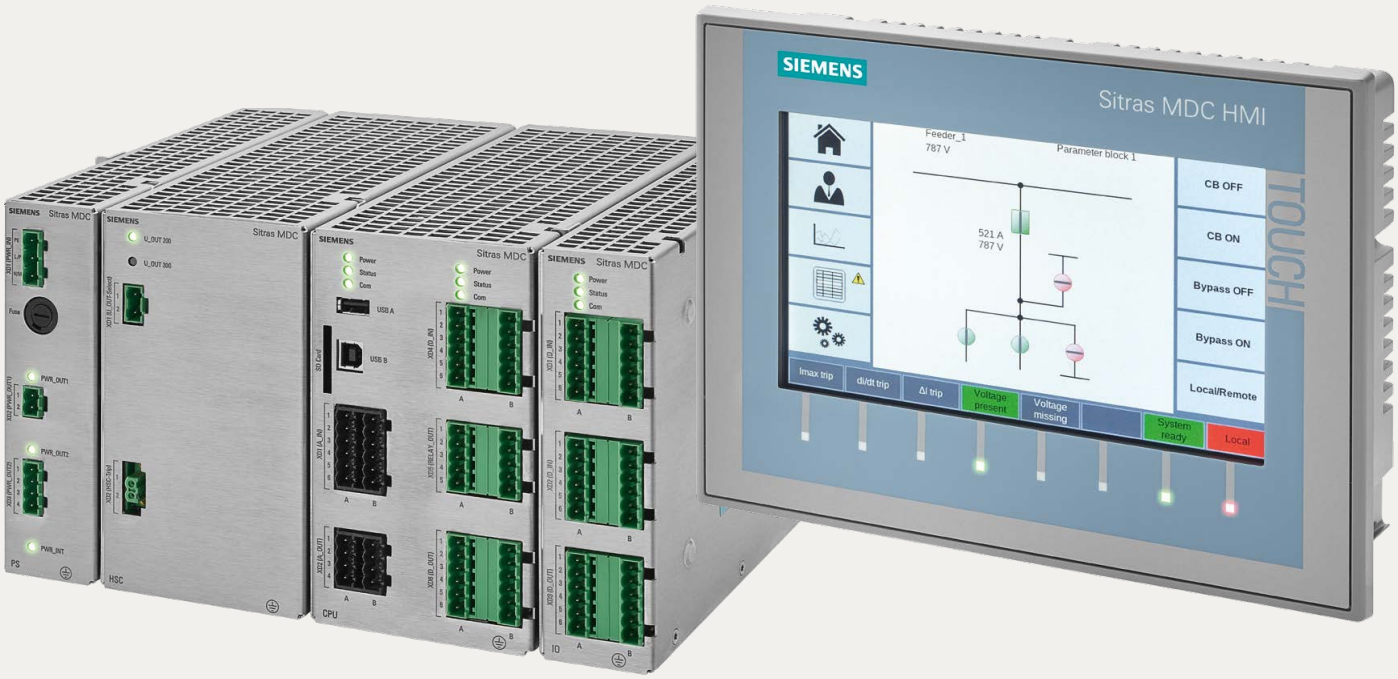


Version
1.0.2

PRODUCT INFORMATION

Sitras MDC –
DC protective unit and controller for traction power supply

siemens.com/rail-electrification

SIEMENS

The modular digital controller Sitras® MDC is used in the power supply for DC railways in mass transit and mainline systems up to DC 3 kV.

As DC protective unit it protects DC switchgear and contact line systems against critical operating conditions and detects short-circuits during the current rise even before the maximum short-circuit currents are reached.

Sitras MDC succeeds the successful DC protective unit and controller Sitras PRO. In addition to the proven functions, further features were implemented.

Features – of the Sitras MDC Modular Digital Contoller

- Complete functionality in a single unit
  - Protection
  - Measurement
  - Control
  - Automation
  - Free programmable PLC
  - Integrated switch functionality
- Flexible adaptation to system requirements
- Standard communication interfaces
- High-performance diagnostics, comprehensive event and measured value memory
- Compliance with all relevant standards
- Modular Hardware- and Software design

Overview

Sitras MCD can be used as secondary line feeder protection in the DC traction power supply as well as in different configurations for further control and automatization applications.

Productline

The product line Sitras MDC consists of the following modules:

- Sitras MDC PS - Power Supply Unit
- Sitras MDC HSC - High Speed Capacitor Tripping Unit
- Sitras MDC CPU - Central Processing Unit
- Sitras MDC IO - Input / Output Unit

Furthermore the following modules are used for measured value acquisition:

- Sitras PRO BA - DC Buffer Amplifier
- Sitras PRO CM - Cable Monitoring Module

Hardware

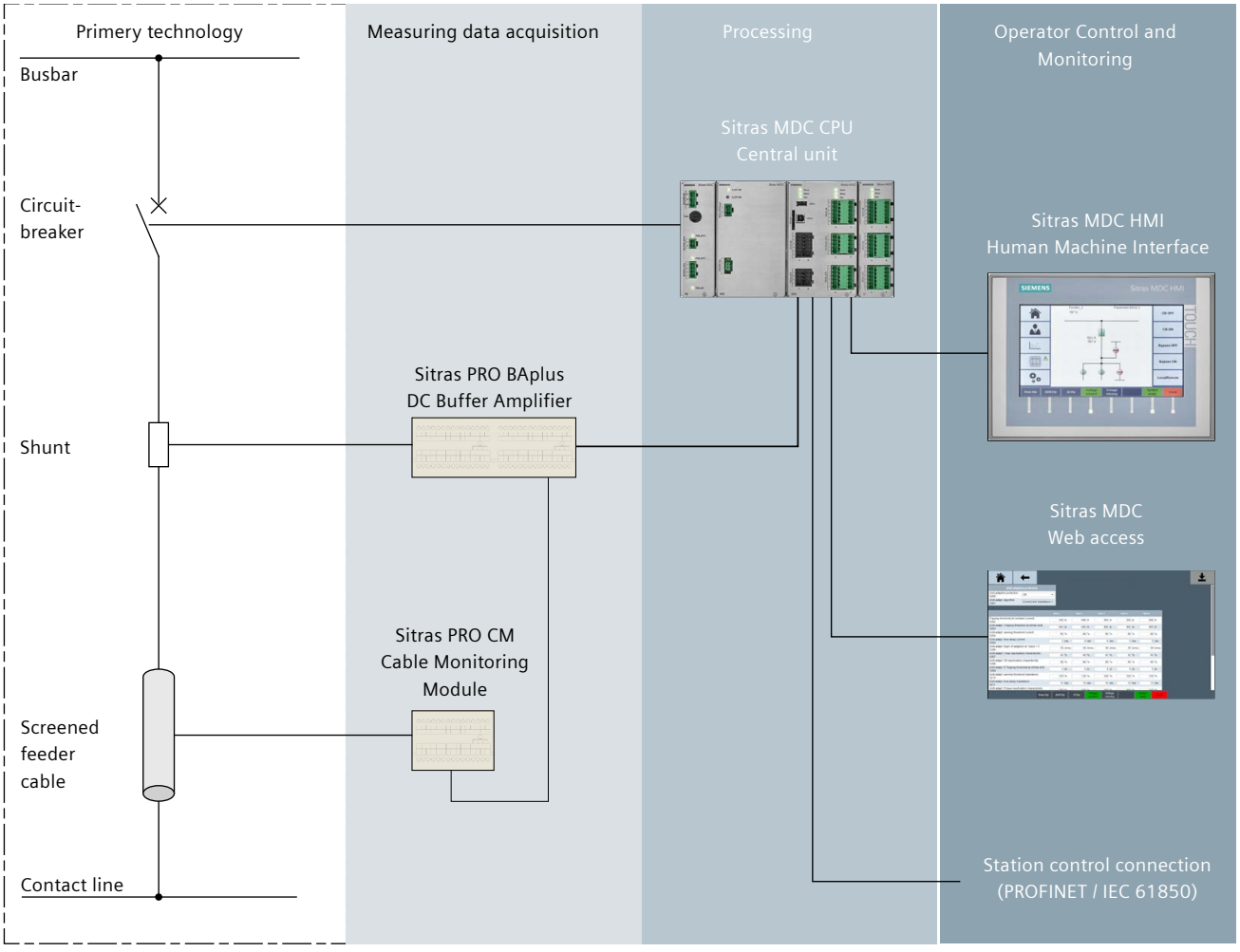
The modular system Sitras MDC is flexibly adaptable to the necessary conditions. The minimal configuration consists on the power supply unit (PS) and the central processing unit (CPU). Because of the fact that the CPU is already equipped with digital and analog inputs and outputs, some applications can be realized with this configuration. Furthermore all communication interfaces are located on this unit.

The system can be extended in various ways. For service and operation the HMI and for measured value acquisition the Sitras PRO BA buffer amplifier can be connected.

One or two input / output units can be added for extension of the periphery. All digital inputs can be used with DC 24 V - 110 V (+/- 20%).

For tripping very quickly the circuit breaker, a high speed capacitor tripping unit is available.

System configuration



Typical integration of Sitras MDC / PRO to the DC traction power supply

Functions –
DC protection functions

- **Overcurrent protection (I_{max})**
  This monitors the instantaneous current for a maximum current in the direction of incoming supply, in the direction of energy recovery and for an undirectional maximum current. Tripping is initiated if one limit is exceeded for an adjustable period of time.
- **Current surge protection (ΔI)**
  The current surge protection samples the current rise and detects a fast current rise that is not compliant with any operating mode. The short-circuit is detected far below the peak current. This significantly reduces the load on the system and the breaker abrasion.
- **Current rate of rise protection (di/dt)**
  The most distant short-circuit must be detected and isolated. This is done by initiating a tripping of the circuit-breaker if the set threshold for the current rate of rise is permanently exceeded and the adjustable period of time has elapsed.
- **Overcurrent-time protection (I_{DMT})**
  The overcurrent-time protection detects currents that exist for a long time and are not consistent with any regular operating mode. The current is monitored in the direction of incoming supply and in the direction of energy recovery.
- **Thermal overload protection**
  The maximum permissible operating temperature of equipment may be exceeded in case of overload without the short-circuit monitoring function detecting a fault. With this protection function, the operating temperature of the feeder cable, contact wire and catenary wire can be monitored.
  Furthermore there is a thermal overload protection which can protect an additional operating material by k-factor and time constant.
- **Overvoltage / undervoltage protection (V_{max}/V_{min})**
  When the outgoing cable voltage rises above or falls below a preset value and if this condition persists longer than the preset delay, a alarm and/or tripping is initiated.
- **Circuit-breaker failure protection**
  The circuit-breaker failure protection verifies that a tripped circuit-breaker actually interrupts the current flow. Using a parameterizable signal, this allows tripping of an upstream medium-voltage circuit-breaker if necessary.
- **Impedance protection**
  The impedance protection monitors the resistance in the supply area and trips the circuit-breaker when resistance falls below a preset value.
  In contrast to the I_{max} function, the fluctuation of the substation voltage and the voltage drop under load is taken into account with this function.
- **Frequency monitoring**
  This frequency monitoring function is used to monitor the harmonic component at the contact line.
- **Switching between protection parameter groups**
  With up to five parameter groups, the Sitras MDC can be configured locally or remotely for the respective operating conditions.
- **Monitoring analogue value**
  A message and/or a trip is generated if the analogue value rises over an adjustable limit or falls under a second adjustable limit and stays there longer than an adjustable time delay.
- **Monitoring of cable insulation and cable screen break**
  In combination with the Sitras PRO BAplus DC Buffer Amplifier and one or two Sitras PRO CM Cable Monitor Modules, the following faults can be detected:
  - Insulation failure between the L+ conductor and the screen
  - Insulation failure between screen and earth or the conductor L–
  - Screen break
- **Measurement comparison**
  Extensive possibilities are available for carrying out measurement comparison. E.g. the value of an analog input can be compared with the current value of the buffer amplifier and either a warning or a trip can be generated. This enables the use of a second buffer amplifier for supervising the measurement of the feeder current. Furthermore any desired analog inputs can be compared with each other.

Functions –
Basic functions

- **Event buffer**
  The device contains a circular buffer in which the last 8192 events are stored. These are operating events, faults, trips and alarms.
  Furthermore modifications of parameters and Login- / Logout- activities are documented.
- **Fault recording**
  In the inernal memory the last 32 fault records are stored. Ech fault consists in 8192 measuring point with a minimal sampling rate of 100µs. Current, voltage, di/dt and 4 binary traces are recorded. With the usage of a SD card up to 1000 fault records can be stored.
- **Measured values recording**
  In addition to the fault recording it is possible to record measurement curves of the current and the voltage. The sampling rate can be adjusted betweem 100µs and 1s. These measurement values are stored at the SD card and can be read out also from remote.
- **Contact line and busbar voltage monitoring**
  This function is designed to monitor the voltage in the supply area and at the busbar and to generate a “Voltage present” message.
- **High-speed capacitor trip**
  In combination with specially equipped circuit-breakers, the high-speed capacitor trip can be used to achieve even faster disconnection.
- **SNTP time synchronization**
  In this type of time synchronization all devices will get the time from a central master clock via Ethernet.
- **Standard dialogue languages**
  The conversational language can be changed at any time between Chinese, English, German, Italian and Spanish.
- **Additional conversational languages**
  The standard conversational languages may be complemented with additional languages (up to eight). This may also include Asian or Cyrillic fonts.

Functions –
additional optional functions ..

- **Control**
  In addition to the protection function, the central unit is also capable of controlling the line test and the switching of the circuit-breaker (test and automatic reclose function). This does not require any separate control.
  Another feature is the transfer trip function which trips the circuit-breaker in the neighboring substation or causes its own circuit-breaker to trip due to a transfer trip by the neighboring substation.
  Bypass disconnect interlocks are also provided on the bypass bus disconnector for the section feeder panels with bypass.
  Another possible control function is the calculation of the residual section resistance based on the measured voltage contact line voltage and the test current.
- **Integrated programmable logic controller (PLC)**
  In addition to the dedicated control functionality of the central unit, the integrated PLC enhances the control unit with a freely programmable automation functionality, e.g. for the control of motor-operated disconnectors.
  This eliminates the need to use a separate PLC and ensures a uniform design of the control and protection equipment in the entire DC switchgear. In combination with IO modules more inputs and outputs are available. User defined messages can be added to the event system.
- **PROFINET IO communication**
  The bus communication enables the transfer of status information, measured values, control commands and control parameters as well as the time synchronization.
- **IEC 61850 Communication (Edition 2)**
  Process bus, used to transfer status information, measured values, control commands and control parameters to a station control. Also the communication of protection and control relays between each other (GOOSE), e.g. for interlockings. Furthermore the object orientated data model makes the engineering of the station control system more easy.
  With the functionality file transfer, the fault records can be transmitted from the protection relay to the station control system.
- **Advanced current rate of rise protection (di/dt adaptation)**
  This continuously changes the I_{max} value and/or impedance value as a function of di/dt in order to achieve a significantly finer adjustment of the I_{max} and impedance protection and thus even faster disconnection in case of faults.
- **Power / energy calculation**
  This is based on the values of the incoming and recovered power as well as of the incoming and recovered energy of the section feeder.
- **Storage of breaker loading (maintenance diagnostics)**
  Various measured and calculated values (e.g. switching cycles, load integral) for the breaker loading are indicated.
- **Frame Fault Protection**
  With this function Sitras MDC can be used for frame fault protections. Thereby the DC currents as well as the AC currents were supervised. With usage of a Hall sensor for measured value acquisition the perfect functioning of the measurement can be proven automatically each day.

Measured value acquisition

Sitras PRO BA – DC Buffer Amplifier

The DC buffer amplifier is used for measuring the current and voltage while, at the same time, ensuring electrical isolation.

The measured values are output to the Sitras PRO central unit via fiber-optic cable (FO). Analog outputs are also available, such as

for the display of section feeder current

for the display of section feeder voltage

for the display of test voltage (voltage in the feeder section)

Sitras PRO BAplus, the DC buffer amplifier, can also be combined with one or two cable monitoring modules to implement a cable monitoring function.

Sitras PRO CM – Cable Monitoring Module

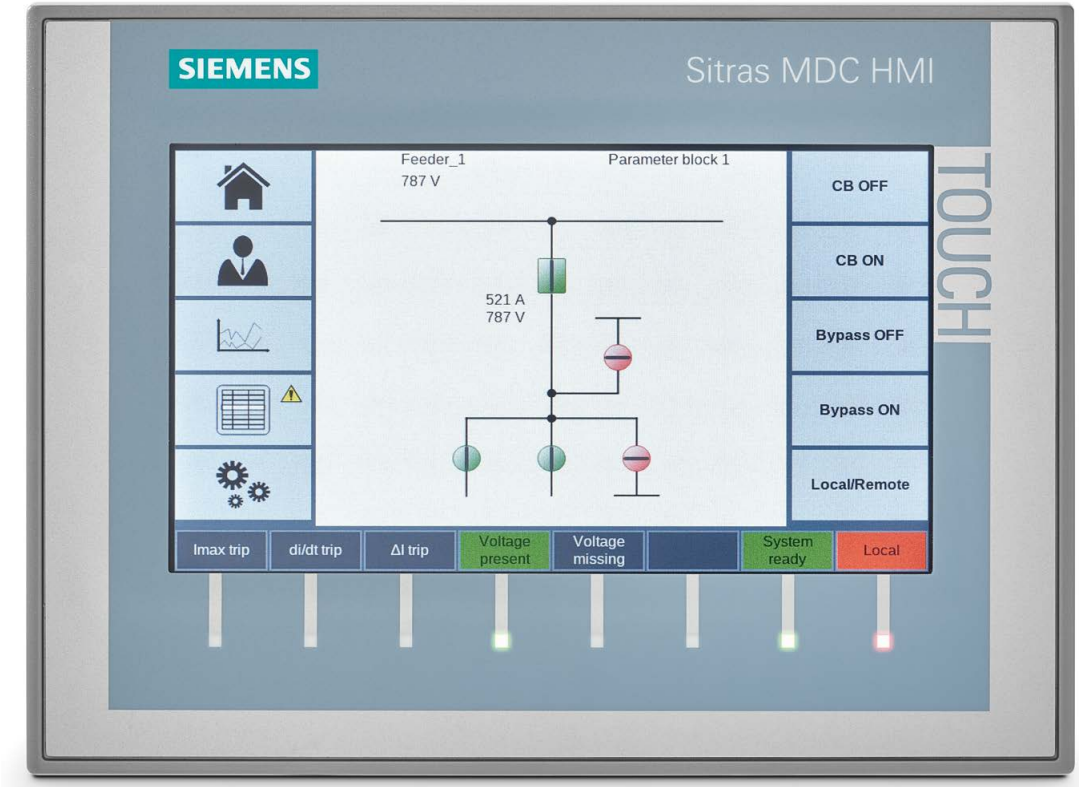
The cable monitoring module is used for measuring the insulation resistance of the feeder cables. The cable screen can also be monitored for open circuit (breakage). The readings are sent to the central unit via the DC buffer amplifier.

The cable monitoring module is designed to monitor screened feeder cables in traction power supply systems with positive contact line voltages of up to DC 1500 V. It can be connected to any cable that has a concentric screen and conductor and an insulating outer sheath.

The cable monitoring module is connected to the central unit via the Sitras PRO BAplus DC buffer amplifier and is powered by the contact line voltage. A maximum of two cable monitoring modules may be used.

Sitras MDC
can be controlled and parameterized

- via the externally accessible Sitras MDC HMI – human machine interface,
- via the web browser Chrome,
- via one of the many communication interfaces using Sitras SCS-DC.



Sitras MDC HMI – Externally accessible human machine interface

Sitras MDC HMI – Human Machine Interface

Sitras MDC HMI is integrated in a user-friendly manner in the door of the low voltage compartment of the DC switchgear.

The features are:

- Color-Touch-Screen
- Dynamic display of switch positions
- Editable mimic diagram (symbols and positions)
- Measured value display of the current and voltage (feeder / busbar)
- Individually parameterizable LEDs (functional assignment and text labels)
- Individually parameterizable two color (red / green) function keys (functional assignment and text labels) at touch screen
- Extensive input and operation possibilities at the display.
- One circuit breaker and up to 10 disconnectors can be visualized, selected and controlled.

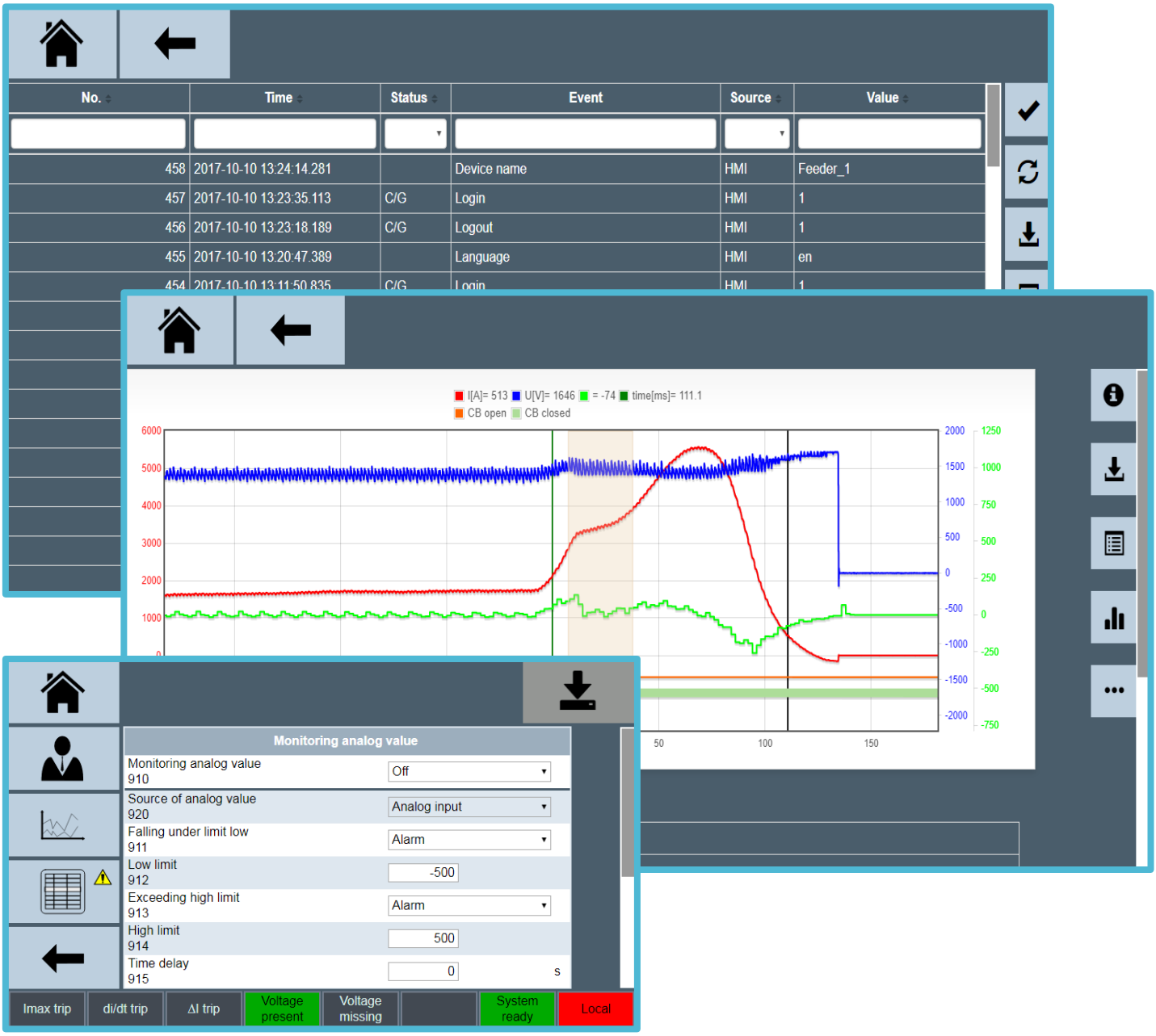
Sitras MDC – Web interface

The parameterization interface of the Sitras MDC can be opened in a simple manner with a web browser. This can be done locally via USB or Ethernet interface as well as from remote via the station control system.

A convenient tool that simplifies and accelerates operations and diagnostics is provided by that – from set-up and start-up of the equipment to analysis and documentation of system faults.

The Sitras MDC web interface is characterized by the following features:

- Contained in the Sitras MDC CPU as standard
- User guidance identical to the HMI
- Easy parameterization with
  - context menus
  - drop-down lists for selection of applicable parameters
  - display of limits for values
- Trace visualization
- Trace analysis
- Visualization measured value acquisition
- Print function
- Event System with filter and sorting functions
- Display of LED Status



Sitras MDC – Web-Interface

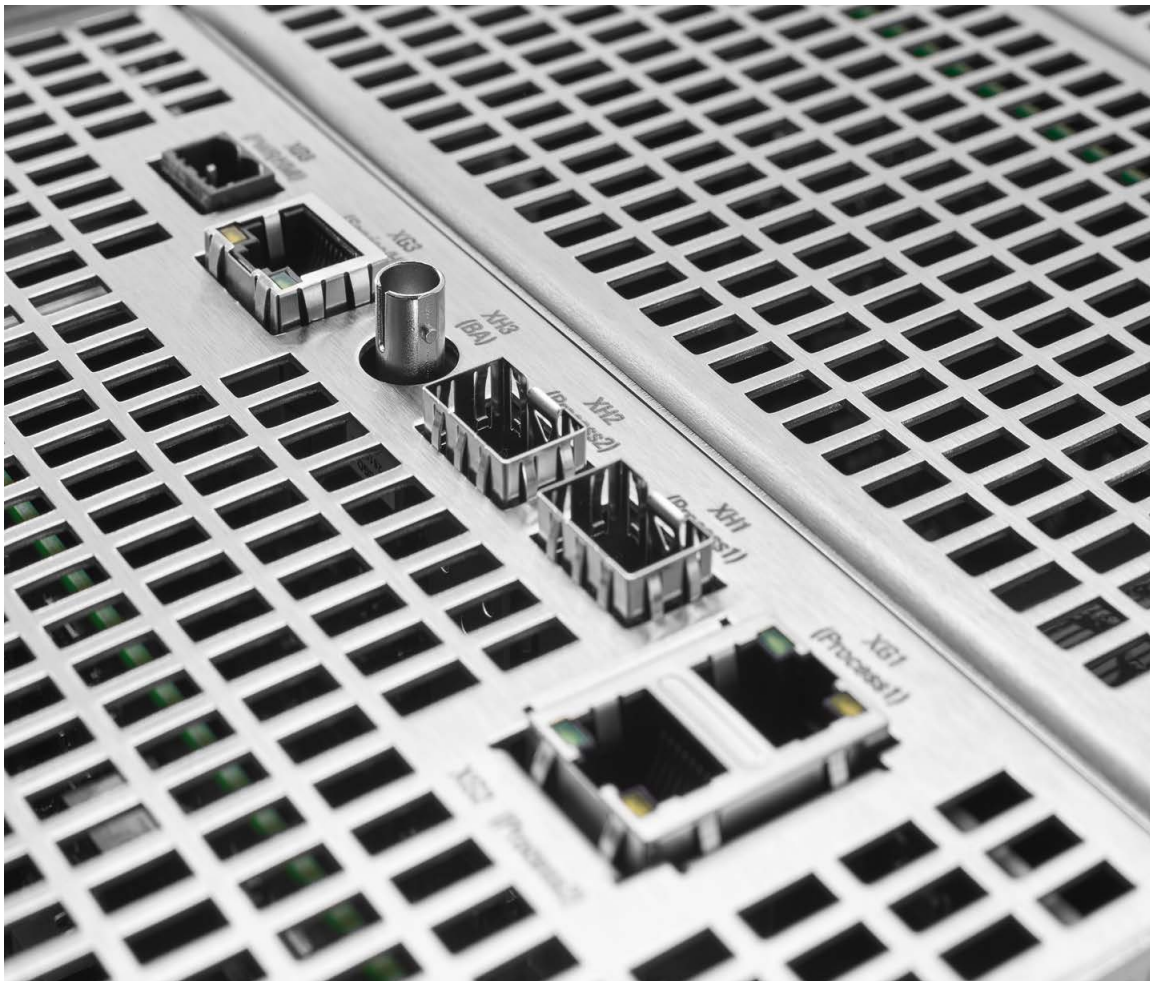
Communication – Numerous standardized interfaces and protocols provide flexible communication options for operation, parameterization, service and time synchronization.

Interfaces

- Ethernet, Fast Ethernet
  - 2x RJ45 incl. switch functionality
  - 2x SFP, optional FO interfaces with switch functionality
  - 1x RJ45 (HMI or Service)
- USB (Type A and Type B)
- SD-Card
- 1x F-ST, fiber-optic cable (connection to Sitras PRO BA)

Protocols

- PROFINET IO
- IEC 61850 Edition 2
- SNTP



Technical data

Sitras MDC PS / HSC / CPU / IO

Supply voltage		[DC]	24...240 V
(Voltage range ±20 %)		[AC]	110...240 V
Inputs / Outputs			
HSC	Tripping output		
	switchable	[V]	200 / 300
CPU	Relay outputs		4
	Digital inputs		8
	Digital outputs		8
	Analog inputs		4
	Analog outputs		2
IO	Digital inputs		16
	Digital outputs		8
Permissible ambient temperature			
Operation		[°C]	-5...+55
Storage, transport		[°C]	-25...+70
Max. humidity (no condensation)*		[%]	95
Degree of protection acc. to IEC 60529:2013			IP20
Dimension without counter plugs (W x H x D)			
Sitras MDC PS		[mm]	46 x 160 x 202
Sitras MDC HSC		[mm]	92 x 160 x 202
Sitras MDC CPU		[mm]	92 x 175 x 202
Sitras MDC IO		[mm]	46 x 160 x 202

* other values on request

Sitras MDC HMI

Permissible ambient temperature*		
Operation	[°C]	0...+50
Storage, transport	[°C]	-20...+60
Max. humidity (no condensation)*	[%]	90
Degree of protection acc. to IEC 60529:2013		
Front		IP65
Rear		IP20
Dimension (W x H x D)	[mm]	214 x 158 x 46

* other values on request

Sitras PRO BA – DC Buffer Amplifier

for nominal voltages	[DC]	600...3000 V
Interfaces		
Analog outputs		3
FO output (connection to central unit)		1
FO inputs, only Sitras PRO BAplus (connection to cable monitoring modules)		2
Permissible ambient temperature		
Operation	[°C]	-5...+60
Storage	[°C]	-40...+70
Max. humidity (no condensation)	[%]	93
Degree of protection acc. to IEC 60529:2013		
Housing		IP40
Terminals		IP00
Dimensions (W x H x D)	[mm]	200 x 123 x 84

Sitras PRO CM – Cable Monitoring Module

for positive nominal voltages	[DC]	600...1500 V
Interfaces		
FO output (connection to DC amplifier		1
Permissible ambient temperature		
Operation	[°C]	-5...+60
Storage	[°C]	-40...+70
Max. humidity (no condensation)	[%]	93
Degree of protection acc. to IEC 60529:2013		
Housing		IP40
Terminals		IP00
Dimensions (W x H x D)	[mm]	100 x 118 x 84

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