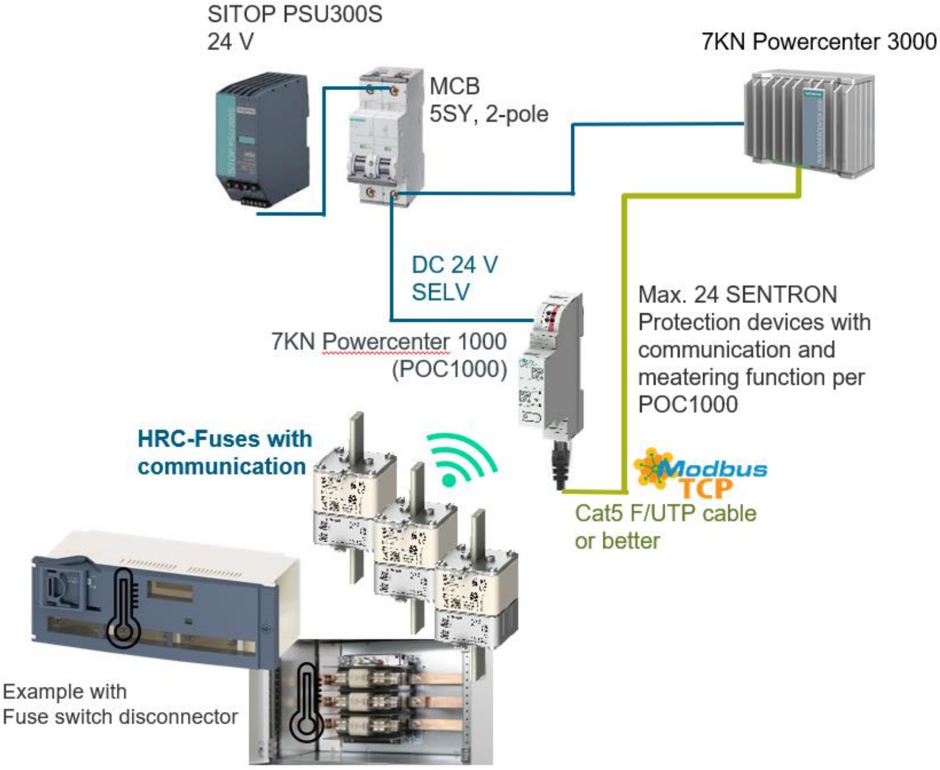


Fig. 19: Graphic showing the 7KN Powercenter 3000, which can be used as a central gateway with integrated web server (also for push messages) for all devices

The 7KN Powercenter 1000 functions here as a breaker data server for the fuses as well as for modular installation devices with communication capability. For connection and commissioning, you need the free SENTRON powerconfig app to set the necessary communication data, including the phase sequence of the installed device.

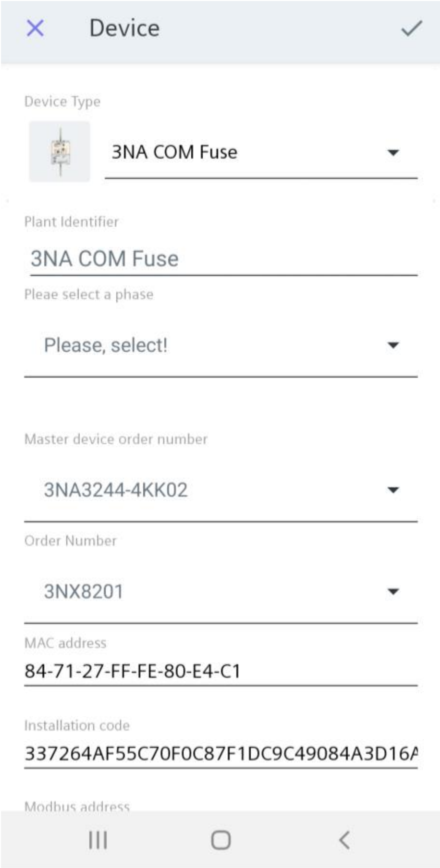


Fig. 20: SENTRON powerconfig mobile screenshot

The SENTRON powerconfig app supports the individual fuse settings. The temperature presets for standard alarms or warnings can be set individually. The rated current setting of the fuse cannot be changed.

The 7KN Powercenter monitors the data and values after commissioning of the 7KN Powercenter 1000. The data and value transmission is done via Modbus TCP between the 7KN Powercenter 1000 and other Modbus TCP-capable devices such as the 7KN Powercenter 3000 or other Modbus TCP devices including router.

Condition monitoring for modular installation devices – made to detect hazards in the branch circuit

MCCBs or LV HRC fuses protect and supply the sub-distribution boards as described above.
The loads and load circuits supplied via the sub-distribution boards are protected with fuses or miniature circuit breakers (MCB), depending on local installation habits and requirements. For specific requirements, residual current devices (RCD), residual current monitoring devices (RCM), insulation monitoring devices (ICM), EMC filters or arc fault detection devices (AFDD) are used to protect the equipment or installation environment.

MCBs, RCDs or AFDDs (arc fault detection devices) are integrated into the electrical equipment as modular installation devices and typically undergo adjustments, load changes or technical reviews over the operational life of the power distribution system. Condition monitoring supports availability from initial commissioning, monitors and reports the changed demand in case of adjustments, and supports the technical review. This minimizes unexpected failures due to overload trips and allows the need for inspection and maintenance to be planned. In addition, required safety checks may be extended for up to 4 years.

We recommend monitoring of all supply-relevant loads or the supply of safety-relevant energy distribution systems with regard to their availability. In this way, possible overloads that may lead to supply failures can be identified at an early stage and scheduled promptly via the maintenance or service requirement function.

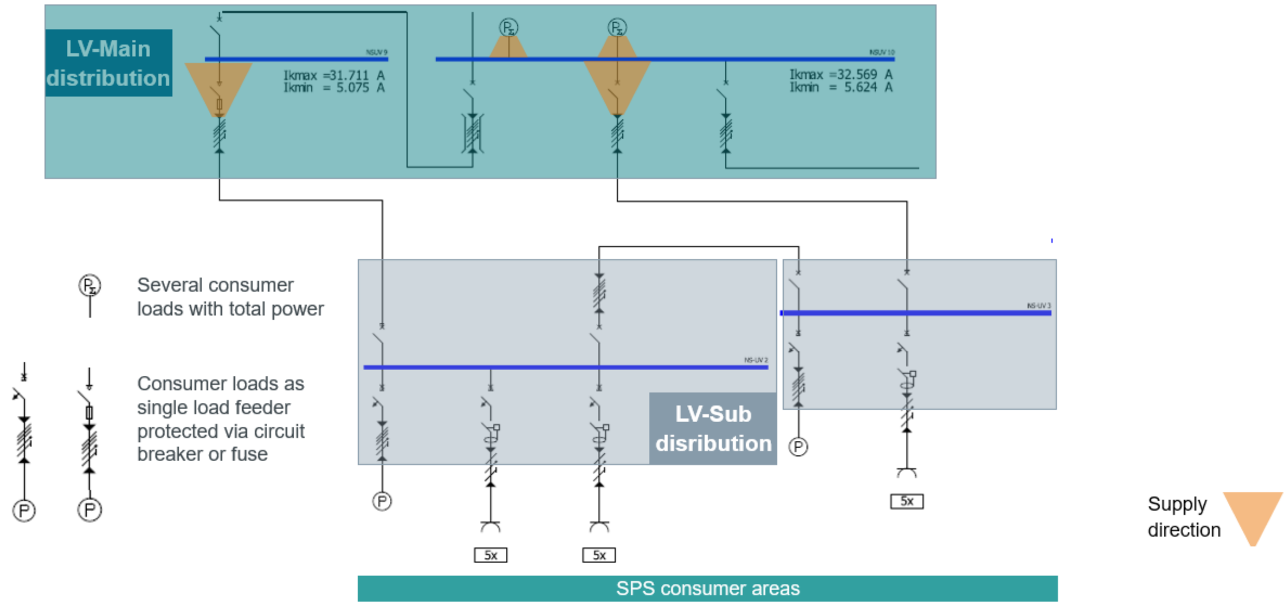


Fig. 21: Network diagram with main and sub-distribution boards as well as relevant power supply loads and color coding of the MCCB or LV HRC fuse outlets for supplying the sub-distribution boards.

Depending on country-specific requirements, the sub-distribution boards provide the mounting frame for the modular installation devices to protect the load circuits and supplied loads.

Unfortunately, modular installation devices usually do not provide:

- Information about the temperature at the device or about the switching frequency
- Warnings

The circuit is switched off without prewarning if faults occur.

With the support of communication-capable modular installation devices or communication-capable auxiliary switches, the necessary transparency is now obtained for:

- Current/voltage/power/energy
- Warnings e.g. in case of overload
- Arc faults
- Manual ON/OFF
- Tripped
- Operating cycles
- Temperature, including exceeding the upper temperature limits
- ...

MCBs and AFDDs can measure and communicate the following variables:

- Temperature (incl. mean value)
- Current (incl. average and maximum)
- Overcurrent and undercurrent alarm 1 and 2
- Voltage and frequency
- Apparent power, reactive power, active power, and power factor
- Overvoltage and short circuit detection
- Operating hours with/without load current
- Mechanical operating cycles
- Tripping operations and short circuit releases
- Upper temperature limits

Additionally for AFDD:

- Voltage undershoot AFDD trip
- Overvoltage and undervoltage alarm 1 and 2

The communication-capable 5ST3 COM auxiliary switches allow the integration of non-communication-capable modular installation devices such as:

- MCB: 5SY, 5SP4, 5SL,
- RCCB: 5SV,
- RCBO: 5SV1, 5SU1

This allows the switching status, the mechanical operating cycles, the number of tripping operations, as well as the operating hours and the temperature to be acquired on the basic unit.

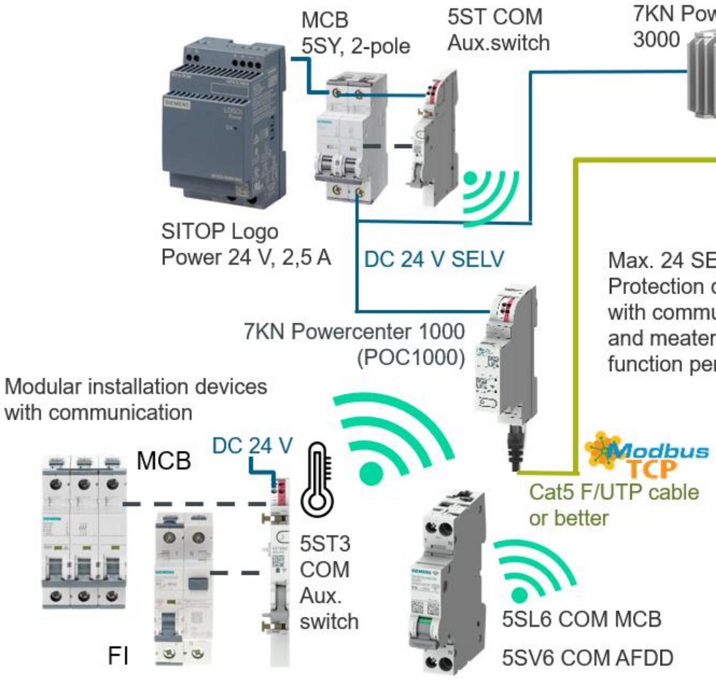


Fig. 22: Basic structure for modular installation devices with communication

An external 24 V DC power supply is used to supply the communication-capable modular installation devices 5ST COM auxiliary switch and 7KN Powercenter. The communication-capable MCB and AFDD are self-powered via the operation of the device.

Figure 22 also shows, among other things, the 7KN Powercenter 3000, which can be used as a central gateway with integrated web server (also for push messages) for all devices.

For the initial installation or commissioning of the modular installation devices and for setting the current and temperature values for alerting, the SENTRON powerconfig app must be used, as for the communication-capable fuses.

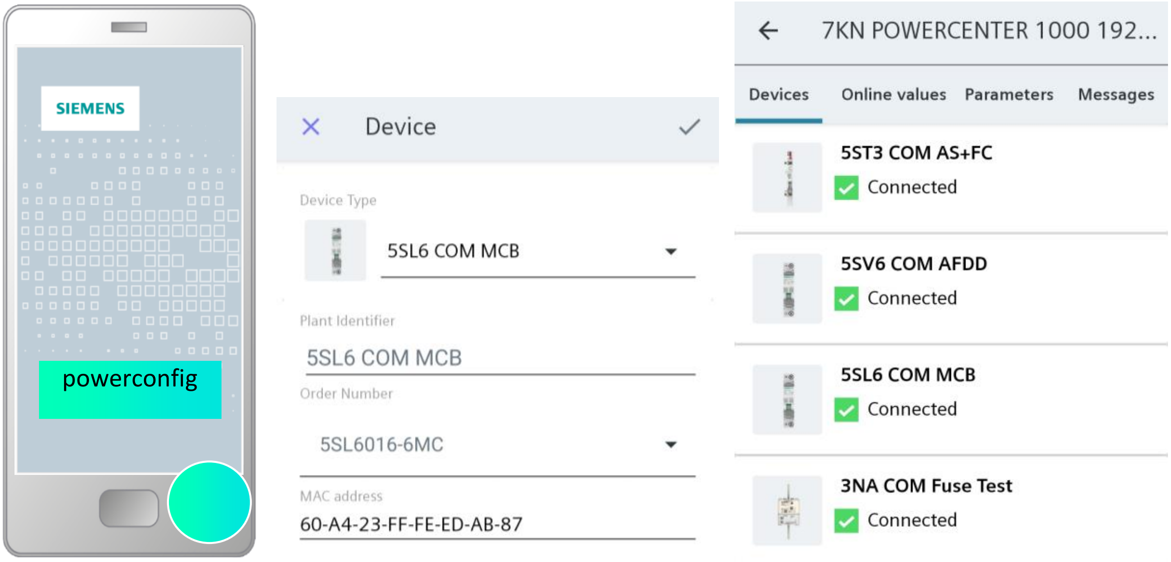


Fig. 23: Screenshots from the SENTRON powerconfig app

The SENTRON powerconfig app supports the individual device settings and designations. Temperature or current settings for standard alarms or warnings can be set individually. However, the rated current setting of the protection devices cannot be changed.

The 7KN Powercenter 1000 monitors all of these data and limit values, which are transmitted via a Modbus TCP cable between the 7KN Powercenter 1000 and other Modbus TCP-capable devices, including routers, after the initial commissioning of the 7KN Powercenter 1000.

Communication capable recording of operating/-data and -states for efficient and economical condition monitoring

For the selected example, the use of a 7KN Powercenter 3000 is generally recommended. This is a data collector to which all listed devices can be connected. Due to the web server integrated in the device, no further software solutions are required to obtain an overview of all relevant data. In addition, messages are actively generated when warning or alarm values are exceeded or undershot. If a connection to higher-level systems such as the SENTRON powermanager, Desigo CC, or a cloud connection to powermind is required, the 7KN Powercenter 3000 is also the ideal solution.

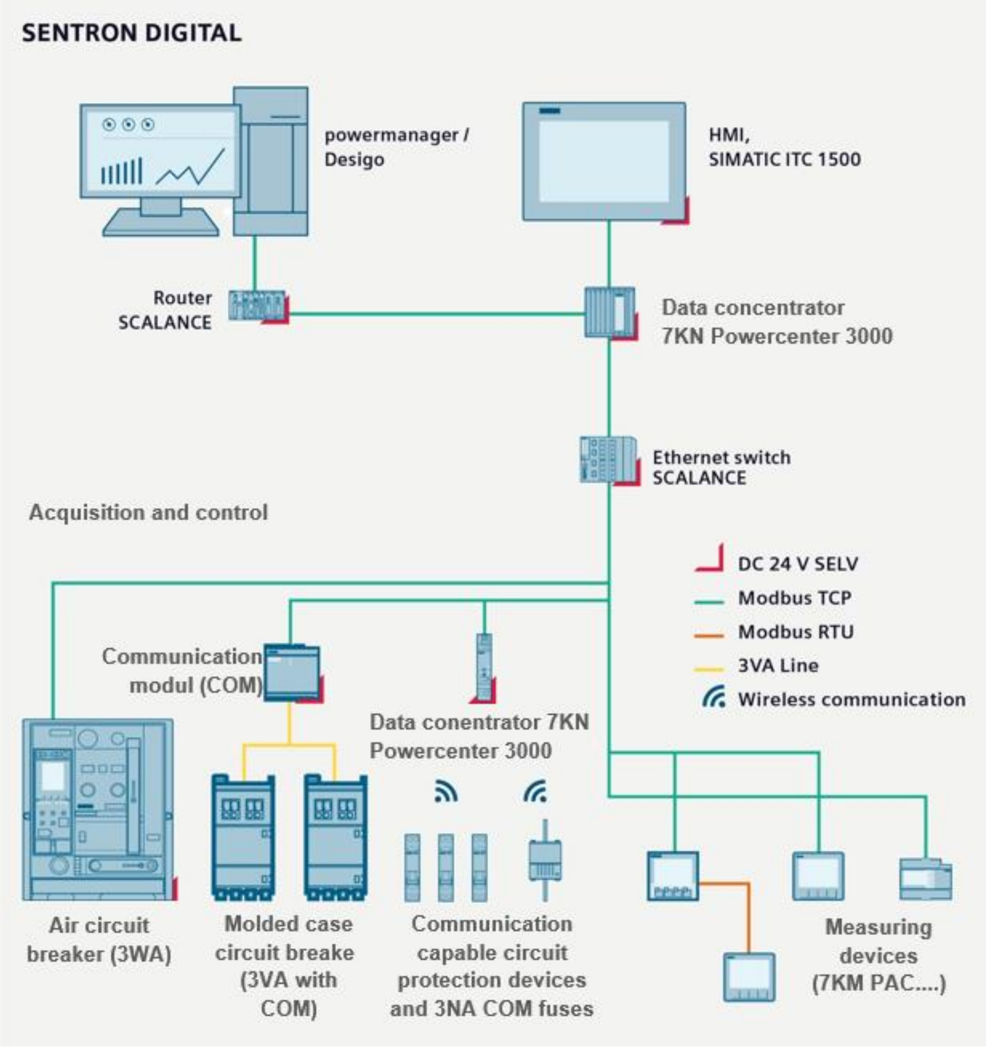


Fig. 24: General overview of the communication structure of the protection devices including further measuring instruments and the 7KN Powercenter 3000

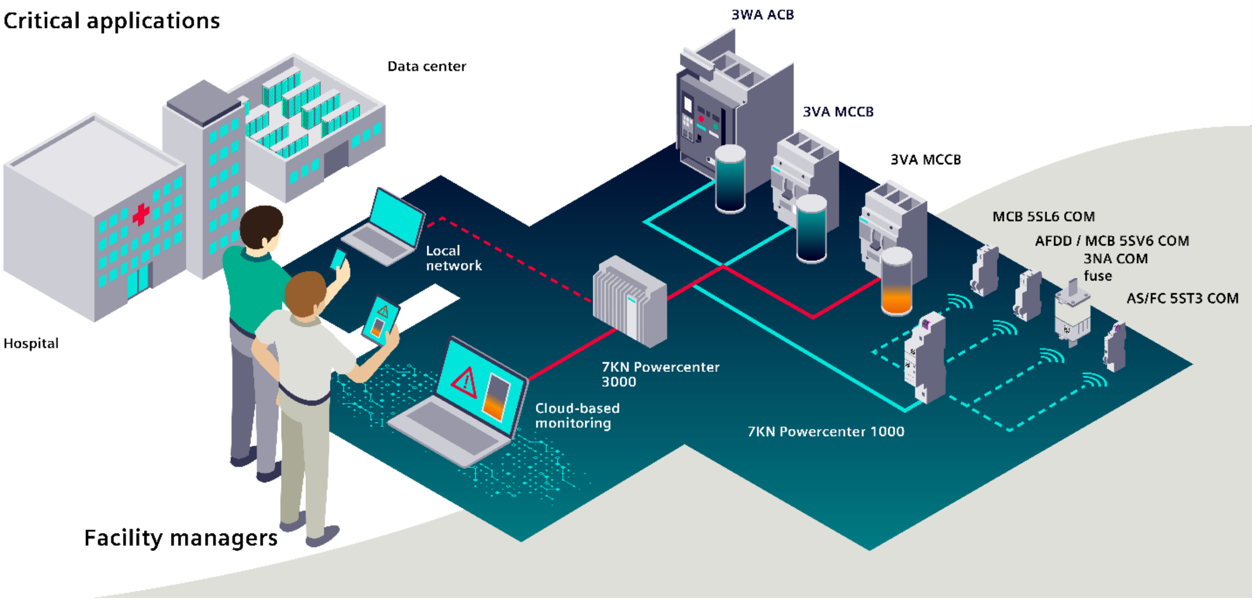


Fig. 25: Example of a condition monitoring concept in a low-voltage power distribution system

Summary

Functionalities such as condition monitoring are made possible by the acquisition and transmission of data and their evaluation using intelligent algorithms. Predictive maintenance of plants and their components based on real usage data reduces downtimes, contributes to higher plant availability, and permits process optimizations. Risks due to critical temperature increases that can cause gradual damage to equipment are reported in a timely manner before damage occurs unnoticed.

Integrated temperature sensors can be used to detect creeping processes such as impaired plant or room air conditioning and communicate them through warning or alarm messages. This enables risks to be reported in advance or detected automatically. In addition, service and maintenance activities can be optimized, contributing to a cost-optimized OPEX approach.

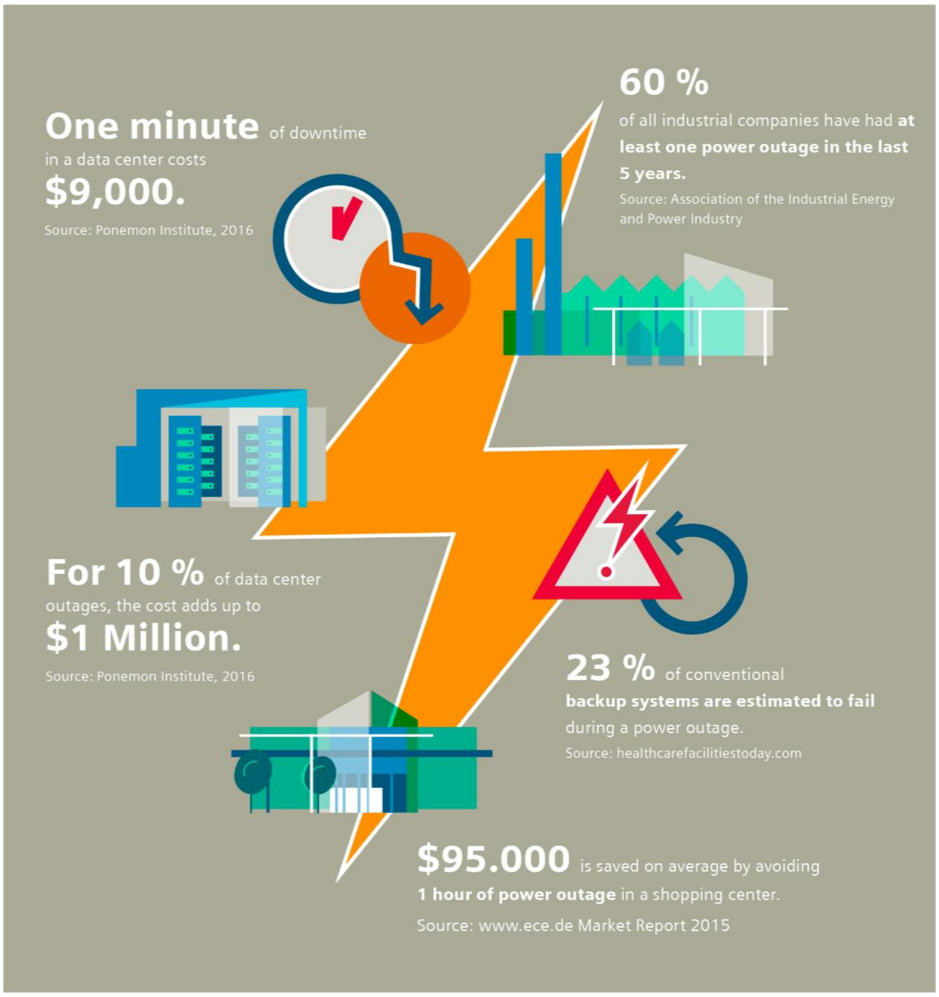


Fig. 26: Economic significance of power failures

The challenges and financial risks posed by a power supply failure cannot always be quantified precisely and depend on the application. Apart from the economic risks caused by the failure of a power supply, possible damage to the company's reputation cannot be assessed in financial terms.

This also applies to many public facilities, such as shopping malls or train stations, which often do not have a redundant structure or an emergency power supply. In addition, the data from the protection devices is also used to record energy values, which permits further cost savings in operation and results in an even faster return on investment.

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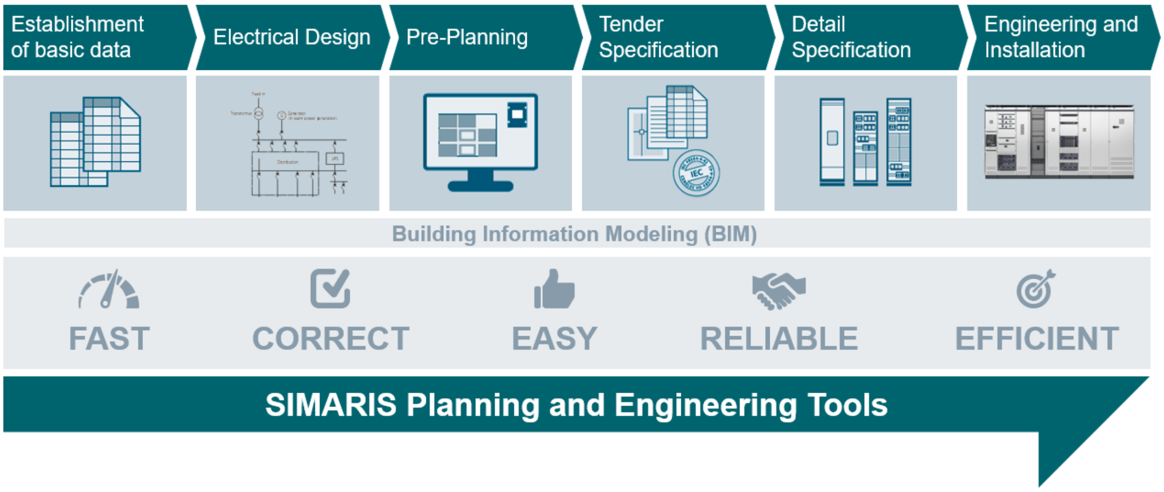

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