

Modular Switchgear Monitoring (MSM)

User Manual



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1. Introduction

1.1. About this document

This manual applies to MSM systems running with CCM firmware version 2.2.4.

For older firmware versions, some of the described features may not be available. To upgrade your system to the most recent firmware please refer to chapter 4.6.11.2.

1.2. About the Modular Switchgear Monitoring (MSM)

The Modular Switchgear Monitoring (MSM) is an add-on system to supervise gas density and circuit breaker timing and wear parameters in all circuit breakers operating at voltages above approx. 50 kV. Also available is disconnecter monitoring with supervising of motor operation time and current RMS, heater monitoring of gas compartments or cubicles, internal arc localization, humidity monitoring of SF₆. It is suitable for all kinds of switchgear layouts and operates independently of existing control and protection devices. The MSM system is applicable for the upgrade of existing substations and new installations.

1.3. How to use the manual

This manual helps you to operate the MSM system in a substation.

Additional warnings, information, and tips are highlighted as follows:



Note: A text highlighted 'Note' contains additional information, hints, and tips.



Caution: A text highlighted 'Caution' contains information on things you should give attention to.



Warning: A text highlighted 'WARNING' contains information on things you should give special attention to.

2. MSM System

2.1. Monitoring features

The Hitachi Energy Modular Switchgear Monitoring system is used to monitor high voltage switchgear with SF₆ / EconiQ gas for insulation and current interruption. It improves the availability of the switchgear by online monitoring of SF₆ / EconiQ density in all gas compartments. SF₆ / EconiQ leakages, which may become critical, are early detected providing enough time to plan and execute countermeasures. The system supports maintenance optimization by automated data collection and forecasting. Therefore, maintenance costs can be reduced.

The SF₆ / EconiQ density data of the switchgear is acquired periodically. The SF₆ / EconiQ density is converted into a temperature compensated pressure at 20°C. The implemented trend algorithm calculates the leakage rate for all connected SF₆ / EconiQ gas compartments. Both, the pressure and leakage rate are displayed on a local web panel (optionally) and in the Web Interface. To access the Web Interface, a PC can be connected to the MSM. In addition, monitoring data is provided using the DNP3 or IEC 61850 protocol (both optionally).

Additional functions of the system are:

- SF₆ / EconiQ gas density acquisition of sensors with 4...20mA output,
- SF₆ gas humidity acquisition of integrated sensors with EIA-485 interface
- SF₆ / EconiQ gas density acquisition of integrated sensors with EIA-485 interface,
- internal arc localization from SF₆ / EconiQ gas density monitoring,
- measurement of mechanical properties of circuit breaker (timings and velocities),
- supervision of circuit breaker accessories
- counter of (fault) operations and calculation of contact wear,
- measurement of disconnecter accessories
- monitoring of heater functionality
- self-supervision of all devices and sensors,
- monitoring data are processed and stored inside the MSM on non-volatile memory and can be exported for detailed analysis (CSV and XLS type),
- System notifications and alerts are reflected in binary output status changes.

MSM is an independent monitoring system that doesn't block or trip any switching devices.

2.2. Hardware components

An MSM system consists of several components which are referenced as 'modules' in the following text. Multiple modules are connected via CAN-Bus on DIN rail. Such a connection of multiple modules is referenced as 'MSM stack'.

An MSM system can consist of multiple stacks which are connected via Ethernet.

2.2.1. Stack Overview

An MSM stack consists of one Control & Communication Module (CCM) and at least one other input module based on a specific application. At maximum, up to 10 different modules can be part of one stack. Figure 2.1 shows the connection scheme of an MSM stack with two Analog Input Modules (AIM) for SF₆ monitoring or an MSM Stack with two Serial Interface Modules (SIM) for SF₆ / EconiQ monitoring. The AIM module can also be used to monitor heaters. A 24 VDC power supply is connected to the CCM.

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All other modules are powered and communicate to the CCM through the MSM CAN-Bus which is integrated into the module housing. Take circuit breaker monitoring & disconnector monitoring for example, 2 Binary Input Modules (BIM) and 3 Fast Analog Input Module (FAIM) can be part of one stack. Figure 2.2 shows the typical connection scheme of an MSM stack with three AIM, one BIM, and three FAIM for SF₆, circuit breaker, and disconnector monitoring. The modules connected to CCM can be customized based on specific requirements from customers.

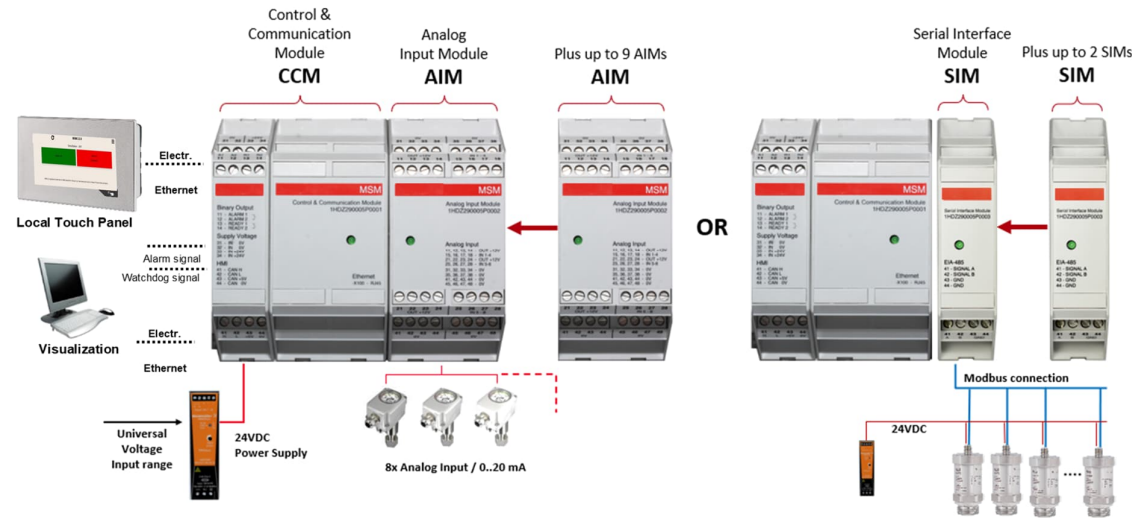


Figure 2.1: MSM stack schematic for gas monitoring

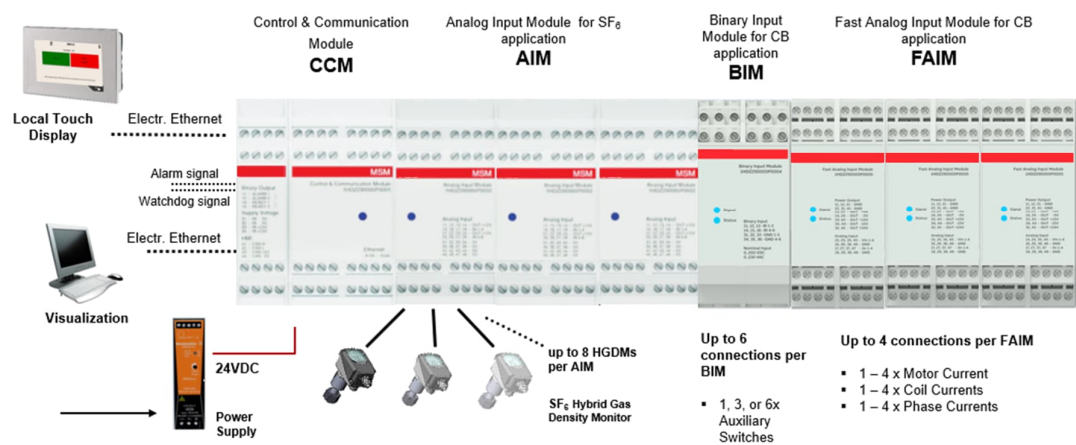


Figure 2.2: MSM stack schematic for gas, circuit breaker, and disconnector monitoring

Table 2.1: Technical data MSM

Technical data – Modular Switchgear Monitoring (MSM) system	
Maximum number of modules per MSM stack	10
Maximum number of MSM stacks	No limit
Operating ambient temperature	-40...+70 °C
Operating temperature LCD display (clearly legible)	-5...+50 °C
Operating temperature touch panel	-20...+60 °C
Protection class	IP 20

2.2.2. Power supply

The MSM system is delivered with a power supply with an input range of 85-264 VAC or 90 – 350 VDC. It feeds the MSM system with 24 VDC.

Depending on the number of installed I/O modules and MSM stacks, the MSM system is delivered with power supplies of different series and power.

Optionally a power supply redundancy module is available.

2.2.3. Control & Communication Module (CCM)

The Control & Communication Module (CCM) contains the main CPU, data storage, and the following communication and user interfaces: Ethernet, two binary outputs, CAN-Bus (to an external display). The CCM collects processing data from all I/O modules which are connected via CAN-Bus. To correctly analyze and visualize monitored data, MSM CCMs are configured individually to the monitored switchgear. The CCM is equipped with a single, green LED which reflects the CCM internal status (see Table 2.4).



Figure 2.3: Control & Communication Module

Table 2.2: Technical data CCM

Technical data – Control & Communication Module (CCM)	
Dimensions W / H / D	79 x 99 x 113 mm
Nominal supply voltage	24 VDC, $\pm 10\%$
Module power consumption	< 6 W
Isolation voltage	Max. 2 kVAC
Communication Ethernet interface	RJ45, 10/100 Mbit/s
Communication protocols	IEC 61850-8-1 (MMS), DNP3.0, SNTP, FTP/SFTP, HTTP
Supervision, Binary Output 1	Alarm/Warning signal
Supervision, Binary Output 2	Watchdog
LED	Device status indication
Displays	Several local displays are connectable

For detailed technical information, refer to the 1HDG838015 MSM - CCM – Datasheet [1]

Table 2.3: Technical data binary outputs CCM

Technical data - Binary outputs CCM	
Rated load	12 A at 250 V _{AC}
	12 A at 24 V _{DC}
Rated carry current	12 A
Max. switching voltage	440 V _{AC} / 300 V _{DC}

Table 2.4: LED blink code of CCM

Module State	Status LED
Booting and initialization	off
Operational	0.5 Hz interval
Alarm blinking	5 Hz interval

2.2.4. Analog Input Module (AIM)

Up to eight analog sensors can be connected to one Analog Input Module (AIM). The AIM accepts sensors that provide a signal in the range of 0...20 mA signal. The exact sensor type is configured during the engineering. The module is shown in Figure 2.4.

The sensor current is sampled with a 10bit resolution and is then sent to the MSM via the CAN-Bus. Connected sensors can be powered with 12 VDC being provided by the AIM. Alternatively, separate power supplies for sensors can be used. The AIM is equipped with a single, green LED which reflects the AIM internal status (see Table 2.6).



Figure 2.4: Analog Input Module

Table 2.5: Technical data AIM

Technical data – Analog Input Module (AIM)	
Dimensions W / H / D	56 x 99 x 113 mm
Module power consumption	< 3 W
Integrated power supply for sensors	12 V _{DC} , 200 mA (short circuit proof)
Isolation voltage	Max. 2 kVAC
Analog inputs (configurable)	8 channels 0...20 mA
Accuracy	± 1% full scale
LED	Device status indication

For detailed technical information, refer to the '1HDG8380616 MSM - AIM – Datasheet [2].

Table 2.6: LED blink code of AIM

Module state	Status LED
Booting and initialization	1 Hz interval
Operational	0.5 Hz interval
Alarm blinking	5 Hz interval

2.2.5. Serial Interface Module (SIM)

The Serial Interface Module (SIM) is designed to integrate sensors and devices supporting EIA-485 interface. It can be used for monitoring of e.g., SF₆ / EconiQ gas parameters in high voltage switchgear. The SIM provides an EIA-485 interface port, including support for Modbus® protocol. The module is shown in Figure 2.5.

The SIM is used as part of the Modular Switchgear Monitoring system (MSM) it can be connected up to 30 EIA-485 Sensors.

All modules are connected automatically to the internal MSM bus by plugging the modules together. The internal MSM bus allows communication between the modules and the CCM. Typically, the DIN rail-mounted MSM modules are located in the local control cubicles close to the switchgear.

The SIM continuously acquires the EIA-485 signals and monitors the connection status. The results are transmitted to the CCM, which analyzes and visualizes measured signals.

The SIM is equipped with a single, green LED which reflects the SIM internal status (see Table 2.8).



Figure 2.5: Serial Interface Module

Table 2.7: Technical data SIM

Technical data – Analog Input Module (AIM)	
Dimensions W / H / D	34 x 99 x 113 mm
Module power consumption	< 1 W
Isolation voltage	Max. 500 VAC
LED	Device status indication

For detailed technical information, refer to the '1HDG8380617 MSM - SIM – Datasheet [3].

Table 2.8: LED blink code of SIM

Module state	Status LED
Booting and initialization	1 Hz interval
Operational	0.5 Hz interval
Alarm blinking	5 Hz interval

2.2.6. Binary Input Module (BIM)

The MSM BIM provides six insulated voltage input channels. Both, AC and DC voltages can be connected to the module. The module is shown in Figure 2.6.

Voltage signals are analyzed with 10'000 samples per second. An event is detected once a configured threshold value is exceeded (upper threshold) or underrun (lower threshold). In a usual configuration, the lower threshold will be 30% and the upper threshold will be 70% of the nominal input voltage. The specific configuration of the modules is documented as part of the system documentation. If configuration changes are required, a new configuration file can be installed using the CCM Web Interface.

The BIM is equipped with two multi-color LEDs. The signal pattern of the LEDs is shown in Table 2.10. Its installation on the DIN rail, removal, and recycling is identically done as for the AIM, sections 6.4.



Figure 2.6: BIM module.


 Warning: arduous voltages can occur on the connectors of the BIM even if the MSM system itself is switched off. Non-observance can result in death, personal injury, or substantial property damage. Only a competent electrician can carry out the electrical installation. National and local electrical safety regulations must always be followed.

Table 2.9: Technical data BIM

Technical data – Binary Input Module (BIM)	
Dimensions W / H / D	56 x 99 x 113 mm
Module power consumption	< 0.1 W
Isolation voltage	Max. 2 kVAC
Binary inputs (configurable)	6 channels 48 to 250 VDC/ 48 to 230 VAC
LED	Device status indication

For detailed technical information, refer to the document 1HDG837033 MSM - BIM -Datasheet [4]

Table 2.10: LED blink codes of BIM

Module state	Status LED	Signal LED
Waiting for initialization	Blue blinking	Off
Module started	Green	Any
Waiting for configuration	Green	Blue Blinking
BIM operation started	Green	Green
Binary input error detected	Green	Red
Bootloader active	Violet	Off
Can bus sync message	Flicker	Any
Event detected	Any	Flicker

2.2.7. Fast Analog Input Module (FAIM)

The Fast Analog Input Module (FAIM) provides 4 analog input ports, each port can accept either 0~20 mA or ± 5 V analog signals, and it provides power supply for external sensors with a voltage level of 24 V, ± 15 V, ± 5 V. The module is shown in Figure 2.7.

Analog signals like coil current, phase current, motor current and travel curve could be recorded with a sampling rate of 10 kHz, together with current sensors (e.g., hall-effect sensor). An event is detected once a configured threshold value is exceeded. The specific configuration of the modules is documented as part of the system documentation. If configuration changes are required, a new configuration file can be installed using the CCM Web Interface.

The FAIM is equipped with two multi-color LEDs. The signal pattern of the LEDs is shown in Table 2.12. Its installation on the DIN rail, removal, and recycling is identically done as for the AIM, sections 6.4.



Figure 2.7: FAIM module

Table 2.11: Technical data FAIM

Technical data – Fast Analog Input Module (FAIM)	
Dimensions W / H / D	56 x 99 x 113 mm
Module power consumption	< 15 W
Integrated power supply for sensors	24 VDC, ± 15 VDC, ± 5 VDC
Isolation voltage	Max. 2 kVAC
Analog inputs (configurable)	4 x ± 5 V / 0 to 20 mA
LED	Device status indication

For detailed technical information, refer to the document 2GHV049550 MSM - FAIM – Datasheet [5]).

Table 2.12: LED blink codes of FAIM

Module state	Status LED	Signal LED
Waiting for initialization	Blue blinking(2s)	Off
Module started	Green	Any
Waiting for configuration	Green	Blue Blinking
Can bus sync message	Flicker	Green
Input signal detected	Green	Flicker

2.2.8. Local touch panel

The local touch panel has a 4.3" display in landscape format. It shows the monitoring data of one specific bay. The touch panel is connected to the CCM via Ethernet and HTTP. The panel resolution is 480 x 272 (WQVGA) in an analog resistive touch screen which is surrounded by an aluminum white pinstripe. The panel has the following Interfaces: 2x Ethernet 10/100 Mbit/s (integrated switch), 2x USB 2.0.

A local touch panel can be used to panel monitored data of one bay and is mounted on the front panel of a bay's Local Control Cubicle (LCC).



Figure 2.8: Local touch panel of MSM

For detailed technical information, refer to the local touch panel manual [12].

2.2.9. Local Display

The local display consists of two components: the communication module (MFD-CP4-CO) and the LC display/operating unit (MFD-80-B).

A local display can be used to display monitored data and is mounted on the front panel of a bay's Local Control Cubicle (LCC). Figure 2.10 shows a schematic illustration of front panel mounting.



Figure 2.9: Local display for MSM (left: front piece, right: back piece)

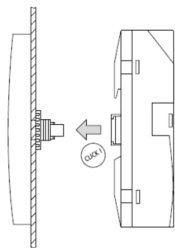


Figure 2.10: Schematic illustration of front panel mounting

The MSM local display features a red LED (alarm), a green LED (operation), a 16x4 character display and navigation keys. The local display is connected to the CCM via CAN-Bus interface. For instructions how to use the local display, refer to chapter 4.9.

For detailed technical information, refer to the local display manuals [8] and [9].

2.3. System architectures

The MSM system could be installed in different architectures: bay-wise, centralized and mixed, depending on specific application or monitoring features. The following paragraphs describe these architectures.

2.3.1. MSM system with bay wise MSM stacks

In bay-wise installations, MSM stacks are installed in every bay cubicle (see Figure 2.11).

All MSM stacks are connected via Ethernet to a central station switch to be able to process the monitored data in a central MicroSCADA or display the data of all stacks on a Web Interface.

The system can be used to monitor the operating mechanisms of single-pole as well as gang-operated breakers. The system architecture for this feature is bay-wise, only (section 2.3.1). To monitor the performance of disconnectors, circuit breakers and operating mechanisms, motor voltage, as well as auxiliary switch NO or NC (indicating the position of the circuit breaker), are connected to BIM. Travel curve, coil current (close coil and open coil), phase current, and motor current are connected to the FAIM.

The Ethernet connection is functionally not required as every bay can be monitored standalone. However, it is strongly recommended to allow:

- Central access to the monitored data,
- Installing updates in parallel to all CCMs,
- User management modifications.

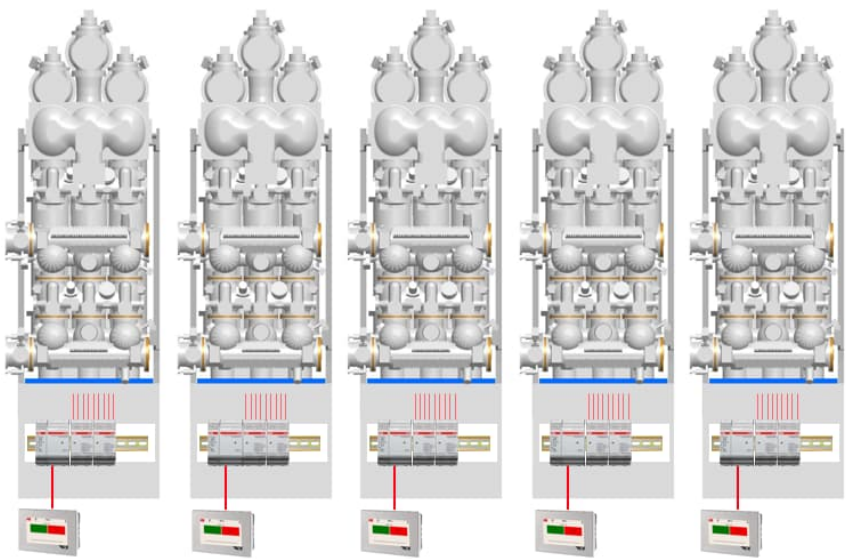


Figure 2.11: Bay-wise MSM system with MSM stack and local touch panel in every bay (example).

2.3.2. Centralized MSM System

At the centralized MSM system, all MSM modules are in one Logical Control Cubicle (LCC). Sensors of all bays are wired to this central LCC and acquired by one or several MSM stacks (see Figure 2.12). The centralized MSM solution is not applicable with circuit breaker and disconnector monitoring.

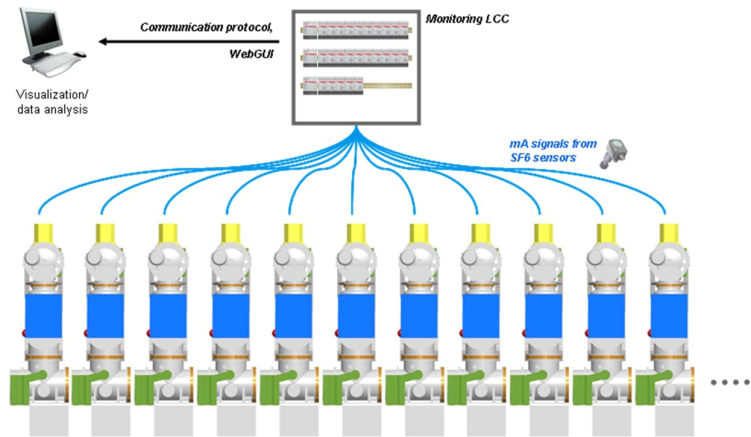


Figure 2.12: Centralized MSM system (example)

2.3.3. Mixed MSM system for 1½ circuit breaker layout

In the case of a 1½ circuit breaker substation layout, it is recommended to use a mixed MSM system structure for every diameter. Because the centrally located LCC provides the most space, the MSM components are usually installed therein. The 1½ circuit breaker MSM solution is not applicable with circuit breaker and disconnector monitoring.

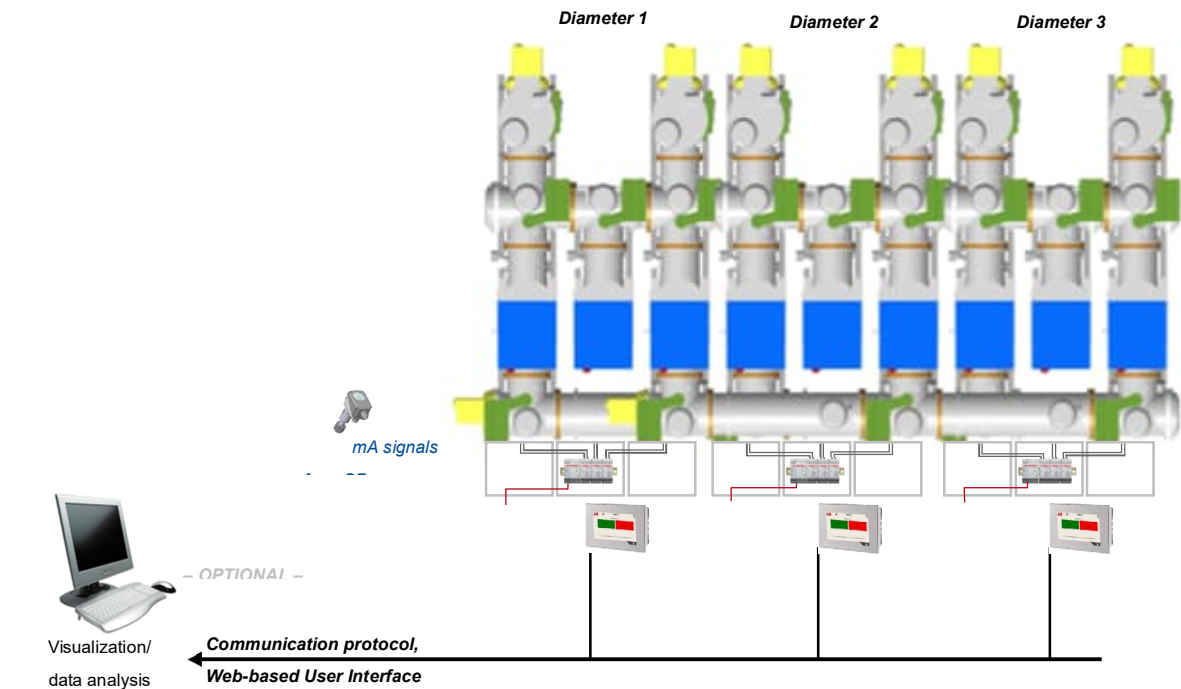


Figure 2.13: Mixed MSM system for 1½ circuit breaker layout (example with 3 diameters)

2.4. Station network overview

2.4.1. Scope of MSM supply

Figure 2.14 shows an MSM station network architecture example, where MSM is installed bay-wise at two bays. MSM stacks are connected to the required MSM network switch, which is connected to the station switch. On this optionally a gateway router for remote access and a time server (see paragraph 2.4.2) can be connected. Figure 2.14 also shows the scope of supply of the MSM components.

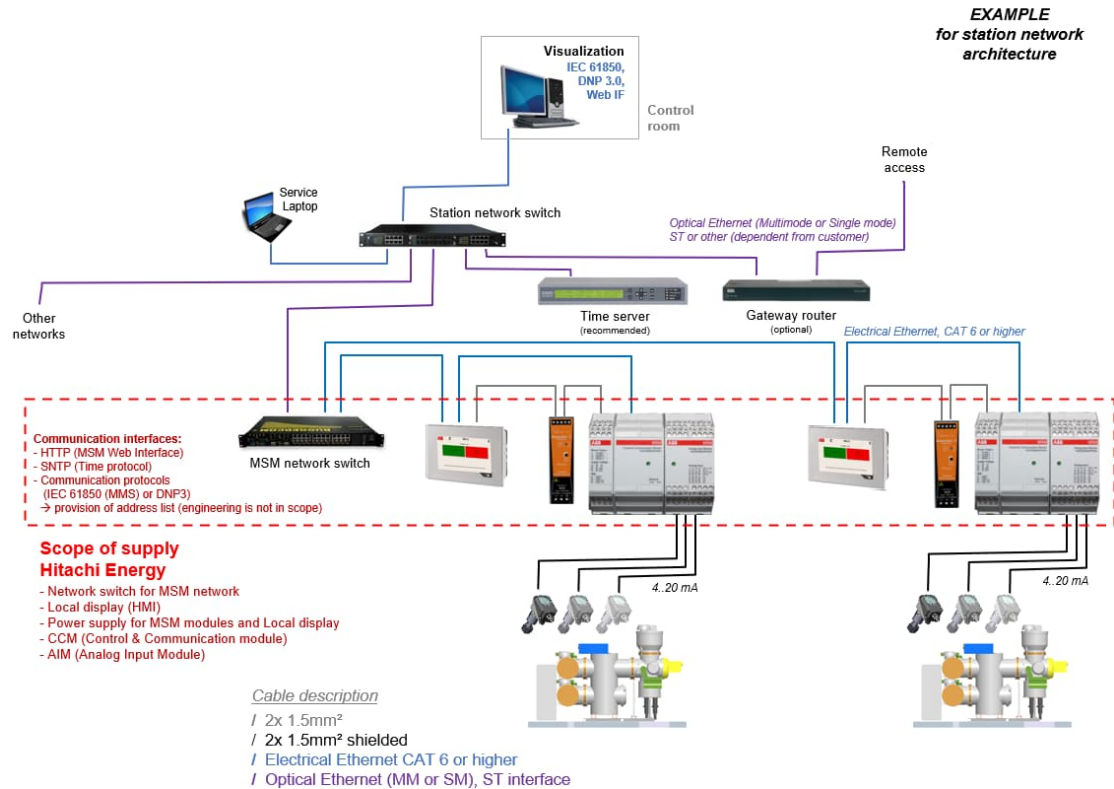


Figure 2.14: Station network architecture (example)

2.4.2. Time server integration (SNTP)

For time synchronization of all components, the integration of a time server is recommended.

MSM provides the possibility for time synchronization via Ethernet with SNTP (Simple Network Time Protocol) and so every CCM can receive the time information from the SNTP time server.

For configuration of the MSM, the IP address of the time server must be integrated, which is done during the engineering.

2.4.3. Configuration of network switch

Please refer to Chapter 3.9.1.

3. Network Interface

3.1. Certificate handling

CCM generates a public and private key after the first startup. These key pairs are used for encryption. Certificates are not implemented.

3.2. Network services

According to the configuration of MSM, some services are activated or disabled. At the Web Interface there is an overview of active services (see 0). MSM provides several encryption algorithms for the following services:

SNTP

An SNTP client is integrated into MSM. The clock of the MSM can be set by this service. An SNTP server sends the time to MSM and the MSM update the system time. This server can be activated by the configuration.

HTTP

An HTTP server is integrated into MSM. The server provides a user-friendly user interface that serves as a central interface for data visualization, updates, etc. Users need to authenticate themselves to get access to this interface.

Encryption algorithms:

The web server provides digest authentication for username and user password transfer. HTTPS is not supported.

SSH

An SSH server is integrated into MSM and supports SSH V1 and V2. The server provides an encrypted remote command line. An SSH client can connect to the server to get access to the command line. The user must authenticate, and the user gets a server authentication. The interface is not required for normal MSM operation.

Encryption algorithms:

3DES, AES, Blowfish, CAST, DES, MD5, MD5-96, RC4, RC4-128, SHA1, SHA1-96

SFTP

An SFTP server is integrated into MSM. The server provides encrypted remote file system access. An SFTP client can connect to the server to get access to the file system. The user must authenticate, and the user gets a server authentication. The interface is not needed for normal operation.

Encryption algorithms:

3DES, AES, Blowfish, CAST, DES, MD5, MD5-96, RC4, RC4-128, SHA1, SHA1-96

3.3. IEC61850

An IEC61850 MMS server is integrated into MSM. The server needs to be activated in the configuration file. It provides all measured and calculated values of MSM. An IEC61850 client can connect to the server to receive the data. A detailed description of the IEC61850 interface is given in *1HDG818022 - MSM IEC61850 Communication Description for MSM [6]*.

3.4. DNP3

A DNP3 slave is integrated into MSM. The slave needs to be activated in the configuration file. It provides all measured and calculated values of MSM. A DNP3 master can connect to the slave to receive the data. A detailed description of the DNP3 interface is given in *1HDG818026 - MSM DNP3.0 Communication Description for MSM [7]*.

3.5. MQTT(s)

A MQTT client is integrated into MSM. The client provides all measured and calculated values of MSM. Via an MQTT broker, the data can be received. A signal list can be exported from MCT.

3.6. OPC UA

An OPC UA client is used for communication with an optional local HMI/web panel.

3.7. Ports

Every active service provides a port for communication. According to the function of MSM, the port is open to get data from the other device.

Table 3.1: Network ports

Service	Port	Status
HTTP	80/TCP	always opened
SSH	22/TCP	always opened
SFTP	22/TCP	opened if configured
IEC61850	102/TCP	opened if configured
SNTP	123/UDP	opened if configured
DNP3	20000/TCP	opened if configured
OPC UA	4840	opened if configured
MQTT(s)	8883/TCP	opened if configured

3.8. Connect to the MSM

3.8.1. Local network structure

Following the network structure, as shown in Figure 3.1, MSM stacks can be managed centrally using one PC and linking it to one CCM. This includes central firmware and configuration updates, central data download, and a complete, dynamic gas scheme of the substation in the Web Interface.

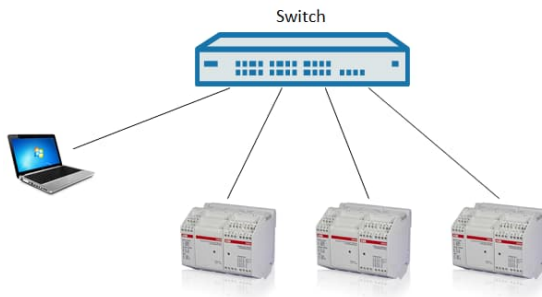


Figure 3.1: Network structure overview



Caution: The MSM system is not designed to be directly internet-facing. Thus, only connections to a local Intranet are allowed.

3.8.2. Network communication test

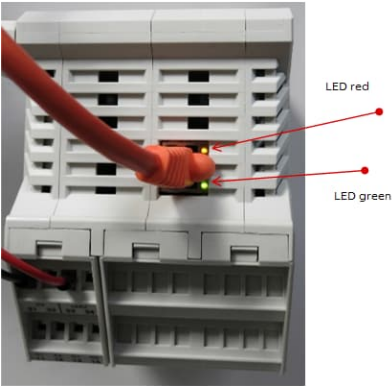


Figure 3.2: CCM network LEDs

To check proper network communication, plug the network cable into a laptop and the CCM. The LEDs in Figure 3.2 indicate the network status.

Table 3.2: CCM network LEDs

Green	OFF	Network speed 10 Mbit/s
	ON	Network speed 100 Mbit/s
Red	OFF	No connect with the network
	ON	Connect with the network
	FLASH	Communication between CCM and Switch or PC

3.8.3. PC Network settings

Your PC needs a network address in the same IP-range as the MSM system.

E.g., on the label of the CCMs the following network addresses are printed:

IP: 172.16.1.11 Subnet mask: 255.255.0.0



Note: IP Addresses of CCMs can be found on a label attached to the left side of the CCM

Check range of all delivered or connected CCM

IP Range: 172.16.1.11 – 172.16.1.16

Subnet mask: 255.255.0.0

Give your PC an IP address in the range:

IP: 172.16.1.1 - 172.16.1.254 that is not used by the CCMs

Subnet mask: 255.255.0.0

E.g., IP: 172.16.1.5 Subnet mask: 255.255.0.0



Note: The PC must have the same Subnet mask address as the MSM system.



Note: Do not use the same IP Address for PC and CCMs.

3.8.4. Change the IP-Address in Windows

Here take Windows 10 system as example, please contact MSM support team if problem is encountered on other windows system.

Press the Windows key

Enter “netw”

Select “Network and Sharing Center”

Or: Start Button->Control Panel-> Network and Internet -> Network and Sharing Center

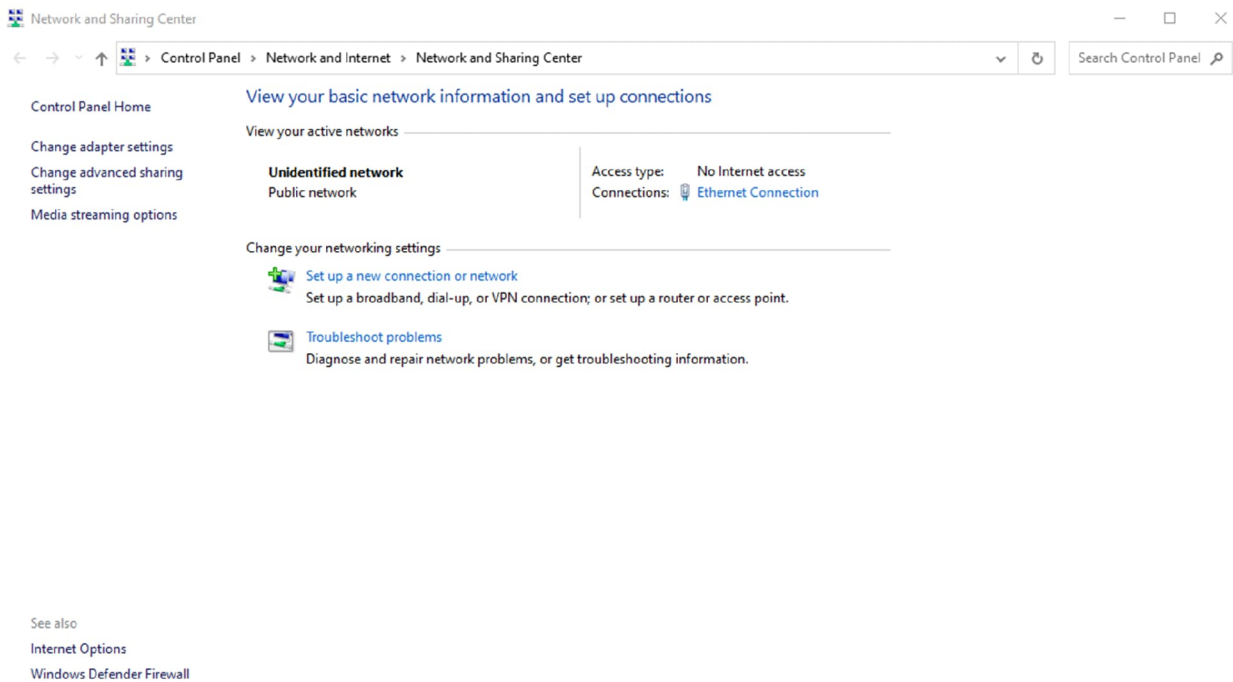


Figure 3.3: Network and Sharing Center

Select “Ethernet Connection” (The name of this ethernet connection can be different depending on customer’s equipment)

Then click on “Properties” following window will open

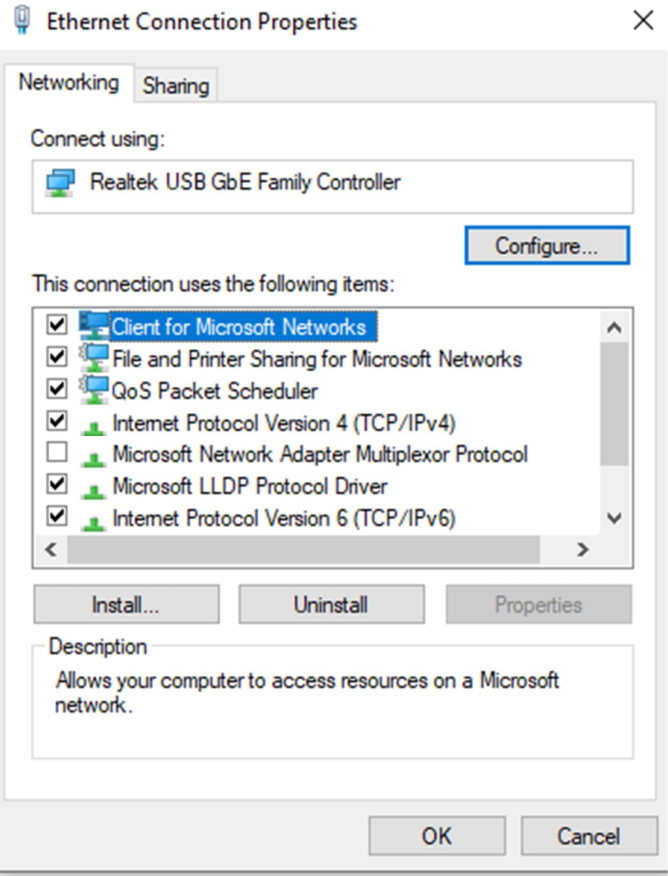


Figure 3.4: Ethernet connection properties

Select "Internet Protocol Version 4 (TCP/IPv4)"

Click on "Properties"

Set IP Address and Subnet mask as chosen for the PC

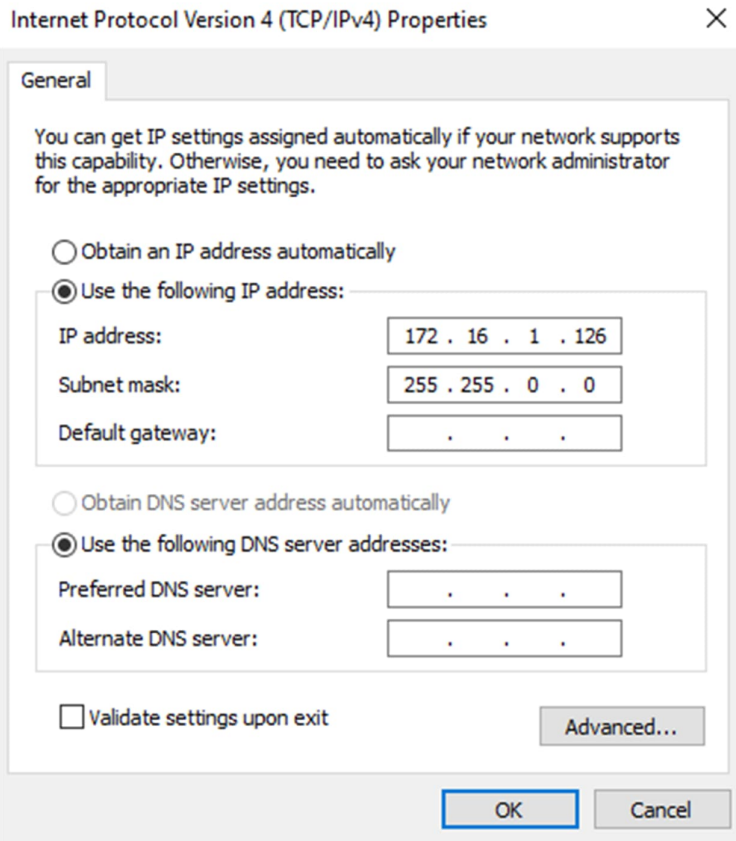


Figure 3.5: Internet Protocol Version 4 (TCP/IPv4)

3.8.5. Connect to the web user interface

Open the Web browser(e.g., Ms Edge) and insert the IP address from one of the CCMs.

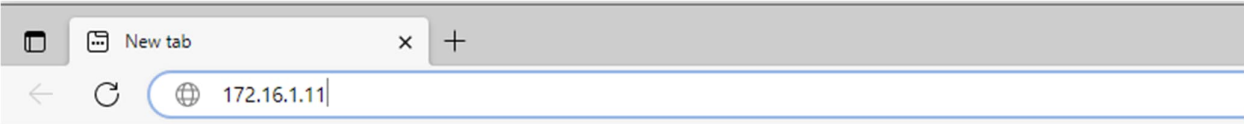



Figure 3.6: Enter the IP address to the browser

The MSM system has factory adjusted a default user and a default IP configuration.

User: admin Password: abb

 Caution: Ask the user to change this account's username and password.

If not specified differently, the IP address of the first CCM is configured to 172.16.1.11.

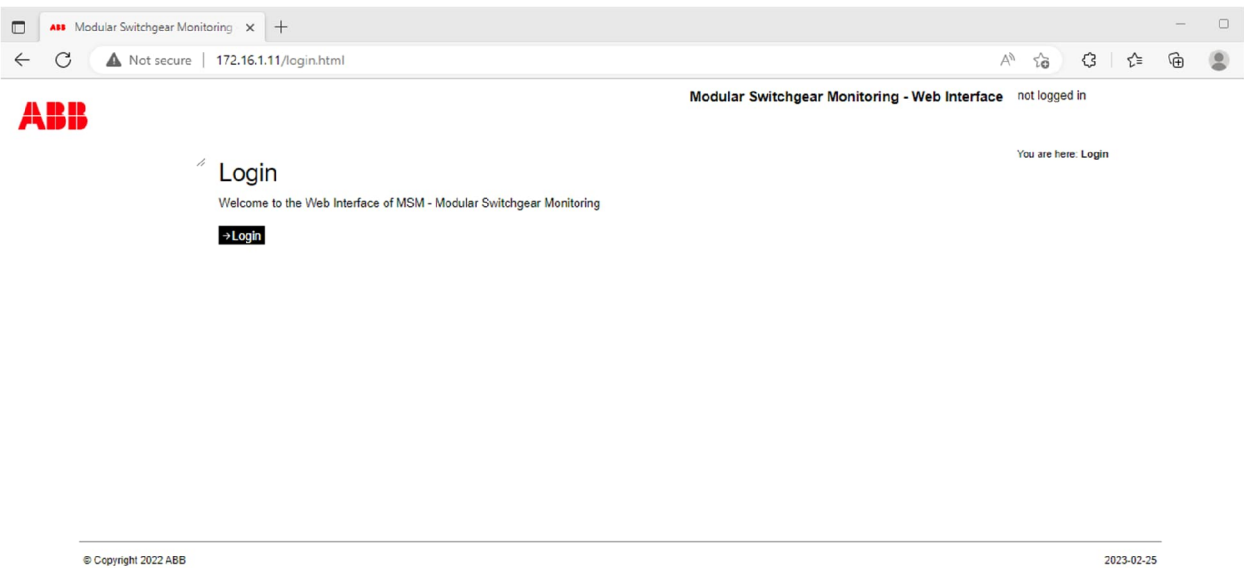


Figure 3.7: Login page

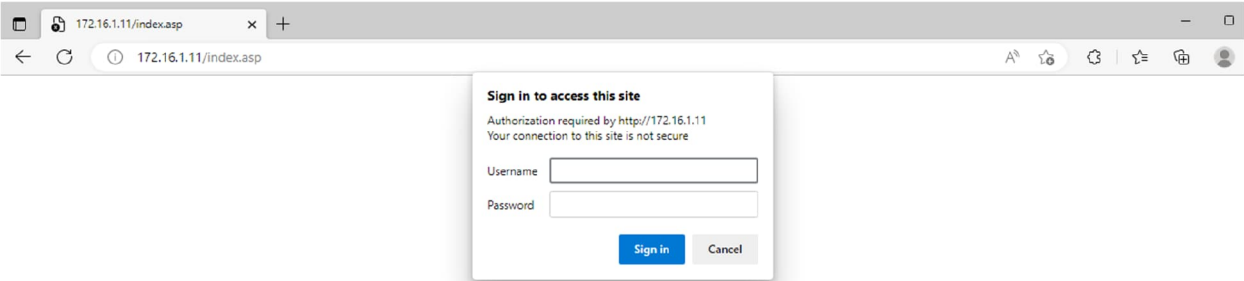


Figure 3.8: Enter default account data

Sign in to access this site

Authorization required by http://172.16.1.11

Your connection to this site is not secure

Username

admin

Password

...

Sign in

Cancel

Figure 3.9: Username and password

ABB

Modular Switchgear Monitoring - Web Interface

Time Standard: Local Time

User: admin

Logout

demostation

bay01

B200

bay02

B200

Event List

Service

System Info

System Report

Commissioning

System Time

CB Maintenance

Update

Equipment

CCM1

GUI Settings

User Management

Add User

Edit User

Delete User

Home

Welcome to the Web Interface of MSM - Modular Switchgear Monitoring

Station name: demostation

Station status: OK

MSM connection status: OK

You are here: Home

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2.2.4

Figure 3.10: The Screen after successful login

3.9. Cybersecurity deployment measures

3.9.1. Port limitation on the switch

An open port does not immediately mean a security issue. But for attackers, it can provide a pathway to the connected system. Therefore, it is recommended to use the rate limiter inside the switch which connects to MSM. The settings for the rate limiter are given in Table 3.3:

Table 3.3: Rate limiter settings

Ingress (all communication modes)	Egress (all communication modes)
Port at which MSM gets connected: 4106 pps (50Mbit/s) Rest of the ports: 74 pps (900 Kbit/s)	Nothing to set
Note: pps stands for packets per second	

3.9.2. Security hardening

End users are advised to deploy these cybersecurity operational measures to enhance the cybersecurity defense and posture of MSM system.

- 1) Use any state of the art. web browsers equipped with cross-site-scripting protection. Enable this feature on those web browsers.
- 2) As much as possible, patch the web browsers and PC environments from where MSM are intended to be accessed.
- 3) Not consider unsolicited emails and do not click weblinks from unknown sources that pretends to claim for any aspect surrounding around MSM. Always check the source (senders) email address of such type of emails to verify their authenticity.
- 4) Use antivirus protection on PC environments from where MSM are intended to be accessed.
- 5) Please do not directly connect MSM with internet. Adopt network segregation measures such as by deploying DMZs between operational network (where MSM system is intended to be deployed) and enterprise network.

Currently, MSM operates on two insecure interfaces namely, HTTP and on the OPC-UA interface. Therefore, end users are recommended to deploy compensating controls such as DMZs or VLAN on the switches.

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4. Operation

4.1. Monitoring application

As a fully automatic system, the MSM needs to compromise between reaction speed and measuring accuracy: a more accurate leakage rate measurement will require more time and thus slow down the reaction speed of the system on leakages. The applied algorithms reflect a compromise between both targets. For this reason, a manual data review is recommended when the system triggers a gas warning (see section 5.1) to ultimately exclude a false alarm and to more precisely quantify a leakage. Used in this way, the MSM system provides early identification of gas leakages and allows enough time to plan and conduct gas-related maintenance activities.

4.2. Gas monitoring basics

In theory, gas leakages can be identified by measuring the gas pressure of a given gas compartment at an identical temperature at two different points in time. The pressure difference divided by the time difference provides the leakage rate of the gas compartment. Practically, the pressure measurement is distorted due to non-laboratory measurement conditions, in particular temperature variations and temperature gradients, Figure 4.1.

Usually, gas monitoring is done with pressure or density sensors which are temperature compensated. There are limitations to this compensation: It applies only to the temperature at the sensor point. Due to external as well as internal effects, e.g., environmental temperature or varying loads on the primary conductor, temperature gradients within the gas compartment as well as between the sensor and the gas compartment can occur. Consequently, even for gas compartments without leakage varying temperature compensated pressures are measured. Instead of interpreting such variations as leakage and triggering an alarm, algorithms are applied that check the persistence of the trend and have a smoothing effect on the signal, Figure 4.2.

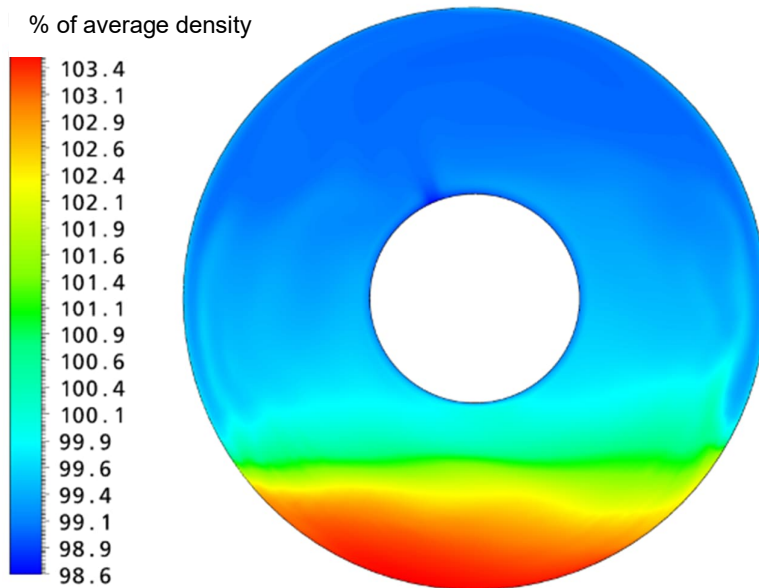


Figure 4.1: Calculated SF₆ density distribution for a horizontal GIS bus bar.

Note to figure: Red color corresponds to a high density, blue color to a low density. The density distribution is caused by a temperature distribution and cannot be corrected for by the sensor, which measures the density at a certain spot. Consequently, the primary load can impact the density measurement.

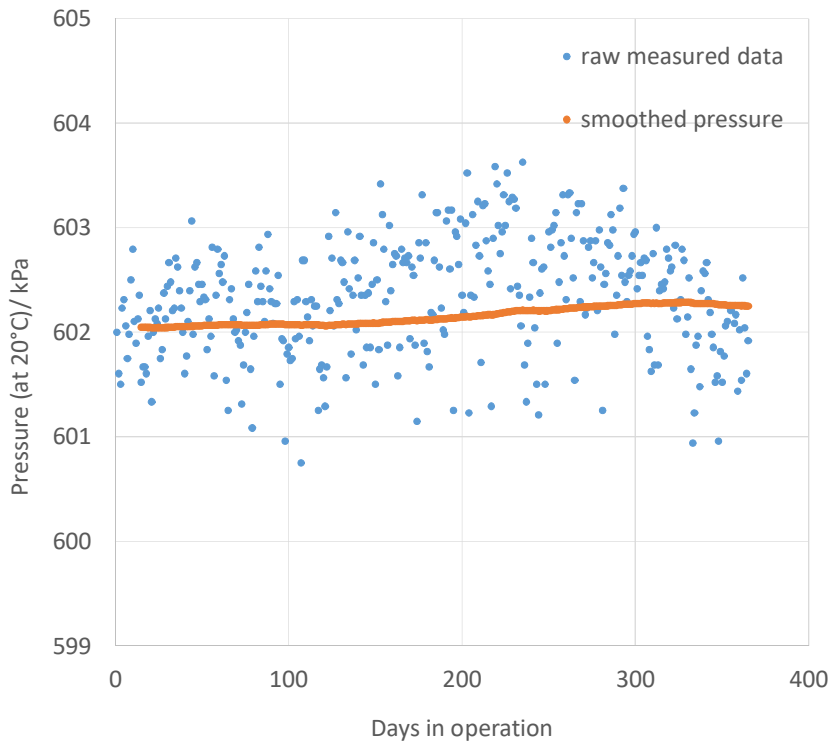


Figure 4.2: Measured pressure in a GIS gas compartment(blue data points) and output of the smoothing algorithm (orange line).

4.2.1. MSM leakage rate algorithm

The algorithm compares a smoothed pressure signal on one day with the smoothed pressure signal from the previous day. The difference between the two smoothed pressure signals on consecutive days is converted into a relative leakage rate with the unit *%/year*. After commissioning or after resetting the trend calculation, the algorithm collects data for 15 days before providing an output. During this period, no leakage rate alarms will be triggered. This period restarts if data is missing. After this period, the calculated rate will converge against the real leakage starting from a lower level, see Figure 4.6. This process takes several months. If the leakage rate is above 1.6%/year, the MSM system will trigger an alarm before the calculation converged to the real leak rate, see Figure 4.7.

Signal smoothing reduces the likelihood of false warnings triggered by the monitoring system. However, it extends the reaction time until leakage is detected. To quickly react to large leakages, e.g., with rates of 100%/year and higher, the MSM system also monitors the pressure and will trigger a warning at the predefined threshold, see Table 5.1.






Note: In presence of leakages approximately larger than 500 %/year, conventional density switches may trigger a warning earlier than MSM. This is caused by manufacturing tolerances of the density switch and measuring accuracy of both items, MSM and the switch.

4.2.2. MSM Humidity Monitoring

Gas humidity is an important indicator for the insulation and arc extinguishing performance of SF₆ insulated switchgear. With the presence of humidity, the primary and secondary by-products during a current interruption in SF₆ atmosphere may form corrosive electrolytes which may damage some of the materials used inside the equipment (e.g., glass and insulation paper). Humidity refers to the water vapor within the SF₆ gas and is expressed in terms of volume ratio (ppmv, numerically equivalent to uL/L). Once it is determined, the expression either ppmv or uL/L has no further pressure dependence and is also independent of the gas type or mixture.




The MSM measures and stores current humidity readings. A warning is triggered if humidity exceeds the configured level (fixed level following IEC 60480-2019 or temperature-dependent level following Chinese standard DL/T 506-2018).

-  Note: Measuring humidity in a static gas is challenging as humidity is not evenly distributed in a gas compartment. After sensor installation, the sensor readings will be too high as the initially local environment of the sensor has higher humidity than the full gas compartment. It takes sensors readings a few days to weeks to drop to the real level.
-  Note: “Humidity Reset” (see chapter 4.2.5) is required after sensor installation or replacement which suppresses warnings for humidity readings in the initial phase with too high measurements.
-  Note: If gas handling (e.g. via sensor with T-piece) increases humidity reading importantly, “Humidity Reset” (see chapter 4.2.5) is required to suppress warnings for humidity readings in phase with too high measurements.

4.2.3. Trend algorithm

The trend algorithm calculates the number of days before the stage 1 / stage 2 pressure level will be reached. The calculation uses the leakage rate described above. It is only correct if the real leakage rate is constant and if the calculated leakage rate has fully converged to the real one. Otherwise, the forecasted period is unstable and stage 1 / stage 2 conditions are likely reached earlier. For this reason, it is recommended to review the actual measured pressure and its history when a *time to stage 1 / stage 2* warning is triggered (see chapter 5)

The MSM trend algorithm is designed to automatically cope with missing data, pressure jumps, and seasonal compensation. To work best, the MSM system needs to be online all the time. If some data readings are missing (e.g., system shutdown or sensor issues), the system automatically corrects or initiates a trend reset to reduce wrong output.

-  Note: After automatic and manual trend reset 15 days of consecutive data are required for an initial leakage rate output. While waiting for the data, no leakage rate value is shown, and the leakage rate history chart shows a message “No data for history chart available”.
- Jumps of the pressure reading (e.g., due to gas handling) can distort a trending algorithm. To avoid this, the MSM system automatically detects jumps of pressure and corrects these values for trend calculation. For very large jumps (e.g., sensor removal) a trend reset is automatically triggered.
-  Note: If a “jump candidate” is detected, the MSM trend algorithm freezes the leakage rate output for a few days until a stable pressure signal is reached. If no stable pressure signal is reached, an alternative calculation method is activated after 30 days.
 -  Note: In contrast to previous MSM versions, gas handling does not require a trend reset anymore. Nevertheless, it is recommended to do a trend reset (see chapter 4.2.4) at the end of commissioning, after repair of a leak and after sensor replacement as this increases accuracy (more details in 4.2.6).

Especially in outdoor installations, the compensated gas pressure can be influenced by seasonality. This influence can be compensated to increase the accuracy of the calculated leakage rate. Starting in the 2nd year MSM trend algorithm once a year checks if such seasonal behavior is present in historic data and automatically activates/deactivates the seasonal compensation.

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Note: For outdoor gas compartments seasonal compensation will be activated after the first year (if configured).



Note: After activation of seasonal compensation a trend reset is triggered. This pauses leakage rate output. 15 days of consecutive data are required for the next leakage rate output.

4.2.4. Reset gas leakage trend

There are two different types of gas leakage trend reset and the humidity calculation reset (only available if it is configured).

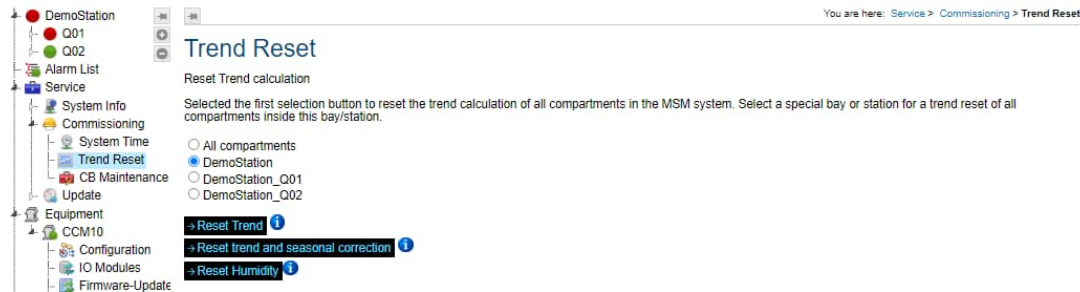


Figure 4.3: Trend Reset via Service Menu

1. Reset trend

This is the regular type of trend reset. It restarts the leakage analysis without using previous data. The information about seasonal variations in the specific gas space is still retained.

2. Reset trend and compensation

This type of reset performs the same action as the regular trend reset. In addition, it includes a reset of the seasonal compensation parameters. It is required when the system is put into operation.

The trend must be reset:

- during commissioning, when the sensor is ready for use and the gas compartment has the nominal gas level (Reset trend and seasonal correction)
- after gas filling with the repair of a leak (reset trend)
- after a leak has been repaired without refilling (i.e., with low gas loss) (reset trend)
- after a sensor has been replaced (reset trend)

The trend can be reset for a single or several gas compartments (see Figure 4.3) or directly for a single gas compartment in the gas compartment overview (see Figure 4.4).

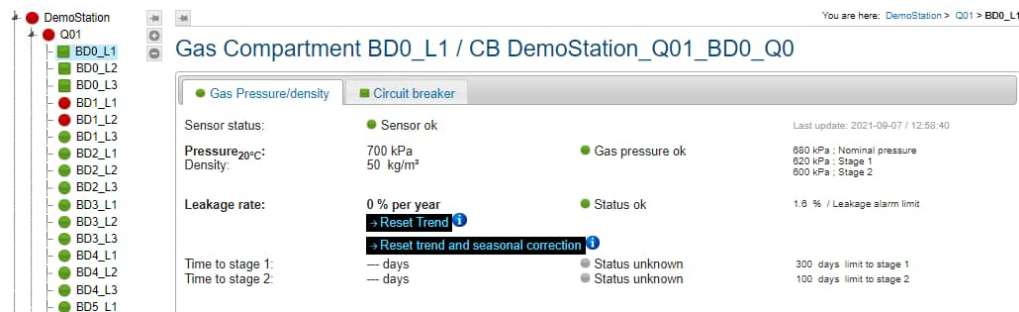


Figure 4.4: Gas trend reset for a gas compartment individual

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Note: Parameter reset cannot be undone. If you are not sure, what parameter reset should be done, please refer to the info-field, the manual, or MSM support. Parameter reset does not affect the 24 h mean values being collected in the past.

4.2.5. Reset humidity

The humidity calculation will be restarted and reset with “Reset Humidity”. The history data (24 h mean values) will remain. After a humidity reset, warnings and alarms on the humidity reading are disabled for up to 6 weeks to allow sensor reading stability. A humidity reset is recommended:

- After sensor replacement or
- Gas handling importantly increases sensor readings.

The humidity calculation can be reset for a single or several gas compartments (see Figure 4.3) or directly for a single gas compartment in the gas compartment overview (see Figure 4.4).



Note: Parameter reset cannot be undone. If you are not sure, what parameter reset should be done, please refer to the info-field, the manual, or MSM support. Parameter reset does not affect the 24 h mean values being collected in the past

Gas Compartment BD0 / CB Q0

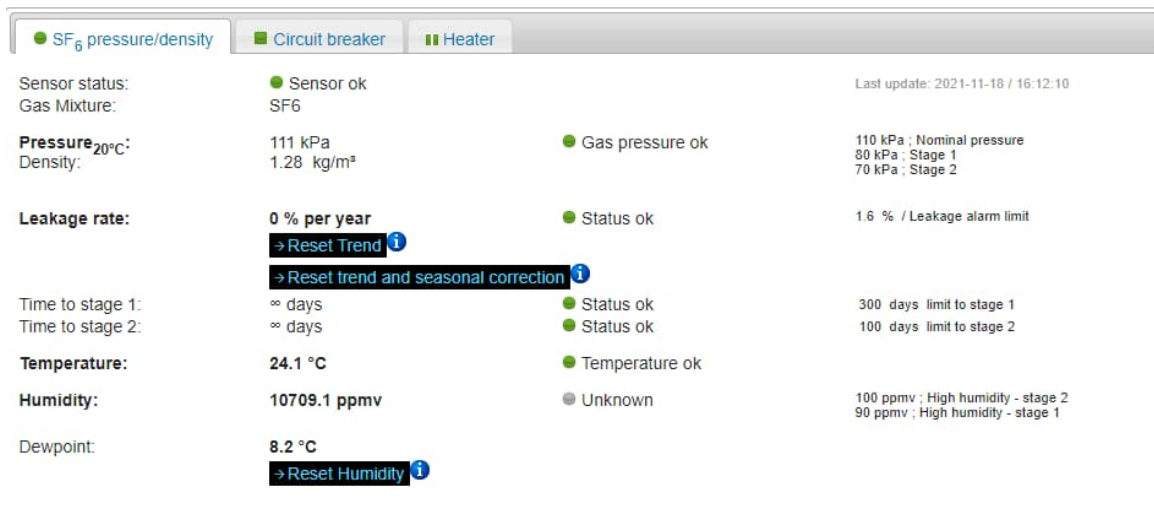


Figure 4.5: Humidity reset for a gas compartment individually

4.2.6. System accuracy

High-end SF₆ or EconiQ pressure/density sensor manufacturers promise 1 % typical accuracy full-scale (FS) and a maximum error of 1.8 % FS. The nature of this error may comprise offset error, gain error and/or drift. While all these errors contribute to the accuracy of the pressure/density measurement, their impact on the leak rate calculation differs:

Gain errors have no impact on relative leak rate calculation because they drop out of the equations

Offset errors have little impact on relative leak rate calculation because any offset will be much smaller than the measured pressure and thus, they become a negligible component in the equations.

Drift errors would be very difficult to distinguish from a gradual gas density change. For this reason, Hitachi Energy utilizes sensors that are like a quartz-watch to a large extent drift-free.

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Total effects of errors arising from sensor accuracy are significantly smaller than the ones imposed by temperature gradients (see next paragraph).

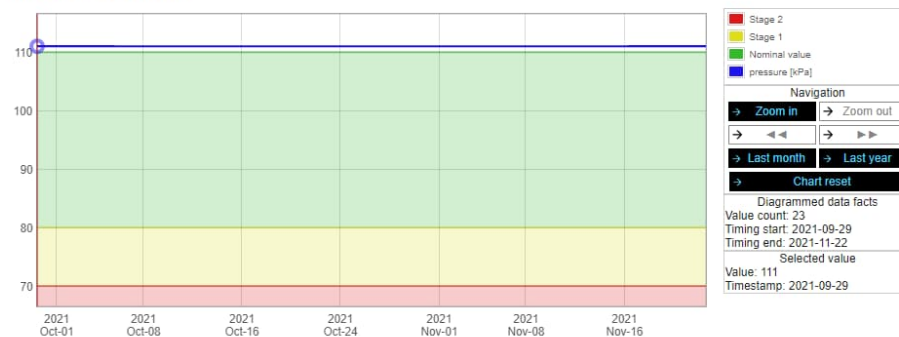
Special challenges are variable temperature gradients within the gas compartment driven by both external environmental changes and load current cycles. Temperature gradients introduce a discrepancy between the density at the sensing point and the average gas density, adding further error to the collected data (see Figure 4.1). Special algorithms seek to eliminate this effect and are quite effective in case of radial temperature gradients caused by seasonal ambient temperature and load variations. This algorithm will require 13 months of data before compensation of seasonal variation starts. Even after this period, the compensation will be limited to the stable component of seasonal variation and will not correct year-to-year variation.

In summary, the accuracy of the system is largely impacted by temperature and load variations which differ from installation to installation. Given enough data, periodic variations can be corrected whereas erratic variations remain a source of inaccuracy. Historic data reflects the strength and frequency of these variations and can be used to estimate the accuracy of the system manually. When delivered, MSM alarm thresholds are set at a level where false alarms are very unlikely. If a leakage rate for a specific gas compartment is below the alarm level but above a level that is acceptable for the user, it is recommended to manually review the data to estimate signal distortion (see description in section 5.1).



Note: Hybrid sensors which have a conventional density gauge and an electronic sensor, pressure readings from both meters will differ within the combined accuracy level of both sensor types. For Trafag hybrid sensors, a difference of up to 3% between the conventional gauge and the MSM pressure can occur in a normal operating system.

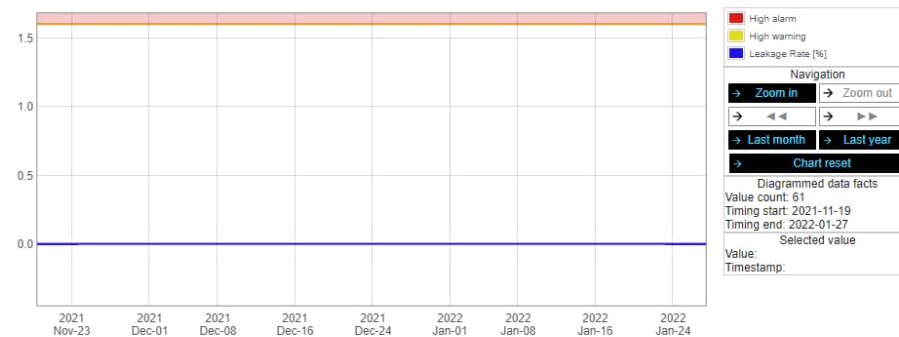
Pressure History Chart



→ Show all available data

Download chart data (for gas compartment 'DemoStation_Q01_BD0')

Leakage Rate History Chart



→ Show all available data

Download chart data (for gas compartment 'DemoStation_Q01_BD0')

Figure 4.6: Exemplary pressure and leakage rate measurement by MSM system.

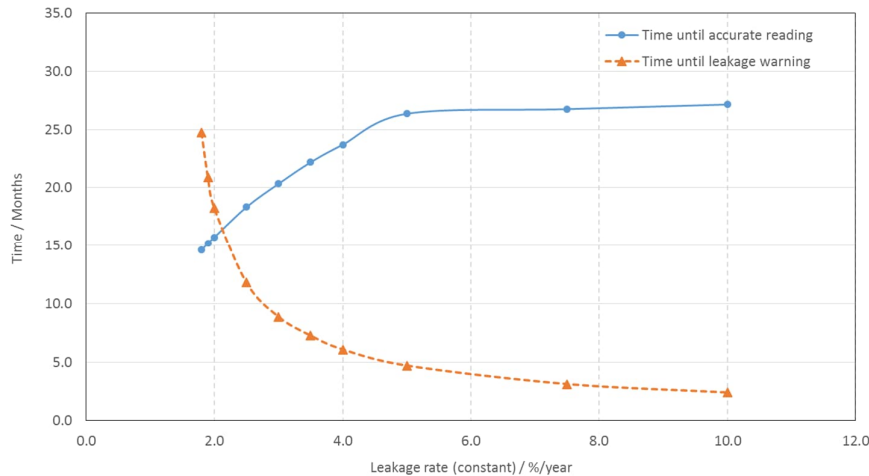


Figure 4.7: Calculated time until the leakage rate algorithm provides an accurate output (blue, accurate: ± 0.5 %/year accuracy up to 5 %/year real leakage rate, 10 % of the real leakage rate for rates above 5 %/year) and calculated time until the warning will occur (orange). The model calculation assumes a suddenly occurring leakage with a constant rate (x-axis) and no distortions on the signal. For leakages above 2.1 %/year, the MSM warning will be triggered before accurate measurement of the leakage rate. *Example:* A leakage rate of 6 %/year will be measured with an accuracy level of ± 0.6 %/year within 26 months. The warning will be triggered earlier, i.e., 4 months after the occurrence of the leakage. The event list of MSM web interface. With pre-configured types of gas compartment, the event is as information for an active compartment (i.p. CB) or alarm for passive compartment (e.g. VT, GIB/GIL). When arc is detected in active compartment, “SwArcDet” Data Object of SARC Logical node is published in IEC61850 and when arc is detected in passive compartment, “FADet” Data Object of SARC Logical node is published.

The sensitivity of the system depends on the volume of the compartment and the amplitude and duration of the fault current. The internal arc fault detection algorithm requires a pressure change of at least 5 kPa (default step size) to register an internal arc, which corresponds approximately to a minimum detected current limite of 1kA, considering 5000L gas volume and 1s arcing time (assuming an arc voltage of 500V).



Warning: The internal arc localization feature is not designed to be integrated in or to active the protection system.



Note: MSM does not distinguish a planned arc (generated by load current interruption) from a fault arc (caused by internal dielectric failure) for circuit breaker due to the limitation of time resolution. Therefore an information is visualized on web UI to record the event and avoid possible false alarm. For a passive compartment where an arc will not show in normal operation, an alarm will be generated instantly once an arc is detected.



Note: It is possible to reduce the threshold to improve the sensitivity of the system to detect lower internal arc fault currents or to detect internal arc faults in larger gas compartments. The main limitation of the sensitivity is noise in the pressure signal—if the noise level exceeds the threshold, then reliable detection of internal arcs is no longer possible. For most practical applications in GIS, a threshold of 5 kPa should be sufficient.

4.3. Circuit breaker monitoring functionality

Using the MSM Binary Input Module (BIM) and Fast Analog Input Module (FAIM) as part of an MSM stack, the MSM system can monitor the mechanical quality of your circuit breakers. This chapter describes the additional hardware as well as the monitoring features. The relevance of specific monitoring parameters differs with the technology of the

operating mechanism. This manual considers circuit breakers with hydromechanical or spring-spring mechanisms. The MSM system can be used to monitor the operating mechanisms of single-pole as well as gang-operated breakers. The system architecture for this feature is bay-wise, only (section 2.3.1).

To monitor the performance of circuit breakers and operating mechanisms, motor voltage, as well as auxiliary switch NO or NC (indicating the position of the circuit breaker), BIM module will be used. To monitoring of Coil current (close coil, both primary trip coil and secondary trip coil), phase current, motor current and travel curve, FAIM module will be used. The monitoring parameters are categorized by subsystems. The subsystems are as follows:

4.3.1. Accessory

Unforced motor starts per day: In hydromechanical systems, e.g., operating mechanism HMB, the number of motor starts without preceding circuit breaker operation per day reflects the integrity of the hydraulic system. A high number indicates a leakage in the high-pressure region of the hydraulic system. Compared to spring-spring mechanisms, it's a unique monitoring opportunity providing condition-relevant information even if the breaker is not operated. The counter is increased by one, if the motor is energized although the auxiliary switch didn't change its status in the previous 10 minutes.

Motor running time: For the hydromechanical mechanism, the motor running time reflects the efficiency of the motor. For identical breaker operations, e.g., close operation, an increase of runtime at the same supply voltage indicates a lower pump efficiency. In the spring-spring mechanism, the motor running time reflects the efficiency of the spring charging mechanism. To suppress wrong measurements, the measured motor running time must be within the interval of 0.1 s (minimum) and 300 s (maximum). Runtimes below or above this interval are considered incorrect measurements and ignored for analysis.

Total motor starts: The total number of motor starts indicates the total workload of your mechanism. For the spring-spring mechanism, it corresponds to the total number of breaker operations. For hydromechanical mechanisms subtraction of unforced motor starts gives an approximation of the total number of breaker operations. The counter is increased by one if the motor is energized.

Last motor running time after close operation: As the name suggests, it is the latest motor running time (as described above in "Motor running time") following a close operation. The spring of a circuit breaker shall be charged within a specified time after a close operation. Long spring charging time indicates possible motor failure or higher friction forces with a mechanical linkage. A shorter recharging time may be attributed to a lower spring constant. In both cases, it needs attention for circuit breaker maintenance. The acceptable range of the measured value is the same as the motor running time above in "Motor running time".

Last motor running time without operation: In hydromechanical systems, e.g., operating mechanism HMB, the motor running time without preceding circuit breaker operation reflects the integrity of the hydraulic system, together with unforced motor starts per day (as described above in "Motor running time"). It should be within a specified time; any deviation of the specified time indicates possible failure of the operating mechanism that needs immediate attention (e.g., serious leakage). The parameter is only applicable to the hydromechanical system.

Peak motor current: The peak motor current is the maximal instantaneous input current when the motor or motor starts. Given the nature of a motor, the start-up current of the motor is usually much higher than its normal current. The peak value of motor current is determined by the design of the motor and the method to limit the start-up current. An overly high peak motor current indicates the deterioration of insulation inside the motor.

For a detailed analysis of these monitoring parameters, monitored data can be downloaded using the Web Interface. This also allows an analysis of the motor running time per operation type. Please Note, the parameter naming does not differentiate between a motor and a motor.

4.3.2. Mechanical

Timing of circuit breaker:

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Opening time: For a circuit breaker tripped by any form of auxiliary power (usually high voltage circuit breaker), opening time is the time interval between the instant of energizing the opening release (circuit breaker being in the closed position), and the instant when the arcing contacts have separated in all poles [10].

Closing time: The closing time is the time interval between energizing the closing circuit (with the circuit breaker being in the open position), and the instant when the contacts touch in all poles [10].

Close-open time: The close-open time is the time interval between the instant when the contacts touch in the first pole during a closing operation and the instant when the arcing contacts have separated in all poles during the subsequent opening operation [10].

The timing of the circuit breaker in the MSM system could be calculated using measured auxiliary switch timing and its offset with the nominal values or using measured analog signal with travel sensors. The calculated parameters are then compared with pre-configured warning and alarm thresholds. In case of warnings/alarms, monitored data can be downloaded and analyzed thus determining the urgency of maintenance activity. A clear deviation from the threshold value indicates decreasing mechanical performance of the circuit breaker which increases the risk of failure for the next operation.

The velocity of circuit breaker:

Close/open velocity: The close/open velocity of the circuit breaker is the contact speed at contact touch (close operation) or contact separation (open operation), and it is defined in a linear segment of the (simulated) travel curve at close/open operation. With simulated travel curve, the velocity in the MSM system is extracted using auxiliary switch timing, and it could be up to 20 % slower than the velocity in factory acceptance tests as it monitors a larger time window, as accuracy described in Table 4.2. With travel curve obtained via a travel sensor, the velocity in the MSM is calculated with pre-defined velocity calculation zone and measured timing. The calculated parameters could be compared with pre-configured warning and alarm thresholds. In case of warnings/alarms, monitored data can be downloaded and analyzed thus determining the urgency of maintenance activity.

Accuracy of monitored parameters (test results from C / O operation):

The accuracy of the mechanical monitoring depends not only on the MSM system itself but also on the characteristics of the monitored assets. The accuracy for Hitachi Energy HPL420 can be found in Table 4.2.

Table 4.1 Accuracy of circuit breaker monitoring parameters

Monitoring parameter	Accuracy
Close time	<1.5 ms
Open time	<1.5 ms
Close velocity	< 5 %
Open velocity	< 5 %

Accuracy of monitored parameters (with simulated travel curve):

The accuracy of the mechanical monitoring depends not only on the MSM system itself but also on the characteristics of the monitored assets. The accuracy for Hitachi Energy GLK04 170 can be found in Table 4.2 Accuracy of circuit breaker monitoring parameters.

Table 4.2 Accuracy of circuit breaker monitoring parameters

Monitoring parameter	Accuracy
Close time	<1.5 ms
Open time	<1.5 ms
Close velocity	0.25 m/s
Open velocity	0.7 m/s

- Accuracy corresponds to 3 standard deviations (99.7 % of values will be within this range).
- Timing parameters: Offsets, i.e., a deviation between measurement values measured with MSM and offline diagnostic devices, are usually smaller than natural scatter in product lifetime and thus not impacting the performance of the monitoring system.
- Velocity parameters: Offsets can occur as speed may be measured in different sections of the travel curve. They can be in the range of 20%.

Time to 1st peak of coil current: The time to 1st peak of coil current is the time from coil energization to the first peak value of the current that flows through the trip/close coil, as point B in Figure 4.8 below. It is an informative parameter for the customer.

Trip & close coils are key components of the operating mechanism. Once coils are energized with trip/close command, the current flow in it rises, driving a ferromagnetic plunger which eventually strikes the latch mechanism and releases the energy stored in the mechanism to operate the circuit breaker. The coil current profile during switchgear operation can provide information about the operating mechanism but also the battery (power source) and the coil itself. A clear deviation from historical data may indicate issues like coil deterioration, or the lubrication condition, but also normal conditions like power source fluctuation in an admissible range for the operation of the circuit breaker.

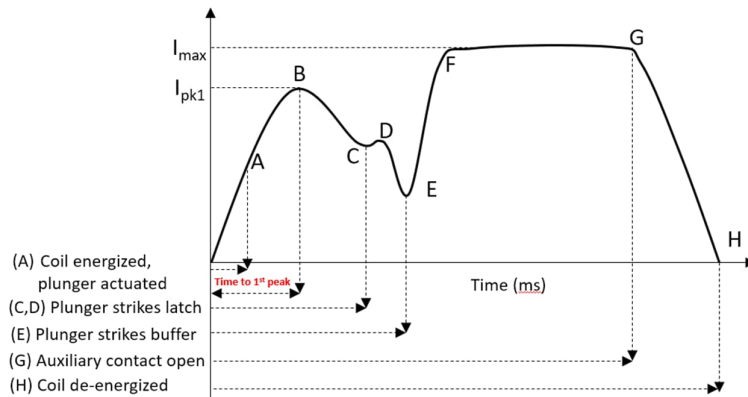


Figure 4.8: Typical coil current profile

Travel curve: The performance of the circuit breaker is highly dependent on the travel characteristics of the closing and open operations. Ideally, a travel sensor should be installed on circuit breakers to record the instantaneous position of the contacts, or some other portion of the mechanism that could be linked to the movement of the circuit breaker. A simulated travel curve can be calculated and visualized using the timing of auxiliary switches when a travel sensor is not available, and some breaker timing can be extracted (e.g., contact speed, timings) with some loss of accuracy, as illustrated in Figure 4.9. With a travel sensor installed on circuit breaker, the travel curve could be obtained, as illustrated in Figure 4.10.

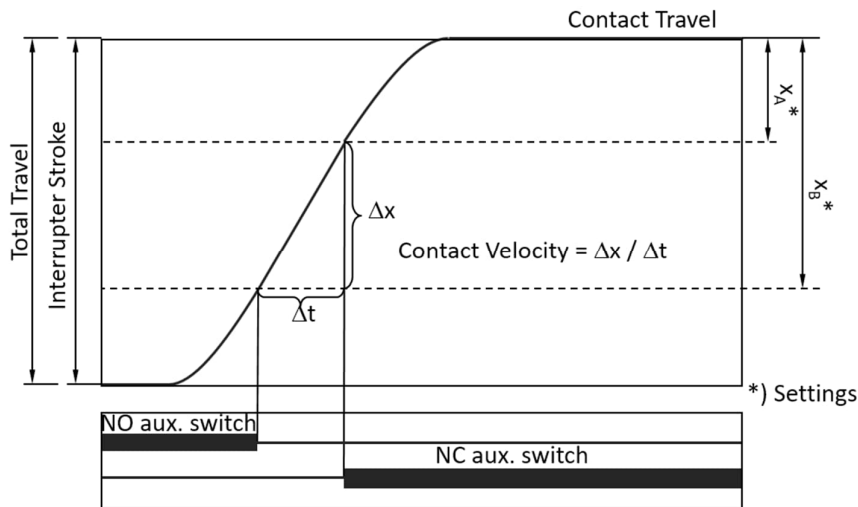


Figure 4.9: Simulated travel curve (e.g. close operation)

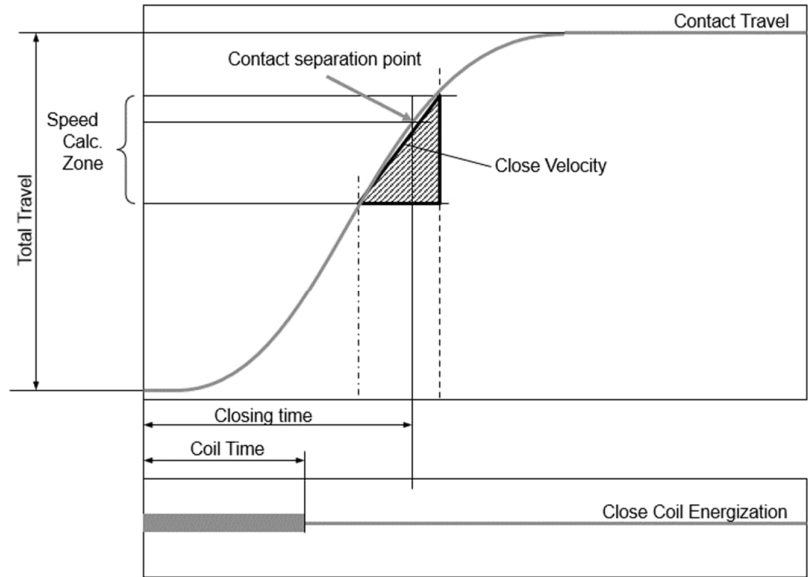


Figure 4.10: Travel curve obtained via a travel sensor (e.g. close operation)

Damping system

Damper is key component of the damping system, which absorb residual kinetic energy after circuit breaker perform close/open position. Malfunction of damper leads to excessive mechanical wear / impact on the interrupter, may even-lead to arc reignition. Key monitoring parameters include damping time, overtravel and rebound depends on the types of operations and the switchgear, as shown in Figure 4.11 below.

Damping time: The damping time is derived from a travel curve measured with travel sensor, it is calculated based on certain calculation zone which depends on specific switchgear.

Overtravel: The overtravel (in mm) is the distance from the first peak to the end of the travel curve, after switchgear operation.

Rebounce: The rebound shows the distance from the second peak to the end of the travel curve, after switchgear operation.

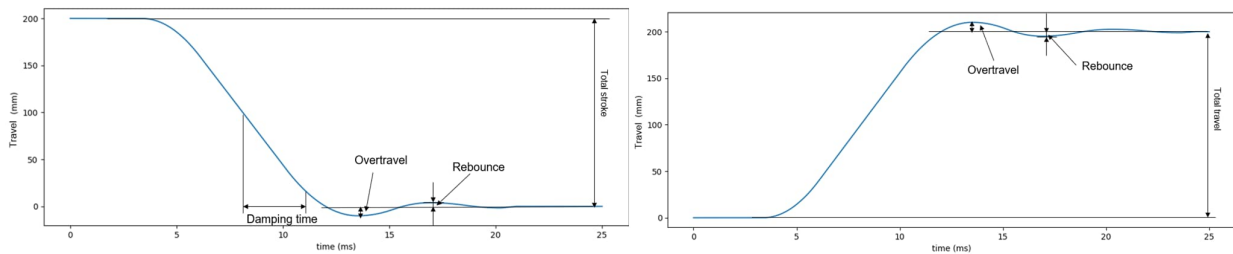


Figure 4.11: Dampint time, Overtravel and Reboune (open operation & close operation)

4.3.3. Wear

Contact wear: The contact wear calculated in the MSM system refers to the wear on arcing contact. MSM applies proprietary models to calculate contact wear. These models have been developed specifically for Hitachi Energy interrupters with the input of interrupter geometry, travel curve, and current waveforms. The contact wear is also calculated during close operations since pre-striking over many operations can cause significant wear as well. The calculated contact wear is accumulated and displayed as a percentage value, relative to the estimated total permissible wear.

Total number of close operations: MSM provides a counter for the close operation of the circuit breaker. The counter is increased by one, if the circuit breaker is closed with auxiliary switches and changes its status accordingly.

Total fault operation: The total fault operation is a counter that indicates the aging of the circuit breaker and is an informative parameter for the customer. The counter is increased by one, if the circuit breaker is opened with the interrupted current exceeding a pre-defined limit.

Phase current: The phase current during operations can be measured and visualized in Web Interface as additional information for your circuit breakers.

For a detailed analysis of these monitoring parameters, monitored data can be downloaded using the Web Interface.

4.4. Disconnecter monitoring functionality

Using the MSM Binary Input Module (BIM) and Fast Analog Input Module (FAIM) as part of an MSM stack, the MSM system can also monitor the mechanical quality of your disconnectors. This chapter describes specific monitoring features including the total number of disconnector starts, motor running time, motor RMS current, state transition, as well as motor current curve.

To monitor the performance of the disconnector, auxiliary switches (NOs and NCs) indicate the positions of the disconnector are connected to the BIM. Current sensors monitor the motor current are connected to the FAIM.

Total number of disconnector starts: MSM provides a counter for operations of the disconnector. The counter is increased by one, if the disconnector is operated from one position to another, with auxiliary switches changing their status accordingly.

Motor running time: Motor running time for disconnector monitoring can reflect the efficiency of the motor that usually drives the disconnector directly. For identical disconnector operation, an increase of running time at rated supply voltage indicates low motor efficiency which further implies possible mechanical degradation.

Motor RMS current: Motor RMS current is one indicator that shows the overall performance of the motor at rated supply voltage for identical disconnector operation. It is calculated by taking the square root of the mean square value of sampled motor current.

State transition: Disconnecter usually has multiple positions, and monitoring parameters (e.g., motor RMS current) may also have different values for different operations. State transition shows prior position of disconnecter to the position with the latest operation.

4.5. Heater monitoring functionality

To monitor the correct operation of heaters, MSM measures the current flow to the heater. If the current consumption is lower (no heater operation) or higher (short circuit) than expected an alarm/warning is generated.

For temperature-controlled heaters (with thermostat) the detection of no heater operation (low heater current) is only active if the temperature is below a configured threshold. To consider thermostat hysteresis this threshold is lower than the thermostat setting as otherwise false alarms might be triggered.

4.6. MSM Web Interface

The MSM system has an integrated web server with a Web Interface. Using this interface, monitored data can be reviewed, alarms can be acknowledged and specific settings can be changed. Every MSM stack of the MSM system can be used to access the MSM Web Interface, which shows the complete MSM system. Up to 30 sec, after a circuit breaker operation occurred, the MSM Web Interface operates with reduced performance as data needs to be collected and analyzed.

4.6.1. Features and system requirements

The MSM Web Interface allows efficient and user-friendly switchgear monitoring.

The following main features are provided for gas monitoring:

- On-line visualization of all monitored connected gas compartments and their status
- Current pressure and sensor status
- Historic pressure and leakage rates including download function
- Display of gas level thresholds
- Trend analysis and leakage rate calculation
- Humidity monitoring for SF₆
- Internal arc localization

The following features are provided for circuit breaker monitoring:

- On-line visualization for all monitored connected circuit breakers and their status
- Motor status
- Mechanical status of circuit breaker
- Wear status of circuit breaker

The following features are provided for both gas and circuit breaker monitoring:

- Historic data (gas and curves) including download function

The following features are provided for disconnector monitoring:

- On-line visualization for all monitored connected disconnectors and their status

The following features are provided for heater monitoring:

- On-line visualization for all monitored connected heater and their status

Event list and System log

Fast and easy Firmware update

For using the MSM Web Interface a web browser is needed. It is cross-browser compatible and the following web browsers can be used:


- Microsoft Windows® Edge
- Mozilla Firefox 3.6 and higher
- Safari
- Google Chrome

4.6.2. MSM System network concept

Once MSM stacks are connected in an Ethernet network they form an MSM system. Within such a system, MSM stacks are inter-connected internally. Thus, as a user, full access to the complete system is available by connecting to one arbitrary CCM within the system. To do so, the IP address of any CCM needs to be entered in the web browser.

4.6.3. Web interface login

Open the Web browser(e.g., Ms Edge) and insert the IP address from one of the CCMs, as introduced in chapter 3.8.5. A user verification window will be displayed after clicking on the *Login* button. For first access, use the default username and password (see chapter 4.6.13). Change the password following the instructions in 4.6.13.4 once successfully logged in.

 Caution: The default password should be changed in the user management section (see chapter 4.6.13).

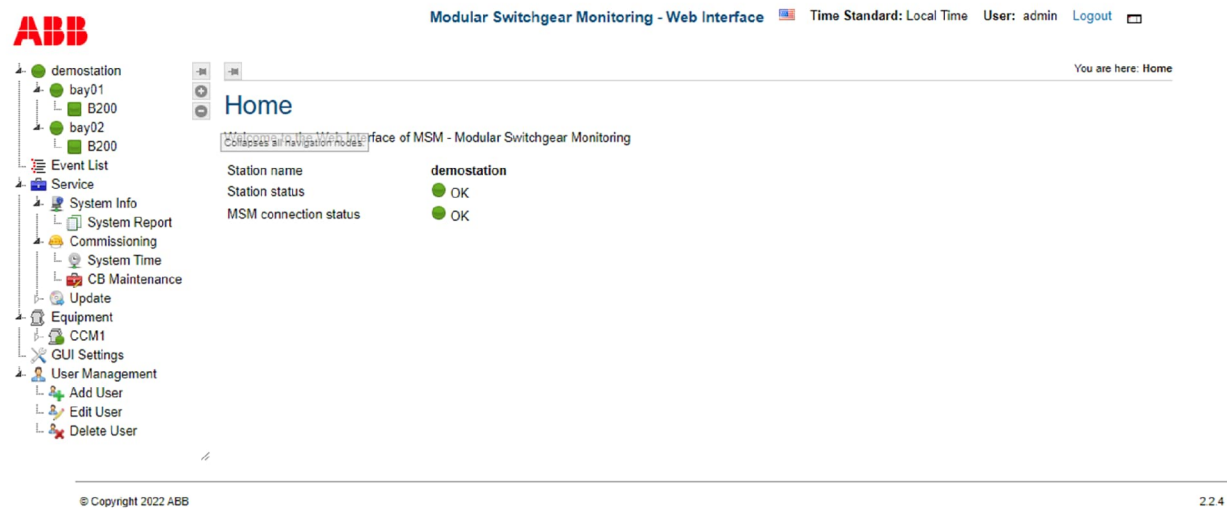


Figure 4.12: Front page of MSM Web Interface

4.6.4. Web Interface overview

On the left side of the interface, the navigation region, dynamic tree navigation is displayed. The title region is placed above the navigation and the main region (see Figure 4.12). It shows the configured language of the Web Interface as a flag. To change the language settings the flag icon can be clicked. The *GUI setting* subpage opens, see chapter 4.6.12.

Next to the *Logout* button, the name of the login user is displayed, and the user group is visualized by the user group icon. The screen mode can be changed by the last symbol. The screen versions are described in chapter 4.6.12.

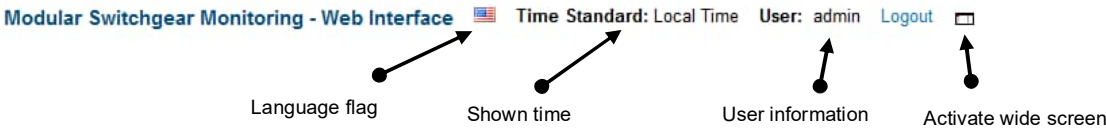


Figure 4.13: Title region

4.6.4.1. Navigation

At the beginning, the expanded navigation tree is shown. By clicking on a triangle (see Figure 4.14) child nodes can be hidden or shown.

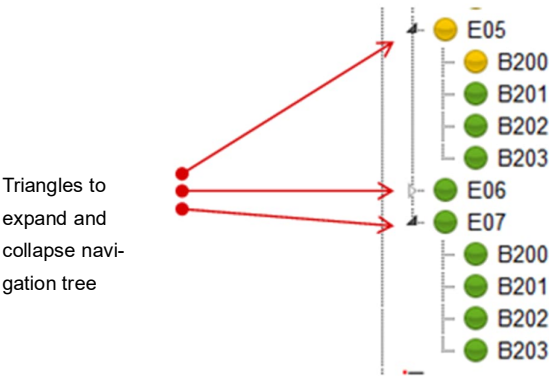


Figure 4.14: Triangles to open and close navigation trees

The navigation structure is divided into five sections:

Section 1 illustrates the gas-insulated switchgear with stations, bays, and gas compartments. The icons indicate the status (see Figure 4.15).

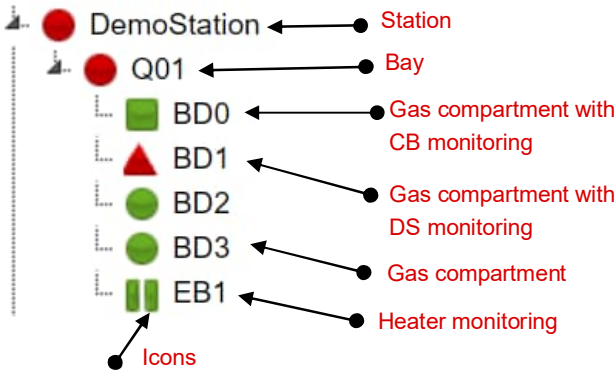


Figure 4.15: First section in the navigation tree



Table 4.3 Web icon coloring

Icon	Color	Meaning
	green	OK
	orange	Warning
	red	Alarm / sensor error
	gray	Status updating
	blue	Information

A parent node in the tree structure always displays the worst status of one of its child nodes. In the example Web Interface screenshot above, compartment “BD1” has an alarm. This alarm is reflected on the bay node “Q01” and the Station node “Demo Station”.




Section 2 is a link to the alarm list of the MSM system. The icon signalizes whether alarms are pending.

Table 4.4: Alarm icons

Icon	Meaning
	No alarms are pending
	Alarms are pending

Section 3 displays the hardware of the MSM system. The MSM stacks are arranged in alphabetical order by name. The icons of MSM stacks show the communication status.

Table 4.5: Web MSM stack icons

Icon	Meaning
	MSM stack is connected
	MSM stack with a different configuration
	MSM stack is disconnected

Section 4 links to the settings of the Web Interface.

Section 5, the user management is available if the current user has enough privileges.

Region pinning:

The main region and the navigation region can be pinned at the top of the screen. Only one region can be fixed at the same time. There are two types of buttons to display the pinning state (see Figure 4.16). To pin one-part means, that for example your fixed part of the navigation region will be shown during you scroll down the page.





Figure 4.16: Navigation region with pinning

4.6.4.2. File download

A file download is assigned by an icon of a floppy disk (see Table 4.6Error! Reference source not found.). There are two different download types.

Table 4.6: File download icons

Icon	Download type
	Direct file download
	Asynchronous file download

Floppy disks with green labels mark direct file downloads. After clicking on the link, the download starts.

Downloads that have a red labeled floppy disk are asynchronous file downloads. These downloads take some minutes to generate the download file. During the generation, a dialog is displayed which shows the progress and the current step (see Figure 4.17). Below the progress bar, the number of steps and the current step is shown. Next to the step overview, a description of the current step is displayed.

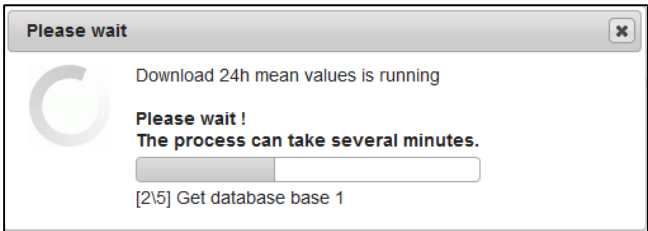


Figure 4.17: Wait dialog box during asynchronous file download

4.6.4.3. File upload

MSM supports file uploads to send a file to MSM. A file can be a configuration, a language file for Web Interface, and so on. Every file upload provides the same user interface which consists of two buttons and the file name.

If a file upload is part of a page the file upload will consist of a button to select the file which should be uploaded (see Figure 4.18). There are two ways to select a file.

Drag and drop file on the *select file* button

Click on the button and select file from your computer

After file selection, the file extension is validated. If the validation is not successful and an error message which describes the error opens otherwise the selected file is valid and the file name is displayed (see Figure 4.19). Click on the upload button to start the file upload. If the wrong file was selected a new file can be selected as described above.

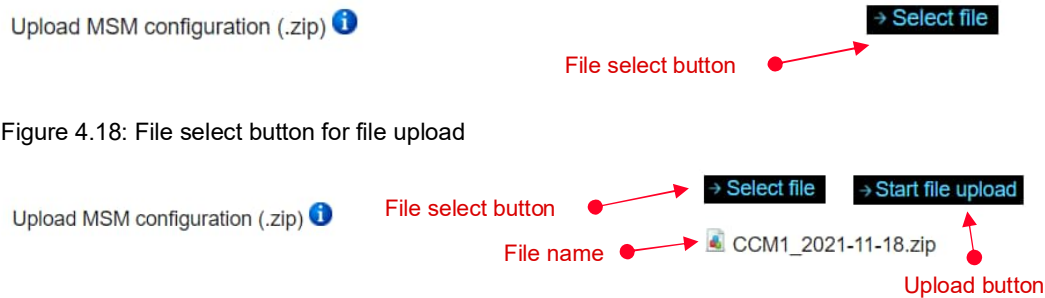


Figure 4.19: File upload button

During file upload, a progress bar is shown in a dialog window.

4.6.5. GIS status nodes

The GIS status node hierarchy has three levels.

Station nodes are the first level. An MSM system can monitor multiple stations. Each station created has a station node on the tree node root.

Every station consists of multiple bays (level 2). Every bay has multiple gas compartments (level 3) according to the physical bay structure (see Figure 4.15).

4.6.5.1. Station overview

By clicking on a station node, the station overview page is displayed in the content window. The station view consists of a *Compartment list*, a *Circuit breaker list (if configured)*, and a *Gas schematic* tab.

Station DemoStation

GC	Pres	Leak	DtSt1	DtSt2	Humidity	Dew Pt	Temp
DemoStation_Q01_BD0	111 kPa	---	---	---	10751.6 ppmv	8.3 °C	23.8 °C
DemoStation_Q01_BD1	521 kPa	---	---	---			
DemoStation_Q01_BD2	560 kPa	---	---	---			
DemoStation_Q01_BD3	556 kPa	---	---	---			

Download table of DemoStation
Download 24h mean values of DemoStation for user-defined time span

Legend and column toggle

- ☒ Pres = Gas Pressure @ 20°C
- ☒ Leak = Gas Leakage [% p.a.]
- ☒ DtSt1 = Days to stage 1
- ☒ DtSt2 = Days to stage 2
- ☒ Humidity = Humidity [PPMv]
- ☒ Dew Pt = Dew point
- ☒ Temp = Temperature

Figure 4.20: Station view with open compartment list tab

Compartment list:

All gas compartments of this station are listed in a table, which consists of a variable number of columns and can be sorted by every column. The first indicates the common/worst status of all monitored values in the compartment.

Below the table, there is a link to download the shown table as a CSV file or XLS file, which can easily be imported into Excel for further data analysis.

The second download link opens a dialog box to download 24h mean values for a user-defined period which is described in chapter 4.6.5.2.

The '*legend and column toggle*' box explains abbreviations in the column header. Columns can be shown or hidden by activating or deactivating the appropriate checkboxes.

Sortable ranking list:

By clicking on a column header, the table will be sorted by this column in ascending or descending order for individual ranking. The sort order can be changed by clicking the column header again. The current sort order is not considered when downloading a CSV file; the CSV file will always be sorted in alphabetic order. For advanced sorting functions, software like MS Excel can be used for further data analysis after importing the XLS file.

Gas Scheme:

The gas scheme represents all compartments in the station and signals their status.

The gas scheme is interactive: By hovering over a gas compartment, the compartment name is shown in the info box. By clicking on a compartment, the compartment overview is shown (see chapter 4.6.5.4)

Station DemoStation

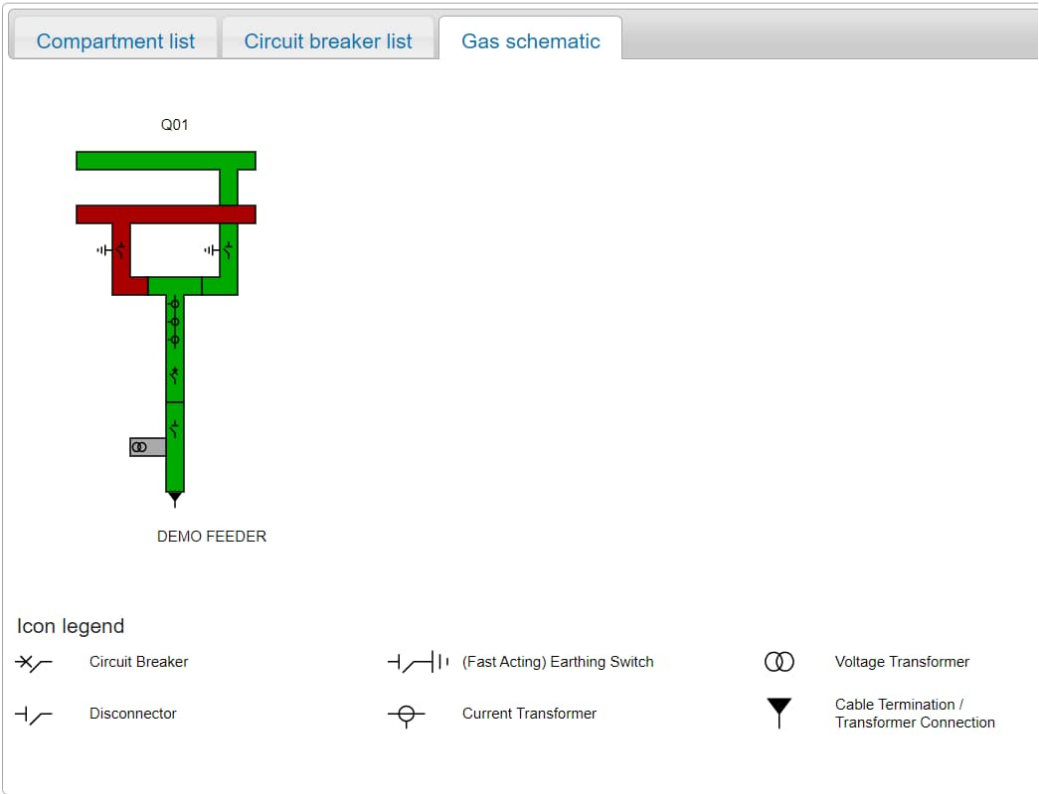


Figure 4.21: Station view with open gas scheme tab

4.6.5.2. Download gas data

On the *Compartment list* tab there is the link “Download 24h mean values...” to download the recorded data (see Figure 4.22).

Station DemoStation

GC	Pres	Leak	DtSt1	DtSt2	Humidity	Dew Pt	Temp
DemoStation_Q01_BD0	111 kPa	--- %	---	---	10751.6 ppmv	8.3 °C	23.8 °C
DemoStation_Q01_BD1	521 kPa	--- %	---	---			
DemoStation_Q01_BD2	560 kPa	--- %	---	---			
DemoStation_Q01_BD3	556 kPa	--- %	---	---			

Download table of DemoStation

Download 24h mean values of DemoStation for user-defined time span

Legend and column toggle

- ☒ Pres = Gas Pressure @ 20°C
- ☒ Leak = Gas Leakage [% p.a.]
- ☒ DtSt1 = Days to stage 1
- ☒ DtSt2 = Days to stage 2
- ☒ Humidity = Humidity [PPMv]
- ☒ Dew Pt = Dew point
- ☒ Temp = Temperature

Figure 4.23: Parameter dialog for 24hr mean value download

Download 24h mean value:

When clicking the link “Download 24h mean values...” a dialog window opens, allowing to select the time span and data type of the download (see Figure 4.24)

Select download data settings

Select a start and end date or download all available data:

All data ☐

Start date 2021-09-07

End date 2021-09-07

Select the datapoints for the download:

Pressure ☐

Leakage rate ☐

Humidity ☐

Temperature ☐

Cancel Start data preparation

Figure 4.24: Parameter dialog for 24h mean value download

After several minutes the preparation of the download is completed. After file preparation, a dialog is displayed to select the file format of the file (see Figure 4.25). Click on “Start file download” to start the download of the file.

File Download

Select the file format:

File format ☒ CSV ☐ XLS

Cancel Start file download

Figure 4.25: Dialog to select the download file format

Note: Downloading monitoring data may require several minutes. During this time the Web Interface becomes temporarily unreachable for any user. The download process can be accelerated by clearing the browser cache before starting the process and by using the download per bay rather than for the complete substation

4.6.5.3. Bay Overview

By clicking on a bay node, a bay overview page is displayed in the content window.

Bay Q01

Compartment list								
Circuit breaker list								
Gas schematic								
GC	Pres	Leak	DIS11	DIS12	Humidity	Dew Pt	Temp	
DemoStation_Q01_BD0_L1	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD0_L2	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD0_L3	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD1_L1	600 kPa	0.0 %	---	---	56.0 ppmv	27.0 °C	33.0 °C	
DemoStation_Q01_BD1_L2	600 kPa	0.0 %	---	---	62.0 ppmv	27.0 °C	33.0 °C	
DemoStation_Q01_BD1_L3	700 kPa	0.0 %	---	---	50.0 ppmv	20.0 °C	20.0 °C	
DemoStation_Q01_BD2_L1	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD2_L2	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD2_L3	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD3_L1	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD3_L2	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD3_L3	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD4_L1	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD4_L2	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD4_L3	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD5_L1	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD5_L2	700 kPa	0.0 %	---	---				
DemoStation_Q01_BD5_L3	700 kPa	0.0 %	---	---				

Download table of DemoStation_Q01

Download 24h mean values of DemoStation_Q01 for user-defined time span

Legend and column toggle

☒ Pres = Gas Pressure @ 20°C

☒ Leak = Gas Leakage [% p.a.]

☒ DIS11 = Days to stage 1

☒ DIS12 = Days to stage 2

☒ Humidity = Humidity [PPMv]

☒ Dew Pt = Dew point

☒ Temp = Temperature

Figure 4.26: Bay view with open compartment list tab

The bay overview is like the station overview (see chapter 4.6.5.1), but only compartment of the selected bay are shown.

Gas Scheme:

The gas scheme represents all compartments in the bay and signals their status. The gas scheme is interactive: By hovering over a gas compartment, the compartment name is shown in the info box. By clicking on a compartment, the compartment overview is shown (see chapter 4.6.5.4).

Bay Q01

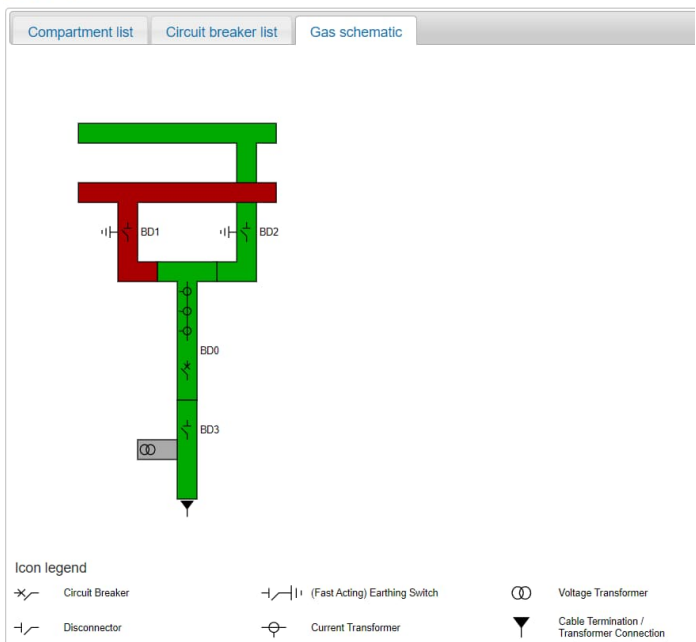


Figure 4.27: Bay gas scheme

4.6.5.4. Overview of gas monitoring

In the compartment view, the monitored parameters of a single gas compartment can be seen. Dependent on the pre-configuration and the installed sensor type one or several tabs are available for one gas compartment. By clicking on the tab, the regarding parameters for the monitoring feature can be opened.

After an MSM restart it takes up to 5 min until measured values update in the Web Interface.

Figure 4.28 shows an opened gas pressure/density tab, where measurements, warning levels, alarm levels, and status information of this gas compartment for pressure and density are displayed.

Status information is illustrated by icons. Coloring is done according to Table 4.3.

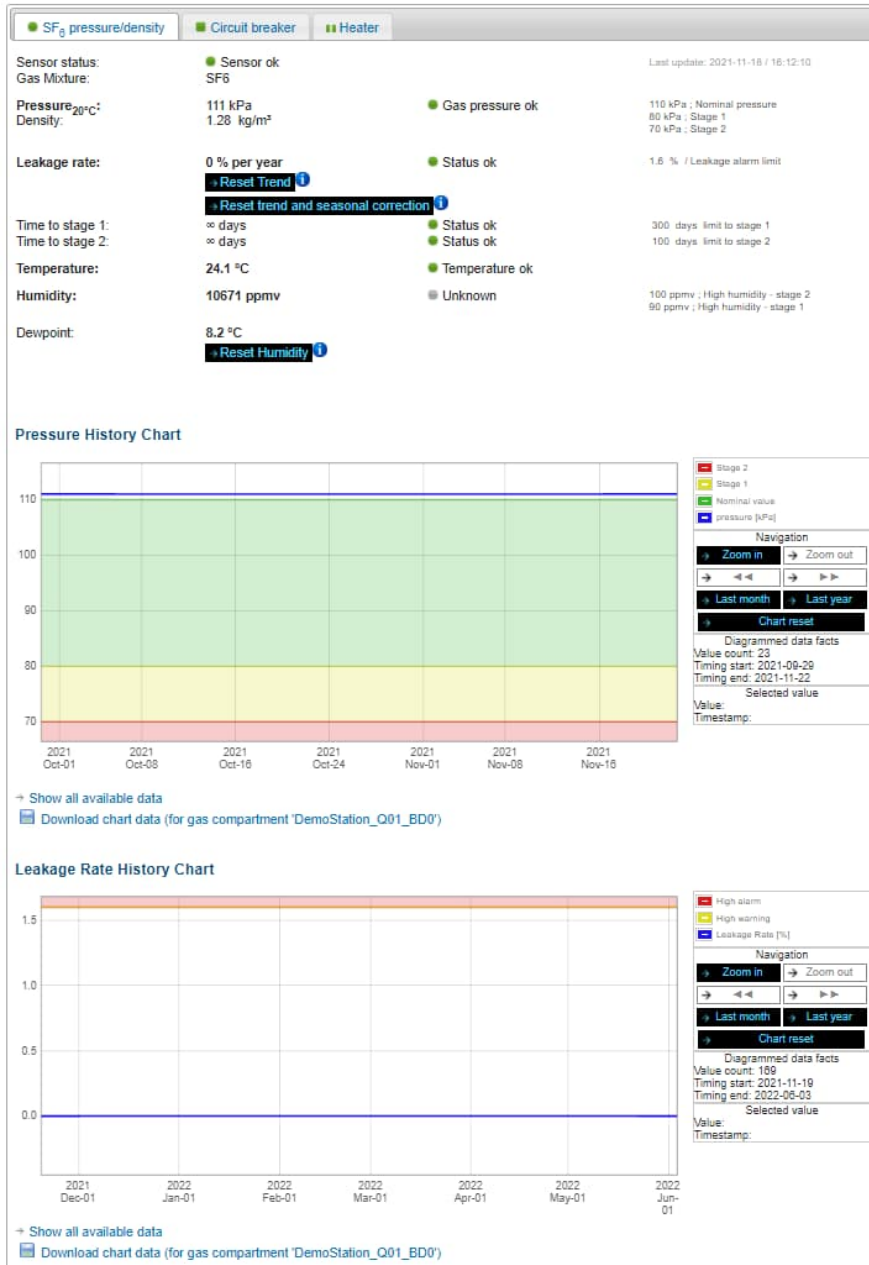


Figure 4.28: Compartment view – SF₆ pressure/density

STATUS	SECURITY LEVEL	DOCUMENT ID	REV.	LANG.	PAGE
Approved	Public	2GHV045871	R	en	51/148

Optionally stage 0 feature can be activated in the MSM system via the configuration file. If the stage 0 feature is activated the stage 0 threshold is displayed in the list of thresholds (see red arrow in Figure 4.29).

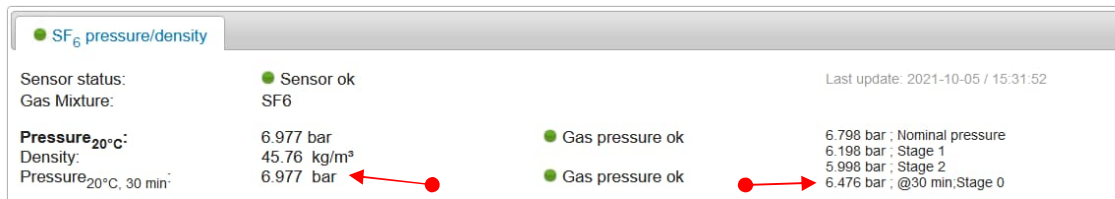


Figure 4.29: Stage 0 threshold

The current value of stage 0 and the threshold is part to download of 24 h mean values. The threshold is part of the history chart for gas pressure.

Below this status and measurement information in the gas pressure/density tab (see Figure 4.28) the gas history chart is displayed. Besides the nominal, warning, and alarm levels, the gas pressure curve is displayed. The alarm limit is red-colored plotted. The warning limit is shown by an orange line. The nominal pressure is plotted in green. The real gas pressure is shown by a blue line. The data points of the real pressure are connected by lines to get one blue line. A red vertical line (crosshair) assigns the position of the mouse in the chart. A small blue circle (selector) marks the selected value. The crosshair and the selector are placed always at the nearest data point of the mouse pointer. If the mouse pointer checks out of the chart the last position of the crosshair and selector will be locked. The position is unlocked by entering the chart with the mouse pointer. The position of the crosshair and selector can also be locked and unlocked by clicking on the chart.

On the right next to the plot the user interface of the history chart is placed. This user interface is divided into four sectors (see Figure 4.30).

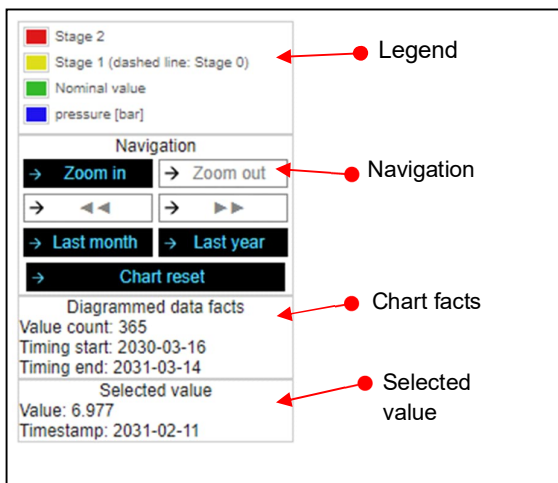


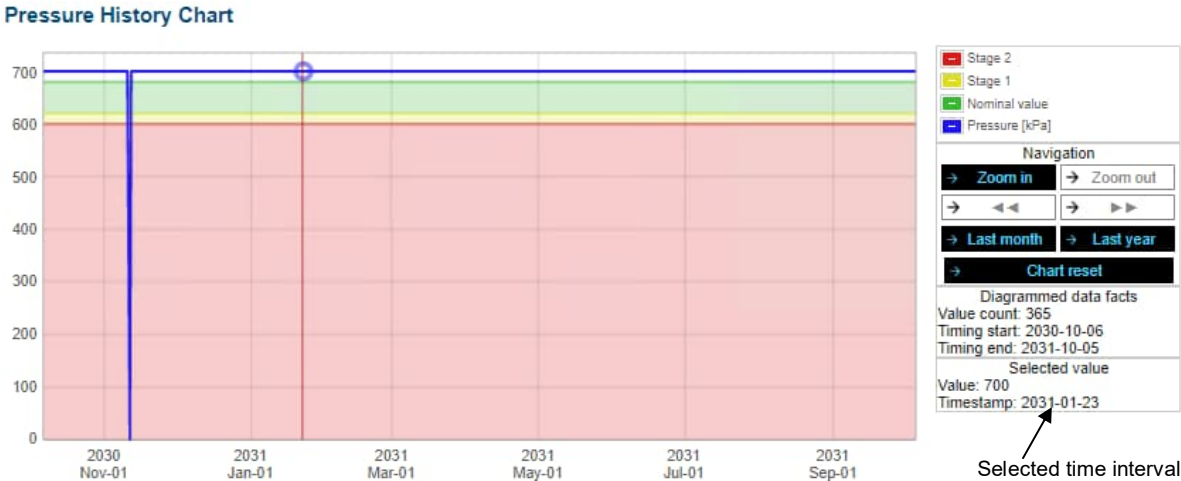
Figure 4.30: The user interface of the history chart

In the legend sector, the legend of the chart is shown.

The navigation of the chart is placed in the second sector. There are seven buttons to navigate. If the position of the crosshair and selector is locked this position will be the center of zoom otherwise the middle of the chart will be the center. The zoom is limited to a week and the whole data points. The buttons with triangles pan the chart to the left or the right. The last month is plotted by clicking on 'Last month'. The button 'Last year' is like 'Last month'. The chart can be reset to the initial view by clicking 'Chart reset'.

The number of values and the timing start and end are shown in the next sector. This information applies to the plotted chart and is refreshed for every plot. The last sector displays the selected value with a timestamp. This value is also marked by the crosshair and the selector. If no value can be selected '---' will be shown as value and timestamp.

Navigation is also possible by selecting an interval on the history chart (see Figure 4.31). Click on the chart and hold the mouse button down to mark the selected interval. As soon as you release the mouse button, the selection is finished and the selected interval is plotted.



Below the history chart, there are two buttons. By clicking on 'Show all available data' a history chart is plotted with up to 10 years of stored data of the gas compartment. The download of chart data as CSV or XLS file is started after a click on 'Download chart data (...)'. All historic data can be downloaded via "24 h download" in Bay or Station overview (sections 4.6.5.1 and 4.6.5.3).

Figure 4.32 shows the humidity & temperature monitoring of this gas compartment. Humidity and temperature are optional configurable and only available if the related sensor is installed on the gas compartment.

If the temperature is enabled the measured temperature value is shown with its configured unit (°C/F) in the gas compartment tab (1). The value will be updated every 5 min. The status of the temperature measurement is shown as icons and letters. (2). The limits for warning and alarm are shown on the right side of the tab (3).

If humidity is enabled the measured humidity and dewpoint value is shown with its configured unit (ppmv/°C or F) in the gas compartment tab (4). The value will be updated every 5min. The status of the humidity measurement is shown as icons and letters. (5). The limits for warning and alarm are shown on the right side of the tab (6).

Status information is illustrated by icons. Coloring is done according to Table 4.3.

At button (7) the humidity calculation can be reset, the blue info icon next to the "Reset Humidity" button explains what happens when a reset is performed. Further information is given in chapter 4.2.5.

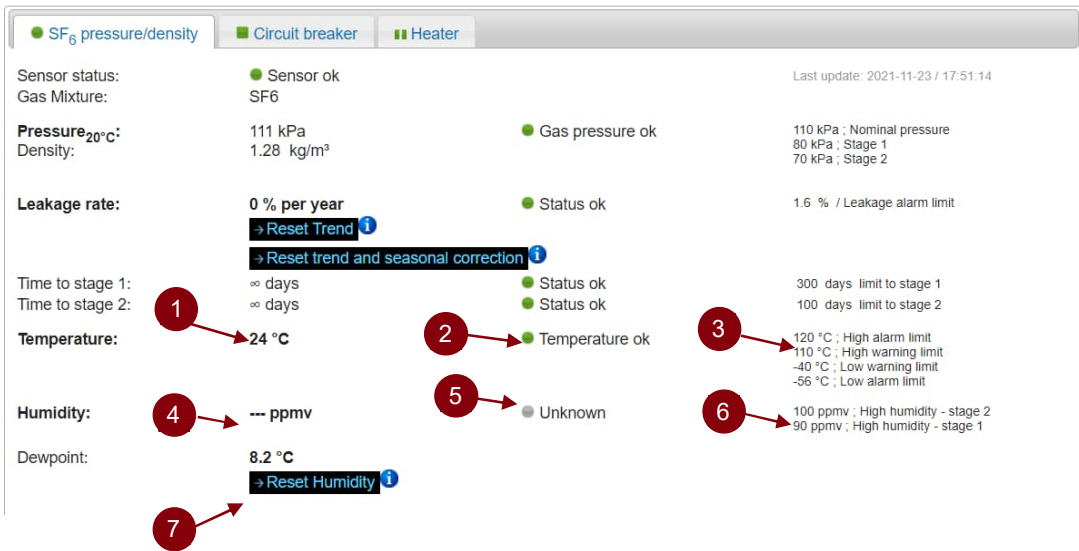


Figure 4.32: Humidity and temperature measurement

If temperature or humidity is enabled the 24hr mean values of the measurement will be stored in the database. After 3 days of data collection, the values will also be available in the history chart of the specific parameter (shown in Figure 4.33).

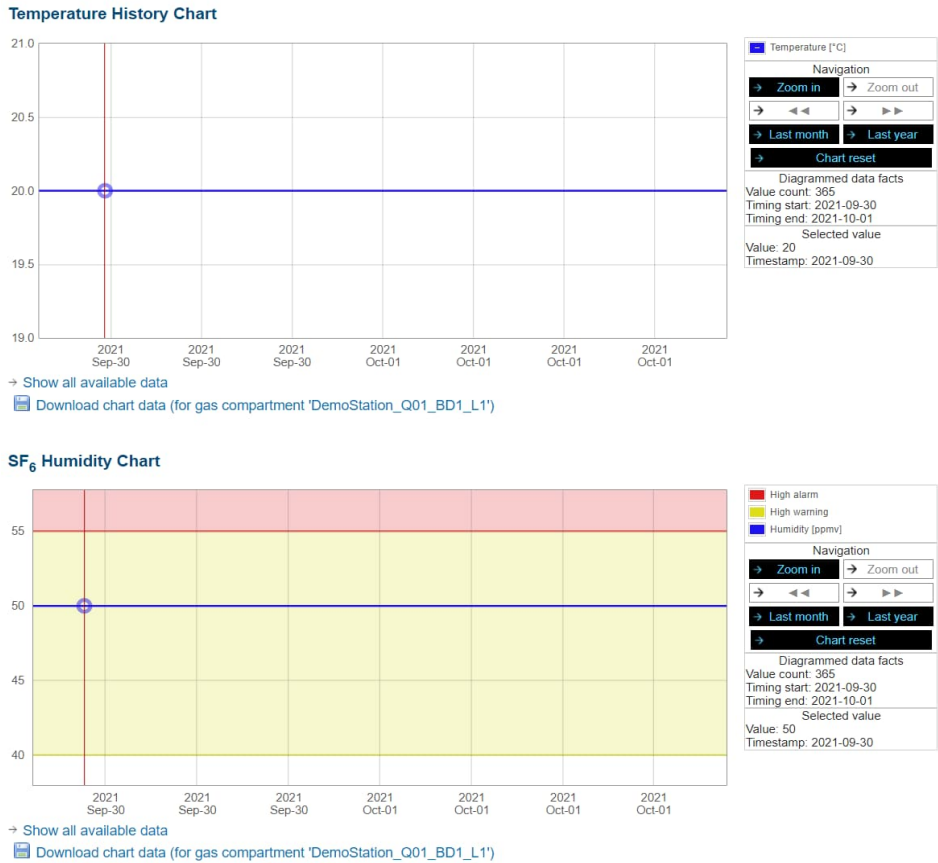


Figure 4.33: History charts for temperature and humidity measurement

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4.6.5.5. Overview for internal arc localization

Figure 4.34 visualizes the internal arc localization feature in MSM system. Internal arc localization is optional configurable and only available with recommended sensor installed on gas compartment.

If the feature is enabled, the text “Arc localization” will show in the gas compartment tab (1). The real time MSM system detected the arc will be visualized(2). The status of the detected arc is shown as icons and letters(3), depending on different type of gas compartments as mentioned in **Error! Reference source not found.**

Status information is illustrated by icons. Coloring is done according to Table 4.3.

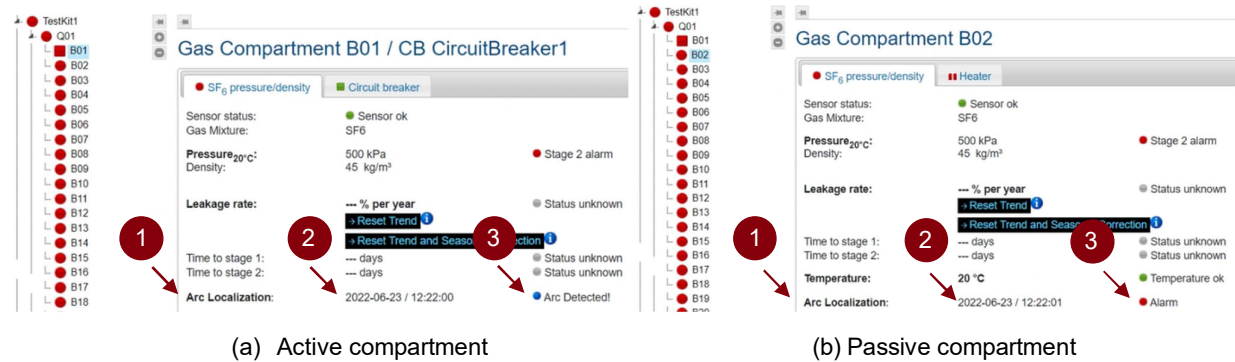


Figure 4.34: Visualization after an arc is detected

4.6.5.6. Overview for circuit breaker monitoring

The MSM Web Interface with enabled circuit breaker monitoring is shown in Figure 4.35. In the tree navigation (1) those gas compartments with circuit breaker are shown by a rectangle icon instead of a circular icon. Clicking on one of these gas compartments with circuit breaker, two tabs become visible on the main screen: the gas pressure/density and circuit breaker (2). The circuit breaker tab has three sub-tabs, Accessories, Mechanical, and Wear respectively (3). Each parameter in sub-tabs has a color bar to indicate the admissible limit, and the warning & alarm thresholds (4). For accessories and mechanical tab, operations selected can be downloaded by button(5). The detailed visualization in each sub-tab is shown in Figure 4.36, Figure 4.37 and Figure 4.38:

- (1) **Accessories tab:** The accessories tab contains the monitoring parameters for the operating mechanism. The last motor running time (1), includes the time durations for each phase, after close operation and without operation respectively. The motor starts (2) include the counter for motor starts per day without operation of the circuit breaker, and the total number for motor starts under any circumstances. Further down, the parameters related to individual operations are shown (3), i.e., peak motor current, and motor running time. Clicking on the individual entries in the operations list shows the record for historic operations. Meanwhile, the motor current profiles in historical operations are shown in curve tab (4). The measured curve data can be downloaded using hyperlink (5). Operation curves can be downloaded through button (5)
- (2) **Mechanical tab:** The mechanical tab includes the monitoring parameters of circuit breaker for each phase (1), for example opening time and closing time, open velocity, and close velocity. Clicking on the curve tab (2), the travel curve and coil current profile could be shown, with the operation list for historic operations. Information of coil current parameter will be displayed in (3). The measured curve data can be downloaded using hyperlink (4).
- (3) **Wear tab:** The wear tab shows contact wear (1), total close operation (2), and total fault operation (3), after each operation of the circuit breaker, this parameter will be updated. The phase current for compartment (4) would be recorded. Clicking on the individual entries in the operations list can access the phase current profile during each operation. The measured curve data can be downloaded using hyperlink (5).

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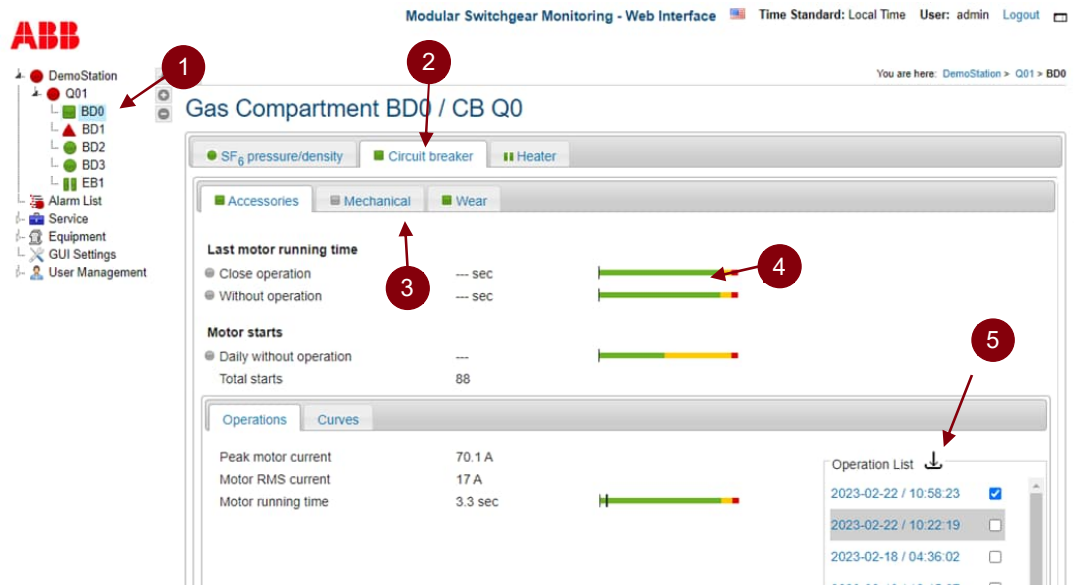



Figure 4.35: Compartment overview for circuit breaker monitoring

 Note: Color bar indicating admissible limit, and the warning & alarm thresholds (4) are not displayed in Mechanical tab when Close-Open operation is selected. No warning and alarms are generated for Close-Open operation.

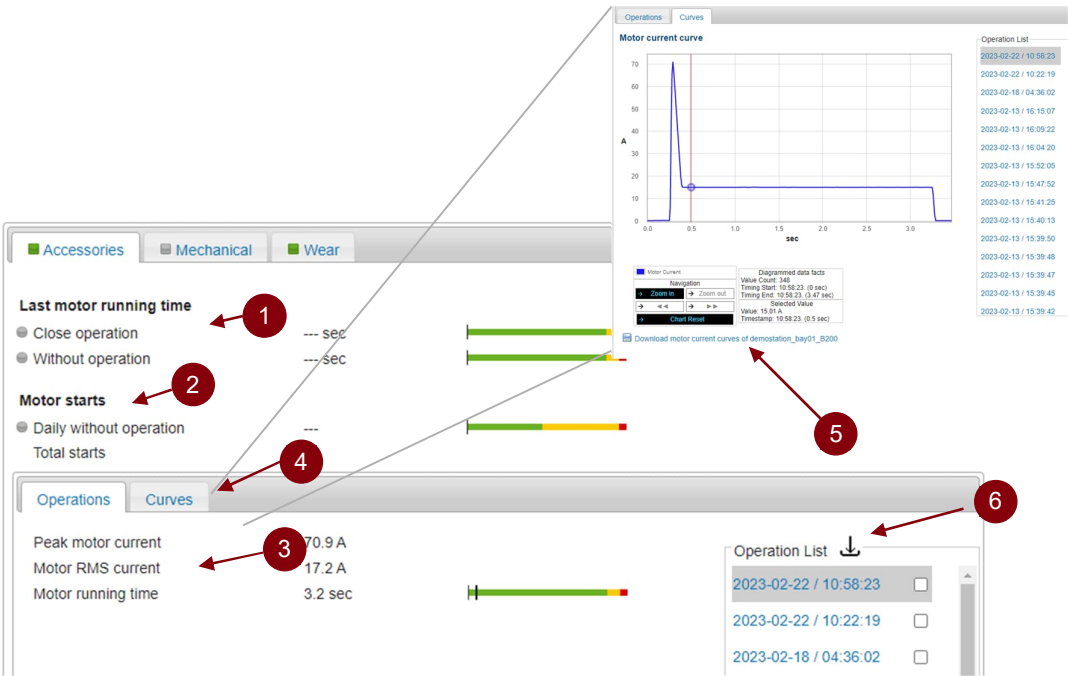


Figure 4.36: Circuit breaker monitoring – Accessories tab



Figure 4.37: Circuit breaker monitoring - Mechanical tab



Figure 4.38: Circuit breaker monitoring - Wear tab

4.6.6. Overview for disconnecter monitoring

The MSM Web Interface with enabled disconnecter monitoring is shown in Figure 4.39.

In the tree navigation (1) those gas compartments with disconnecter monitoring are shown by a triangle icon instead of a circular icon. Clicking on one of these gas compartments with a disconnecter, two tabs become visible on the main screen: the pressure and disconnecter (2). In the disconnecter tab is the counter for the total starts of the disconnecter motor (3) and its warning and alarm limits bar (7). In the sub-tab Operations, the motor RMS current and the motor running time (3) for the selected operation in the operation list (8) are shown. Additional in the sub-tab curves (6) the motor current curve of the selected operation is visible.

The state transition gives the disconnecter movement (5) and the curve data can be downloaded by (9)

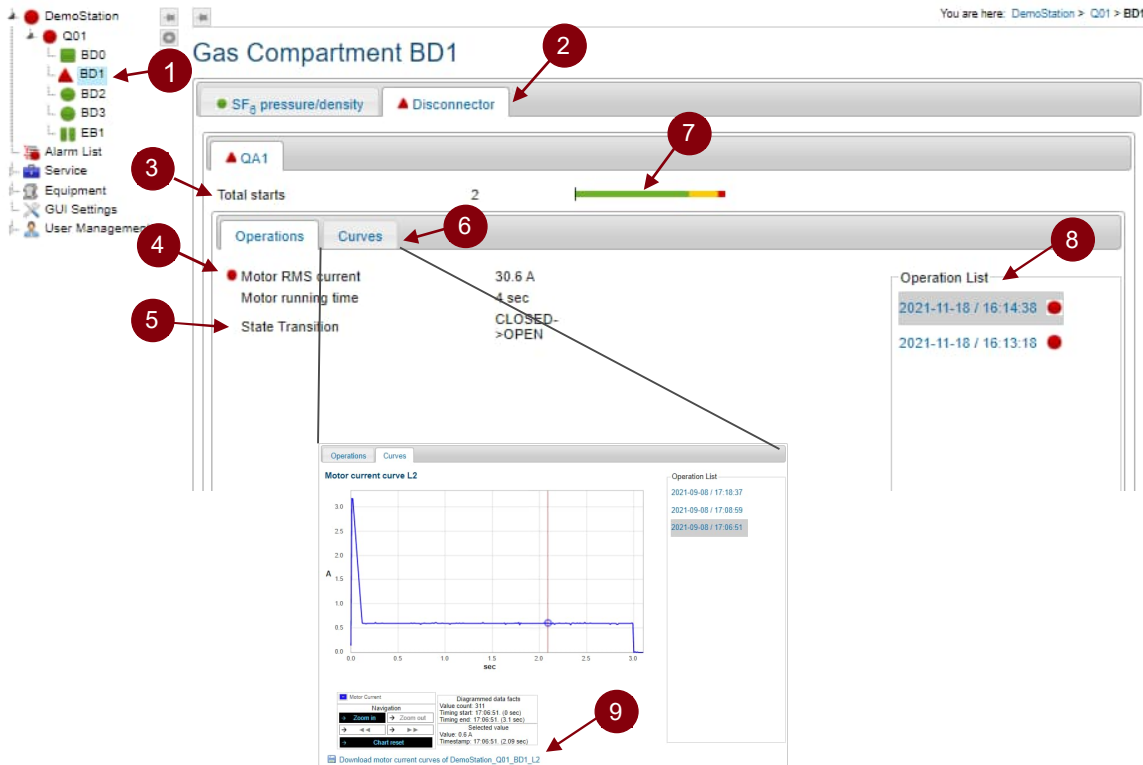


Figure 4.39: Compartment overview for disconnecter monitoring

4.6.7. Overview for heater monitoring

The MSM Web Interface with enabled heater monitoring is shown in Figure 4.40.

In the tree navigation (1) those gas compartments with heater monitoring are shown by an H icon instead of a circular icon. Clicking on one of these gas compartments with heater appears as an additional tab (2). The heater can also be in the bay level of the station e.g., for the heater of the LCC. Heaters connected to a specific compartment can be in the drive cubicle of the circuit breaker/ disconnecter or directly on the gas compartment. In the heater tab, the heater status is shown as icon color change (green: Heater OK, red: Heater ERROR) (3) and as a word (4).

If it is a thermostat-controlled heater the temperature in the cubicle can optionally be shown (5). If this function is enabled the 24h mean value of the temperature measurement will be stored in the database and shown in the history chart (7) below after 3 days. The chart information can be downloaded (8).

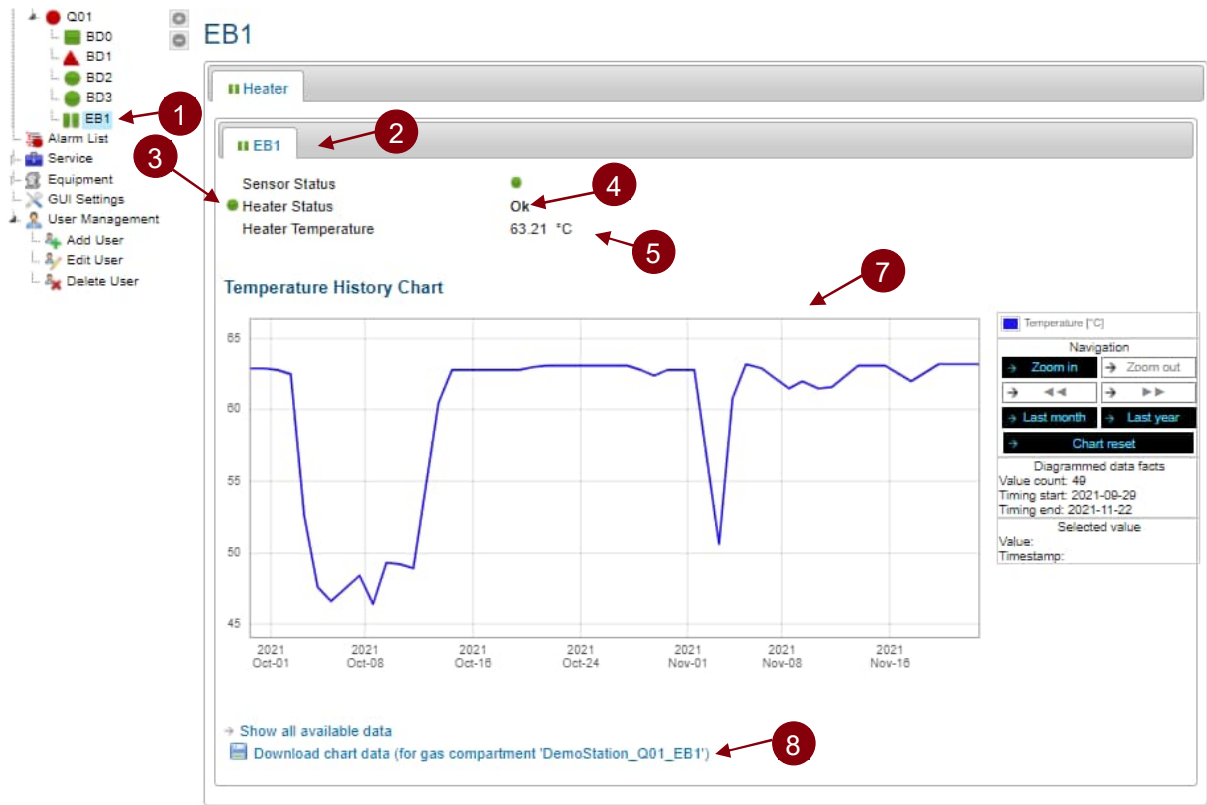


Figure 4.40: Compartment overview for heater monitoring

4.6.8. Service menu

To facilitate the commissioning and service of the MSM system, there is an additional service menu that bundles the maintenance and service functions of the MSM. This system is only available for the user group Administrators or Operators.

4.6.8.1. System info

A system report can be downloaded under the menu item System Info. It is required for a detailed analysis of the MSM system. It contains for example the configuration, the databases, and the software version. The system report is available in the Service Menu under System Info (see Figure 4.41).

 Caution: It can be downloaded for one or more CCMs.

During the system report download, operations of the breaker cannot be recorded.

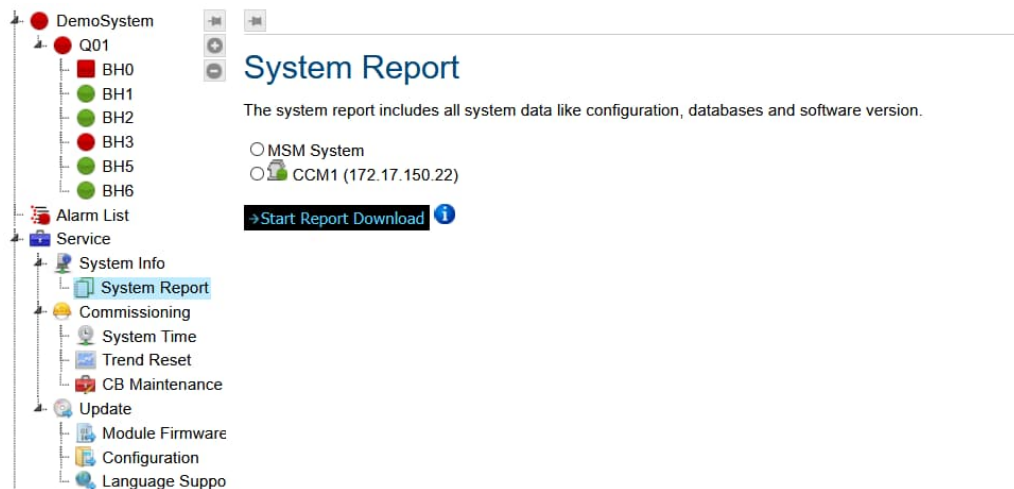


Figure 4.41: System Report

4.6.8.2. Commissioning

The "Commissioning" tab contains all service functions that are important when commissioning the MSM system (see Figure 4.31). In this menu, the system time of all connected MSM stacks can be set. The gas trend reset can be selected in this menu, it can be performed for a stack, a field, or a gas compartment. The sub-region "LS Maintenance" appears when a circuit breaker has been configured in the connected CCM. In this menu item, counter readings of motor startup or operators can be set and reset. Furthermore, a value for contact erosion can be entered.

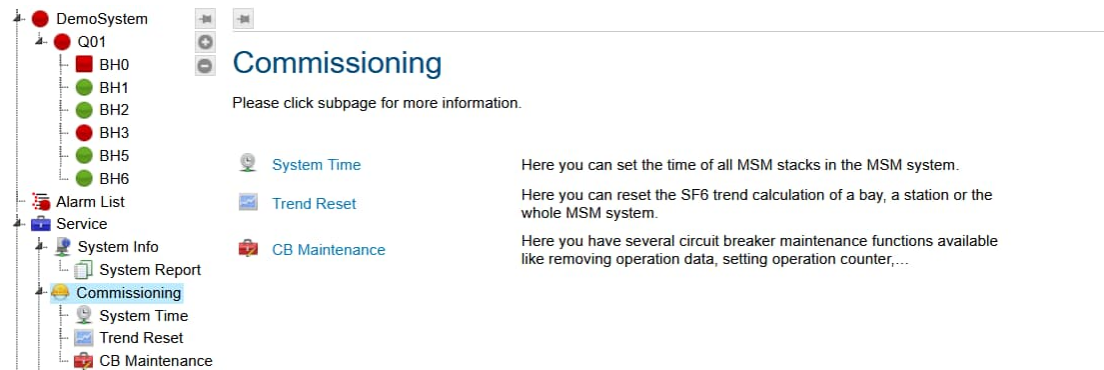


Figure 4.42: Service menu – Commissioning

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4.6.8.3. Update

In the menu item Update, all system updates of the MSM system can be carried out.

Firmware updates for CCMs and I/O modules on the system level can be uploaded. Changes in the configuration of the MSM can be entered into the MSM system via a system-wide configuration update. It is also possible to update the language support of the MSM and add new languages to the web user interface.

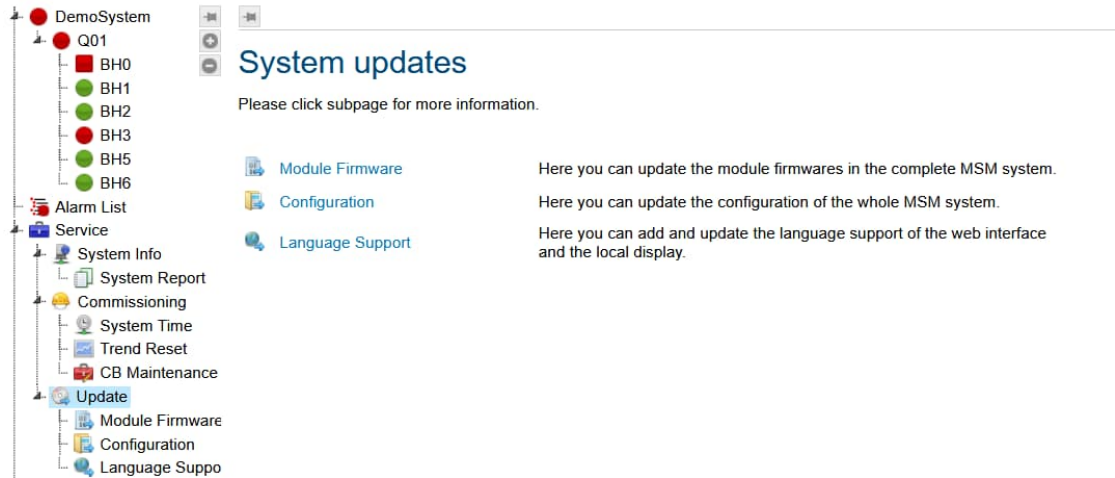


Figure 4.43: Service Menu- System updates

4.6.9. Event list

Every event (alarm, warning, information and so on) of the MSM system is displayed in a table with five columns (see Figure 4.44). The 1st column shows the event status, the 2nd the type of event, the 3rd the location of the event with a link to the location, the 4th the parameter, and the 5th the date and time stamp.

By clicking on a location, the compartment view is opened to get more information.

New events are only created in the event list and logged in the event log when there is a state change (none → warning, warning → alarm (or the other way round)) or information may raise attention.

The columns of the event list can be filtered and sorted.

Event List

Event Status	Type	Location	Parameter	Date
Event Status	Type	Location	Parameter	Date
 Alarm	Gas Compartment	CHLAB_TRAFAG_879x	Arc Detected	2022-11-10 / 11:00:36
 Information	System	CCM1_watchdog_alarm	see System Log	2022-11-10 / 10:58:13

Figure 4.44: Event list


The event status has a colored icon the color code is given in Table 4.3.

The event list can be cleared with the “Clear Events” button below the list. If the list is cleared no event is shown even if there is any pending event.

Event List

Event Status	Type	Location	Parameter	Date
Event Status	Type	Location	Parameter	Date
No data available in table				
Last events clear time : 2023-03-03 / 13:02:16				
→Clear Events →Download Events				

Figure 4.45 Clear and download button for event list

 Note: To allow publishing of 24-hour alarms only during working hours, an alarm publishing window (time frame) can be configured. When alarm publishing window is configured then 24-hour alarms are published only during that time frame. Following alarms are 24-hour alarms and affected by this configuration "Leakage rate alarm", "Time to stage 1", "Time to stage 2", "Daily motor starts without operation"

The warnings/alarm history can be downloaded via the “Download Alarms” Button. The download will provide an excel CSV file (see Figure 4.46)

	A	B	C	D	E	F	G	H	I	J
1	4	2	DemoStation	Q01	BH11	pressure	2021-04-09T12:27:58.1460Z			
2	4	2	DemoStation	Q01	BH01	pressure	2021-04-09T12:27:58.1460Z			
3	1	2	DemoStation	Q01	BH01	pressure	2021-04-09T12:48:02.1450Z			
4	4	2	DemoStation	Q01	BH11	pressure	2021-04-09T13:03:00.5690Z			
5	4	2	DemoStation	Q01	BH01	pressure	2021-04-09T13:03:00.5690Z			
6	4	2	DemoStation	Q01	BH01	pressure	2021-04-30T08:29:51.2560Z			
7	5	2	DemoStation	Q01	BH01	leakage	2021-04-30T08:29:51.2560Z			
8	4	2	DemoStation	Q01	BH01	timeToStage2	2021-04-30T08:29:51.2560Z			

Figure 4.46: Downloaded alarm history table

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4.6.10. System error message

System errors like sensor status errors will be displayed in the Web Interface as a red message in the upper left of the page (see Figure 4.47). It is visible in every level of the Web Interface and will be resolved by removing the root cause of the failure,

For the message “End of Life Time: CCM” refer to chapter 6.1.

The system errors will trigger binary output 2. It is also communicated via the communication protocols IEC61850 or DNP3.

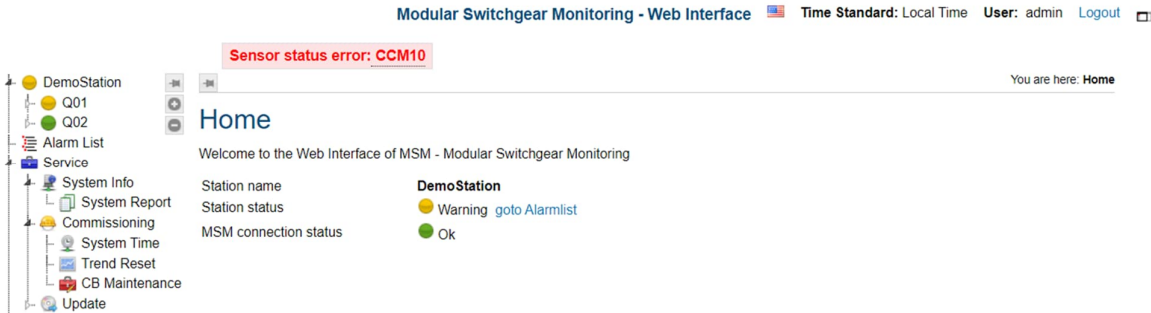


Figure 4.47: System errors are shown in the Web Interface

4.6.11. Equipment

In the section “Equipment” every MSM stack has its branch. These branches consist of four nodes (in administrator mode).

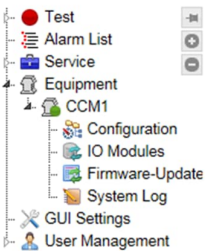


Figure 4.48: MSM tree navigation with equipment branch. All other branches are collapsed, just one CCM is connected to the system.

4.6.11.1. Configuration

Configuration displays information about hardware, network settings, time settings, and the general configuration. These parts are separated by tabs (see Figure 4.49).

Configuration

Hardware	Network Settings	Time Settings	Configuration
System Status	OK		
Firmware Version	2.2.4		
Firmware Date	Dec 23 2022 16:35:52		
MSM Web version	2.2.4_28		
MSM Build date	Dec 23 2022 16:16:03		
MAC-Address	50:2D:F4:2F:F2:90		
CPU Board Production Number	00068565		
CCM S/N	87097068		
CCM Manufacturer	ABB AG		
RAM Total	15.921.152 bytes		
RAM Free	11.624.448 bytes		
SD Card Total	950.235.136 bytes		
SD Card Free	941.379.584 bytes		
SD Card S/N	449188836		
SD Card Revision	1.0		
SD Card Name	AF UD		
SD Card Manufacturing Date	12/2021		
Device Startups	126		
Device Uptime Since Reset	0 days 1 hours		
Device Total Uptime	0 days		

Figure 4.49: Configuration subpage tab hardware

The hardware tab shows different information like system status, firmware version, serial of CCM, and device startups. The total size of SD card storage and RAM drive is displayed. Additionally, the free space on storage is shown.

The network settings tab consists of IP address settings and an overview of running services. The configured IP address is displayed as a static IP address. The configured time server (SNTP server) details are shown. If the IEC61850 server or DNP slave is activated the settings will be displayed, too. A startup log download of the IEC61850 server is displayed. The log file is zipped, and the user needs the user permission for the download. If not, the download is not displayed.

Configuration

Hardware	Network settings	Time settings	Configuration
Static IP address	172.16.5.11		
Subnetmask	255.255.0.0		
Default gateway	not configured		
DHCP client	active - IP assigned: 192.168.0.157 255.255.255.0		
SNTP client	not configured		
SNTP server 0	not configured		
SNTP server 1	not configured		
IEC 61850 server	not configured		
IEC 61850 comtrade output	not configured		
DNP3 slave	not configured		

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Figure 4.50: Configuration subpage tab network settings

Configuration

Hardware

Network settings

Time settings

Configuration

SNTP client

no sync

Timezone

UTC +1 (W. Europe Standard Time)

UTC time

2016-03-08 10:24:51

Local time

2016-03-08 11:24:51

Set MSM local time

2016-03-08 10:48:36

+ Set time

Set system local time

2016-03-08 10:48:36

+ Set time

Daylight savings

running

DST start

last Sunday in March at 02:00

DST end

last Sunday in October at 03:00

Figure 4.51: Configuration subpage tab time settings

At the beginning of the time settings tab, the connection status of the SNTP server is shown. After that, the time zone and the configured time are displayed. The time of the selected MSM stack or the complete system can be updated by entering the time (see Figure 4.52) and clicking on “set time”. The time can be selected in the set time dialog or can be entered in the input field. User permission is required to set time otherwise the command is not displayed.

Set MSM local time

Set system local time

Daylight savings

DST start

DST end

2016-03-08 10:48:36

+ Set time

March 2016

Mo	Tu	We	Th	Fr	Sa	Su
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Time

10:48:36

Hour

00

04

08

12

16

20

Minute

00

10

20

30

40

50

Second

00

10

20

30

40

50

Now

Done

Figure 4.52: Set time dialog

There are two ways to set the time. “Set MSM local time” set the time of the selected MSM stack. “Set system local time” sets the time of all MSM stacks in the MSM system.

The significance of the “Set Time” command is to keep the seasonal correction if possible, even if the system date is changed. The correction factors are calculated by MSM itself.

If the set date time difference is greater than 2 days (See Figure 4.53) to the current CCM date, a dialog box appears prompting the user to confirm yes, no, or cancel the operation (See Figure 4.54).

Configuration

HardwareNetwork settingsTime settingsConfiguration

SNTP client
Timezone
UTC time
Local time
Set MSM local time
Set system local time
Daylight savings

no sync
UTC +0 (UTC)
2021-09-08 07:30:54
2021-09-08 07:30:54
2021-09-12 09:29:24
September 2021
Su Mo Tu We Th Fr Sa
1 2 3 4
5 6 7 8 9 10 11
12 13 14 15 16 17 18
19 20 21 22 23 24 25
26 27 28 29 30
Time 09:29:24
Hour 00 04 08 12 16 20
Minute 00 10 20 30 40 50
Second 00 10 20 30 40 50
Now Done

Figure 4.53: Set time dialog with time difference greater than 2 days

Configuration

HardwareNetwork settingsTime settingsConfiguration

SNTP client
Timezone
UTC time
Local time
Set MSM local time
Set system local time
Daylight savings

no sync
UTC +0 (UTC)
2021-09-08 07:33:02
2021-09-08 07:33:02
2021-09-12 09:29:24
2021-09-08 09:29:24
not configured

Assign correction values

Assign correction value for DateTime will impact the calculated value. Please Confirm to recalculate the value ?

CancelYesNo

Figure 4.54: Set time confirmation dialog

On clicking “Yes”, a dialog appears showing progress and the final status of the set time command. (See Figure 4.55, Figure 4.56).

The CCM current date-time is updated to the new date time and the seasonal correction will be recalculated and get stored in the database

Log entry is added to the system log.

Please wait

Setting of MSM time is completed

Please wait !

MSM Stack: Initialization
Current step: Initialization

Figure 4.55: Set time progress dialog

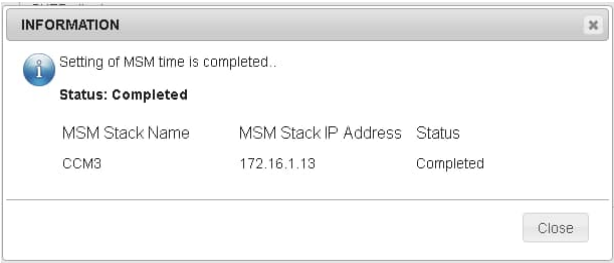


Figure 4.56: Set time status dialog

On clicking “No”, a dialog appears showing progress and the final time set status is displayed (See Figure 4.57, Figure 4.58)

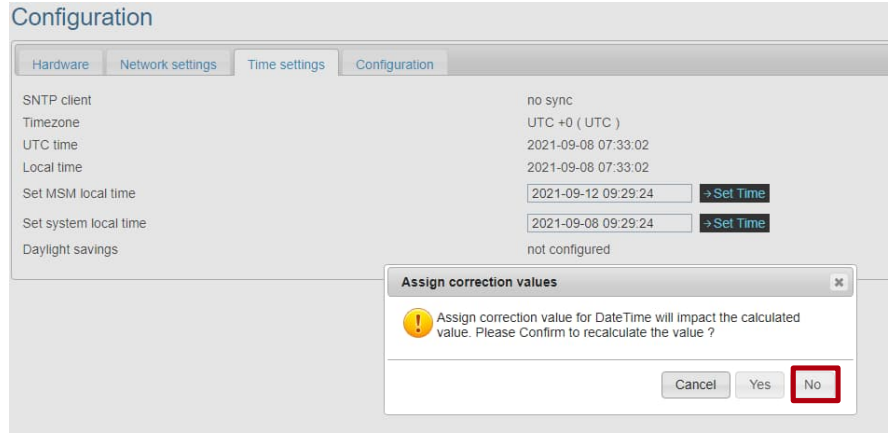


Figure 4.57: Set time confirmation dialog for no

The CCM current date-time is updated to the new date-time and values are not recalculated after this event.

13 months after this event monthly correction values are newly calculated and existing correction values will be reused. But there will be a mismatch between the old values and the new values. Log entry is added to the system log.

On clicking cancel (see Figure 4.58):

Abort date-time update

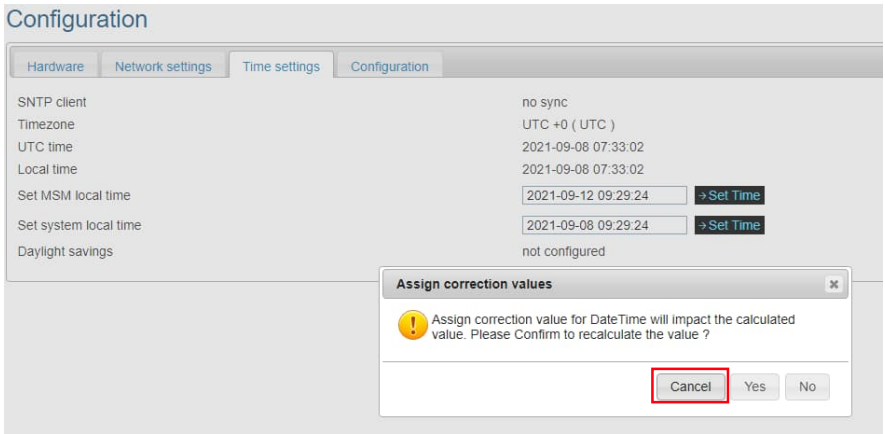


Figure 4.58: Set time confirmation dialog for cancel

If the set date time difference is less than 2 days to the current CCM date (See Figure 4.59 below) and click onset time, a dialog appears showing progress and the final status of the set time command (See Figure 4.55, Figure 4.56)

The CCM current date-time is updated to the date-time sent through the “set time” (see Figure 4.59)

UTC time

Local time

Set MSM local time

Set system local time

Daylight savings

2017-06-08 13:38:12

2017-06-08 13:38:12

2017-06-09 12:42:55

→ Set time

June 2017

Mo

Tu

We

Th

Fr

Sa

Su

1

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

Time

12:42:55

Hour

00

04

08

12

16

20

Minute

00

10

20

30

40

50

Second

00

10

20

30

40

50

Now

Done

Figure 4.59: Set time dialog with a time difference of less than 2 days

Configuration

Hardware

Network settings

Time settings

Configuration

MSM configuration file (.zip)

IEC 61850 system configuration file (.scd)

Signal list (.pdf)

Engineering test report (.pdf)

User management

Alarm Acknowledgment

Upload MSM configuration (.zip)

Upload MSM system configuration (.mzip)

Upload display language file (.xml)

Upload web language file (.json)

msmConfig_CCM1.zip

iec61850_MSM_scd.scd

msmSignalList_CCM1.pdf

msmTestReport_CCM1.pdf

not configured

running

→ Select file

→ Select file

→ Select file

→ Select file

Figure 4.60: Configuration subpage tab configuration

In the last tab, the configuration can be uploaded and downloaded. Language files for the webserver can be added and the display language file can be updated. The format of a file upload is displayed in brackets (see Figure 4.60). The file upload is described in chapter 4.6.4.3.

4.6.11.2. Firmware update

The firmware update procedure for Web Interface is described in 4.11.

4.6.11.3. System log

The system log shows all events listed in a table with several columns (see Figure 4.61). The first column presents an event counter. The timestamp is displayed in the second column. The last three columns describe the event and the location. The last 200 events are listed. The complete system log can be downloaded by a download link below the system log list.

System Log






 No	 Timestamp (local)	 Class	 Location	 Description
9183	2013-11-10 01:28:32	Alarm	DemoStation_Q01_BH09	Pressure ALARM
9182	2013-11-10 01:24:29	Event	DemoStation_Q01_BH09	Pressure OK
9181	2013-11-10 00:22:53	Alarm	User management	initialized
9180	2013-11-10 00:22:50	Alarm	DemoStation_Q01_BH09	Pressure ALARM
9179	2013-11-10 00:22:49	Info	MSM Kernel init	startup finished
9178	2013-11-10 00:22:48	Info	LCD 1	initialized
9177	2013-11-10 00:22:47	Info	MSMB	All IO Modules initialized
9155	2013-11-09 17:06:06	Event	DemoStation_Q02_BH21	Sensor status OK
9154	2013-11-09 17:06:06	Event	DemoStation_Q02_BH11	Sensor status OK
9153	2013-11-09 17:06:06	Event	DemoStation_Q02_BH09	Sensor status OK
9152	2013-11-09 17:06:06	Event	DemoStation_Q02_BH01	Sensor status OK

Figure 4.61: List of system log

4.6.11.4. I/O modules

The node I/O modules display the status of all I/O modules of these MSM stacks and the current measured values of the sensors. Additionally, the configured type of measurement and the connected gas compartment are shown.

4.6.12. GUI Settings

At the GUI setting page, the following user interface settings are configurable. These user-specific settings are stored on the computer which means they depend on the device which you use to connect to the MSM.

Show status update time: If chosen, a countdown is shown on the Web Interface until the next status update (an automatic data update in Web Interface occurs every 120 s). The countdown is displayed below the navigation tree.

Session Timeout enable session management: If session management is enabled, the Web Interface will automatically log off after "session timeout" and a new log-in is required.

Language: The language of the Web Interface can be changed by selecting a radio button in the language section.

Screen version: The Web Interface supports two screen layouts, which can be changed by a button in the title region (see chapter 4.6.4). In the default screen layout, the width of the page is limited by the page style. In the widescreen layout, the page is maximized to the open browser window.

Navigation node sorting: This field allows to sort the navigation nodes either alphabetically or according to the configuration of the MSM.

Time display: This field allows to change the shown timestamp in the Web Interface. The timestamps in the Web Interface can be shown as UTC Time or local time. The PC/browser time zone setting is used for conversion from UTC to local time.

To modify settings, the field *save and reload* must be clicked.


GUI Settings


Show status update timer: ☐


Session timeout sec


Enable session Management ☐


Language:


☐  deutsch

☐  english [GB]


☒  english [US]


☐  français

☐  русский


☐  中文


Screen version:

☒  default screen version


☐  wide screen version


Navigation node sorting:

☐  Sort according to configuration

☒  Sort alphabetically

Time display:

☐  Show UTC time

☒  Show local time

[→Save and reload](#) [→Set to default](#)

Figure 4.62: GUI settings on Web Interface

4.6.13. User Management

The user management section is only displayed in the navigation view if it was enabled in the MSM configuration and the user has logged in as administrator.

The encrypted user passwords are stored on each MSM CCM.



Figure 4.63: User management navigation

4.6.13.1. User groups

There are four user groups. The access rights of all groups are displayed at the *Add user* and *Edit user* subpage.

The *Guests* group members have got read access and are not password protected.

The *Monitoring users* group members have the same access rights as guests but are password protected.

The *Engineers* group members have the same access rights as the *Monitoring users*. Additionally, they can interact with the MSM by firmware updates, configuration up-and-download, alarm acknowledgment, and trend calculation reset.

For firmware version 1.2.0 and higher a *Remote access user* group is added. This group has no access to the Web Interface but can connect via SFTP and SSH to the MSM system (only for usage in service cases).

The *Administrator* group members have full access to all functions of the MSM.


4.6.13.2. Default users

There is one default user.

Name: admin

Passwords: abb

User group: *Administrator* group

 Note: The connections to all configured MSM stacks must be established to be able to change the user management settings. Otherwise, an infobox is displayed, and all acknowledged buttons are disabled.

4.6.13.3. Add user

A new user can be added in the *Add User* page. The Group in which the user is placed defines the access rights in the Web Interface.

Add User


Enter a user name for the new user, a password and a password confirmation. Select the user group in the table below. If the confirm button is disabled an info message will be displayed.


User Name:


Password:


Confirm:


Group:


Guests


Monitoring users


Engineers


Remote access user


Administrators

Read Access	✓	✓	✓		✓
Password Protection		✓	✓		✓
Firmware Update			✓		✓
Configuration Upload			✓		✓
configuration Download			✓		✓
Alarm Acknowledgement			✓		✓
Trend Reset			✓		✓
User Management					✓
Remote Terminal access				✓	✓
Remote file transfer				✓	✓

Add user

Figure 4.64: Add User page

A minimal password policy is implemented by a warning is generated for passwords that are too short. Minimal 5 letters, alpha-numeric characters allowed.

Special characters are not allowed in the username and password. The entered characters are validated, and forbidden characters are printed out (see Figure 4.65). Usernames must exist of at least three characters and passwords of at least five characters. The password must be repeated in the confirmation box.

User Name:

test(=\$


Forbidden characters in input: \$, (, =

Password:

Confirm:


Group:


Figure 4.65: Forbidden characters in username

 Note: Using an empty password is not allowed.

The user group is selected by clicking at a column of table below. This table also describes the access limits of each user group. A column will be selected if it is marked and the radio button in the column is activated.

After a guest group selection, the username and the password are filled automatically and are not editable because the guest user group does not need a user authentication to log in.

 Note: If the guest user group has got a member and is selected a second time to add a new user an info box will be printed out and the acknowledge button will be disabled.



 Note: Only one member can be added to the guest user group.

4.6.13.4. Edit user

The Edit User page allows to change a user's password or to move a user into another group with different access rights.

Edit User

To edit a user you has to select a user in the following section.

User name: ☐  Guest / Guests
☐  admin / Administrators

There are two possibilities to edit a user:






- Change user password
- Change user group

Enter the new password and a password confirmation. To apply the password change click at the button below the password confirmation box.

Password:
 Confirm:

[→Change password](#)

The current user group is preselected. Select a new user group by clicking at the column in the table and click at the button below the table to apply the new user group.


	 Guests	 Monitoring users	 Engineers	 Remote access user	 Administrators
	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Read Access	✓	✓	✓		✓
Password Protection		✓	✓		✓
Firmware Update			✓		✓
Configuration Upload			✓		✓
configuration Download			✓		✓
Alarm Acknowledgement			✓		✓
Trend Reset			✓		✓
User Management					✓
Remote Terminal access				✓	✓
Remote file transfer				✓	✓

[→Change user group](#)

Figure 4.66: Edit User page

After selecting an existing user in the first part of the page, the password or user group can be changed. The user group of the selected user is marked automatically. The guest user is protected and cannot be edited.

A minimal password policy is implemented by a warning is generated for passwords that are too short.

 Caution: It is strongly recommended to change the default administrator password after commissioning!


4.6.13.5. Delete User


The *Delete User* page allows removing a user from the internal user database. This cannot be undone! At least one user must always be a member of the administrator group. This is enforced by internal logic in a way that the last administrator user can neither be deleted nor moved to another group.

Delete User

Select the user who should be deleted and click at the button below to delete the selected user.

User name

☐  Guest / Guests

☐  admin / Administrators

[→Delete selected user](#)

Figure 4.67: Delete user page

Guest user

In the section *Add user* a guest user account can be activated by adding a member to the user group “Guest”. The guest account can be deleted at the *Delete User* page. With an activated guest user, an additional *Login as guest* button appears on the login start page.



Login

Welcome to the Web Interface of MSM - Modular Switchgear Monitoring

[→Login](#)

[→Login as guest](#)

Figure 4.68: Guest user button on the login page

-  Note: A guest has identical user privileges like Monitoring users, but no login is needed.
-  Caution: A guest user should only be activated for demo systems or if no unauthorized persons have access to the monitoring network, to which the MSM is connected.

4.7. Binary outputs CCM

The CCM provides two potential-free contacts, a Warning/Alarm, and a Watchdog binary output.

Configurability of both binary outputs is realized using a relay that is energized or de-energized in a normal state.

4.7.1. Warning/Alarm output (BO 1)

The first binary output indicates critical leakages or pressure levels in all gas compartments connected to the individual CCM (stack). It is wired through contacts 11 and 12 (see Figure 2.3).

By default, this output is *normally open*. This can be changed to *normally closed* by configuration (contact MSM Support).

Table 4.7: Binary output 1 status change parameters

Binary Output 1 Mode	Parameter
Warning mode	Pressure level drops below stage 1 OR
	The leakage rate is above leakage warning threshold OR
	Sensor status invalid
Alarm mode	The pressure level is below stage 2 OR
	The leakage rate is above leakage alarm threshold OR
	Sensor status invalid

4.7.2. Watchdog output (BO 2)

The second binary output reflects the system status of the MSM system. It is wired through contacts 13 and 14 (see Figure 2.3)

Per default, this output is *normally closed*. This can be changed to *normally open* by configuration (contact Hitachi Energy). In normally open mode the binary status BO2 will not change if the system is switched off or the power supply fails.

Table 4.8: Binary output 2 status change parameter (normally open mode)


Binary Output 2 Mode	Parameter
Watchdog	System switched off OR
	I/O module connection error OR
	CCM internal errors

4.8. Local touch panel

4.8.1. Overview

A local touch panel can be connected to a CCM to display the monitored values locally, for example on the front panel of a local control cubicle. The touch panel has two Ethernet ports. At one port the connection to the MSM stack is given. On the other port, an Ethernet switch can be connected.

The mapping of gas compartments to the local touch panel is done during the MSM engineering. For bay-wise stacks (see chapter 2.3.1) one local touch panel can be connected to every bay.

 Note: Each local touch panel can only display monitoring values of the CCM it is directly connected to.

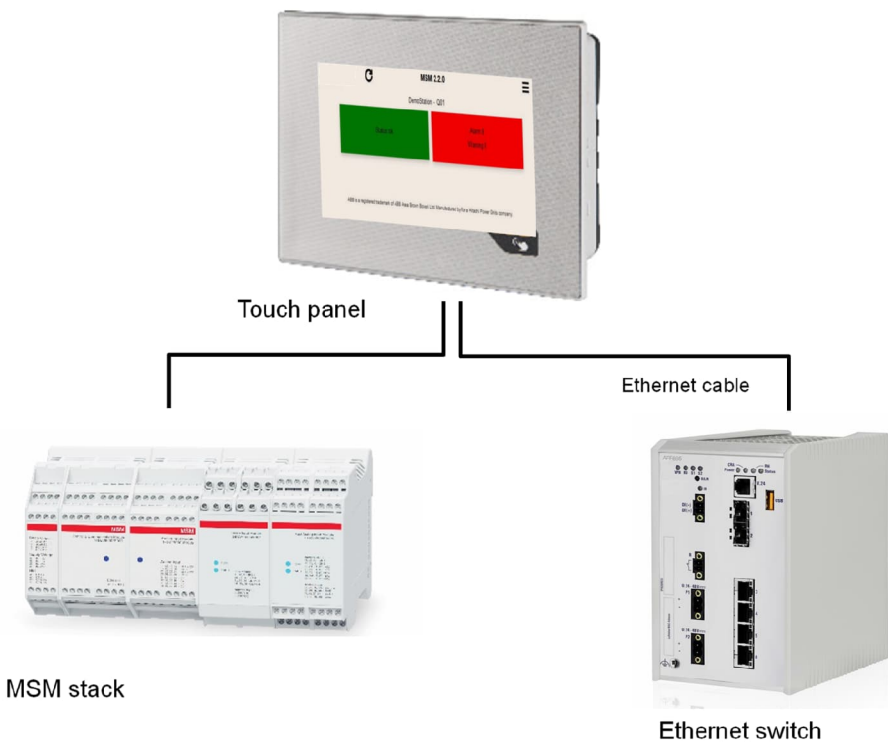



Figure 4.69: Touch panel connection to MSM stack


 Caution: MSM and touch panel are only intended for use in an Intranet. Direct connection to the internet is forbidden

4.8.2. Navigation

4.8.2.1. Login to the local touch panel

With a restart of the connected CCM, a user authentication on the touch panel might be required. User credentials are similar to user credentials of the Web Interface of the CCM

For first access, use the default username and password (see chapter 4.6.13.2). Change the password following the instructions in 4.6.13.4 once successfully logged in.

 Caution: The default password should be changed in the user management section (see chapter 7.3.9).

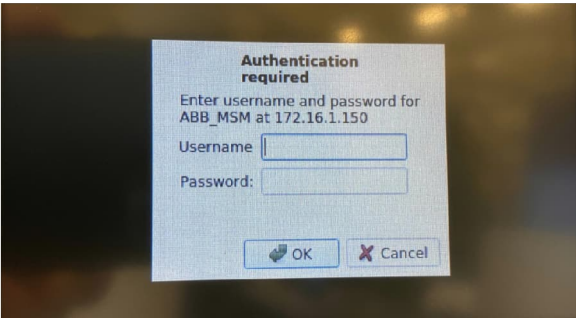


Figure 4.70: User authentication on the local touch panel

4.8.2.2. Dashboard

The Dashboard (Figure 4.71) of the local touch panel is the start page of the touch panel. On the Dashboard, an overview of the system and warning/alarm status is given with two rectangles with color indications. The color meaning is given in Table 4.3. If there are alarms or warnings, touching the “alarms/warnings” rectangle will open the event list.

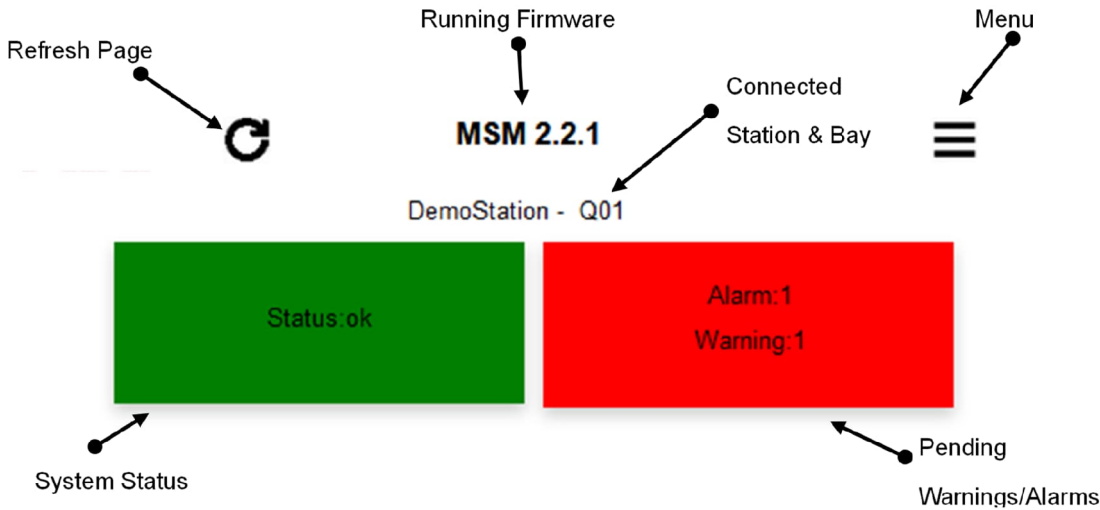


Figure 4.71: Dashboard of the local touch panel

4.8.3. Menu

The local touch panel has a menu (Figure 4.72) in which the following subpages can be found:

- Dashboard – Start page of the local touch panel
- Gas Compartments – List of monitored gas compartments
- Circuit Breaker – List of monitored circuit breaker (optional)
- Disconnecter – List of monitored disconnectors (optional)
- Heater – List of monitored heaters (optional)
- Event list – List of pending warnings/alarms
- System Log – List of events in MSM stack
- Service Menu – Consist of information about CCM configuration, connected I/O modules, and MSM reset

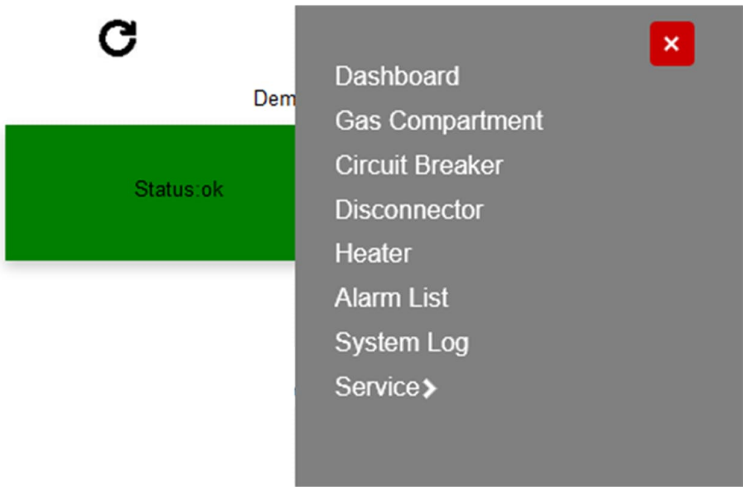


Figure 4.72: Menu of the local touch panel

4.8.3.1. Gas compartment list

In the Gas Compartment list (see Figure 4.73) the monitored gas compartments are listed. Additional information like warning/alarm status, pressure value, leakage rate, Time to Stage 1, and Time to Stage 2 are given. If humidity monitoring is enabled for a gas compartment the humidity values are also given.

MSM 2.2.1								
Gas Compartment								
Status	GC	Pres	Leak	DtSt1	DtSt2	Humidity	Dew Pt	Temp
●	DemoStation_Q01_BD0	111 kPa	0.0 %	∞	∞	10611.8 ppmv	8.1 °C	24.0 °C
●	DemoStation_Q01_BD1	702 kPa	---	∞	∞			
●	DemoStation_Q01_BD2	705 kPa	0.0 %	∞	∞			
●	DemoStation_Q01_BD3	702 kPa	---	∞	∞			

Figure 4.73: Gas Compartment List of the local touch panel

In the gas compartment list, a link to the gas compartment page is given. On the gas compartment page (Figure 4.74) detailed information about the gas measurement can be found.

After an MSM restart, it takes up to 5 minutes for measurements to update.

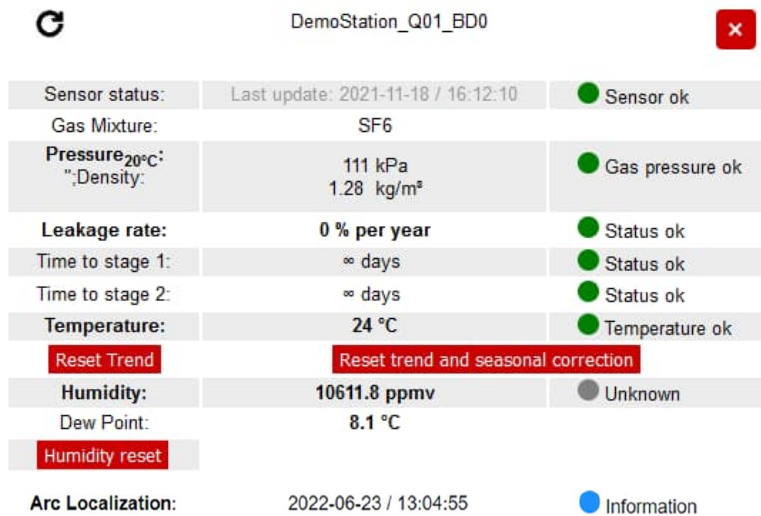


Figure 4.74: Gas Compartment page of the local touch panel

4.8.3.2. Circuit breaker overview

In the circuit breaker list (see Figure 4.75) the monitored circuit breakers are listed. Additional information on its status in the subpage's accessories, mechanical, and wear is given.

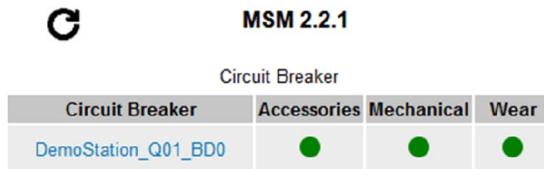


Figure 4.75: Circuit breaker list in the local touch panel

The link in the list opens the circuit breaker subpage accessories (see Figure 4.76) with the information's about the circuit breaker parameters like monitor counter, motor current peak, and motor runtime. Next to the subpage Accessories the subpages Mechanical and Wear are shown. The subpage Mechanical (see Figure 4.77) contains the timing of the breaker and the Wear subpage the calculation for contact wear (see Figure 4.78).

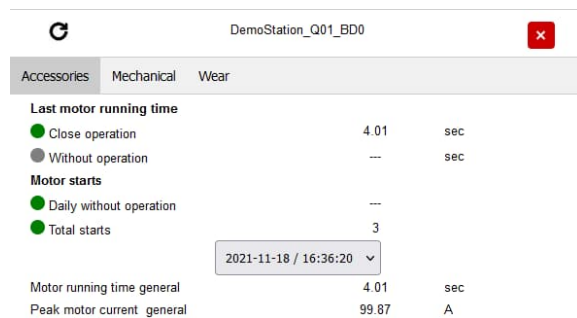


Figure 4.76: Accessories tab of CB monitoring in the local touch panel

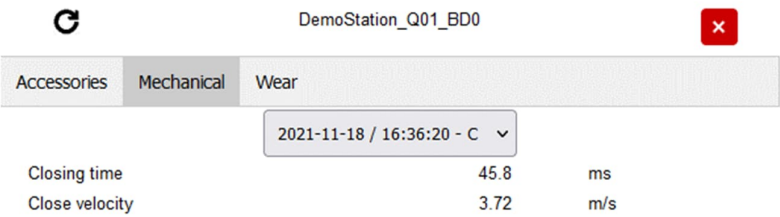


Figure 4.77: Mechanical tab of CB monitoring in the local touch panel

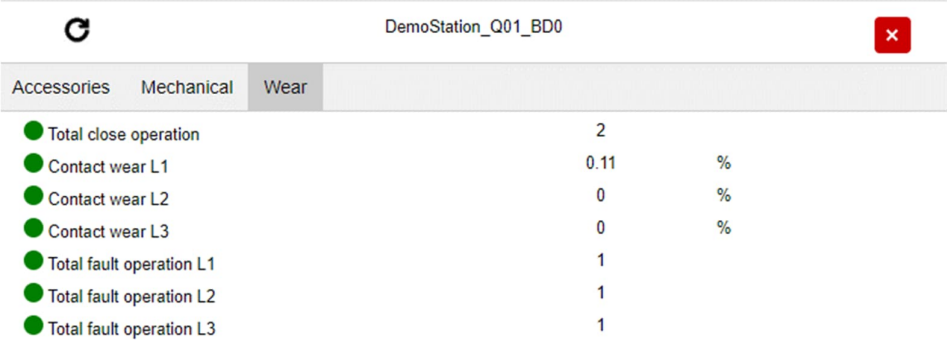


Figure 4.78: Wear subpage of CB monitoring in the local touch panel

4.8.3.3. Disconnecter Overview

In the disconnecter list (see Figure 4.79) the monitored disconnecters are listed. Additional information on its status is given.

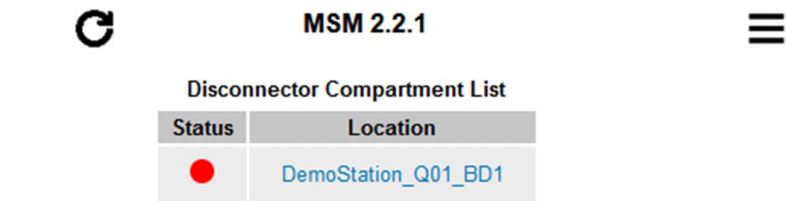


Figure 4.79: Disconnecter list in the local touch panel

The link in the list opens the disconnecter subpage (see Figure 4.80) with information about the disconnecter parameters like motor counter, motor current RMS, and motor runtime.

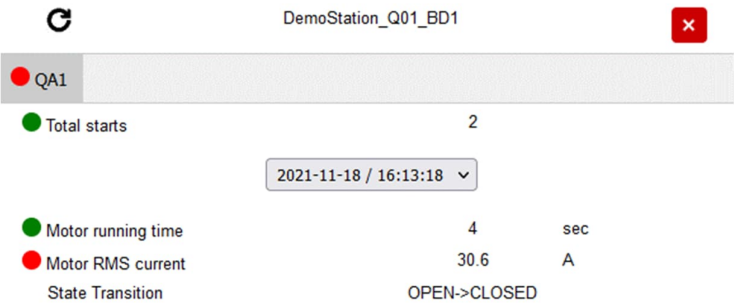
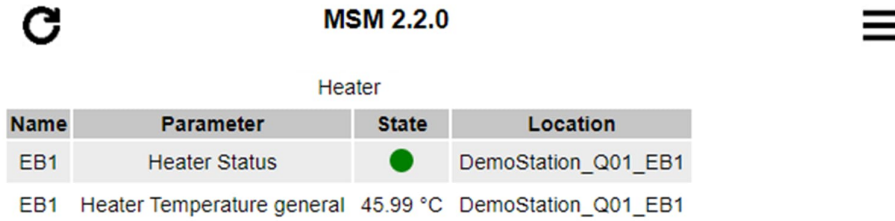


Figure 4.80: Disconnecter subpage of the local touch panel

4.8.3.4. Heater Monitoring

In the heater list (see Figure 4.81) the monitored heaters are listed. Additional information like alarm status and temperature measurement (optional) is given.



Name	Parameter	State	Location
EB1	Heater Status	●	DemoStation_Q01_EB1

EB1 Heater Temperature general 45.99 °C DemoStation_Q01_EB1

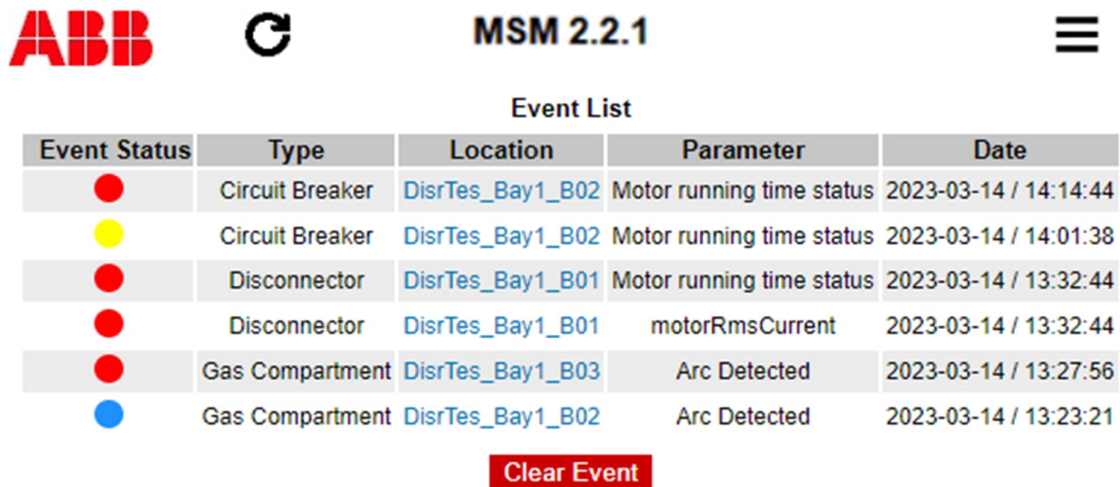
Figure 4.81: Heater monitoring in the local touch panel

4.8.3.5. Event list

In the Event list of the local touch panel (Figure 4.82) the pending warnings/alarms in the connected bay are listed.

The list consists of alarm status (alarm shown as red, warning shown as yellow, information shown as blue), type of Warning/ alarm, location of warning /alarm, parameter, and time stamp.

The list in column location a link to the gas compartment page of the pending warning/alarm is given.



Event Status	Type	Location	Parameter	Date
●	Circuit Breaker	DisrTes_Bay1_B02	Motor running time status	2023-03-14 / 14:14:44
●	Circuit Breaker	DisrTes_Bay1_B02	Motor running time status	2023-03-14 / 14:01:38
●	Disconnecter	DisrTes_Bay1_B01	Motor running time status	2023-03-14 / 13:32:44
●	Disconnecter	DisrTes_Bay1_B01	motorRmsCurrent	2023-03-14 / 13:32:44
●	Gas Compartment	DisrTes_Bay1_B03	Arc Detected	2023-03-14 / 13:27:56
●	Gas Compartment	DisrTes_Bay1_B02	Arc Detected	2023-03-14 / 13:23:21

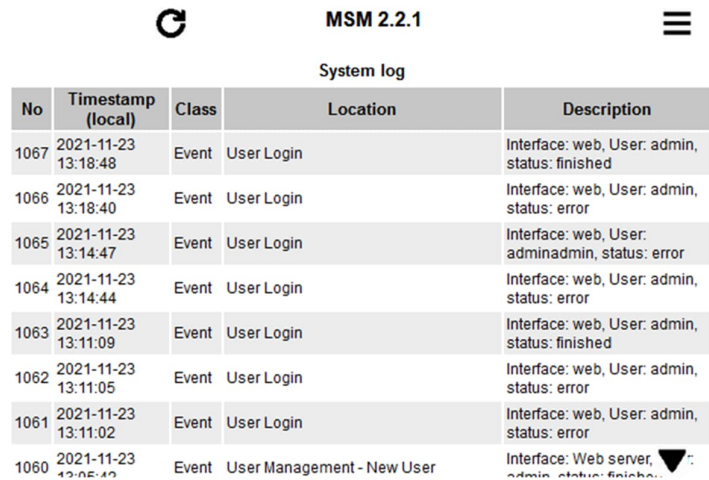
Clear Event

Figure 4.82: Event list of the local touch panel

4.8.3.6. System Log

In the System Log of the local touch panel *the events history* of the connected MSM is listed.

The list consists of event number, timestamp, class, location, and description.



No	Timestamp (local)	Class	Location	Description
1067	2021-11-23 13:18:48	Event	User Login	Interface: web, User: admin, status: finished
1066	2021-11-23 13:18:40	Event	User Login	Interface: web, User: admin, status: error
1065	2021-11-23 13:14:47	Event	User Login	Interface: web, User: adminadmin, status: error
1064	2021-11-23 13:14:44	Event	User Login	Interface: web, User: admin, status: error
1063	2021-11-23 13:11:09	Event	User Login	Interface: web, User: admin, status: finished
1062	2021-11-23 13:11:05	Event	User Login	Interface: web, User: admin, status: error
1061	2021-11-23 13:11:02	Event	User Login	Interface: web, User: admin, status: error
1060	2021-11-23 13:05:12	Event	User Management - New User	Interface: Web server, admin, status: finished

Figure 4.83: System log of MSM Stack in the local touch panel

4.8.4. Reset trend calculation

In the local touch panel, the leakage rate calculation and the seasonal compensation of a specific gas compartment in the connected bay can be reset.

The functionality can be found on the gas compartment page of the specific gas compartment.

Further information about the trend reset functionality can be found in chapter 4.2.4.

The trend reset process starts with the confirmations of the user and is done when the Information notification appears (see Figure 4.84).

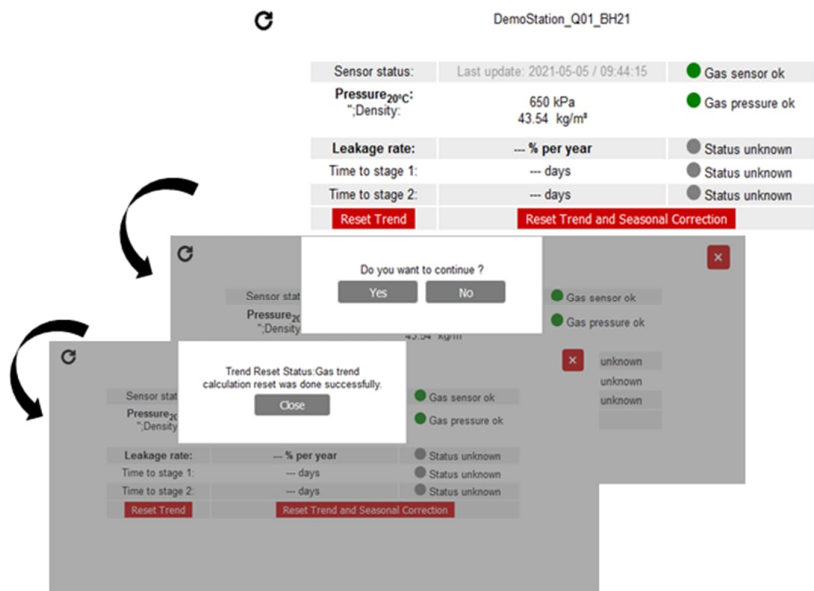


Figure 4.84: Trend reset in the local touch panel

4.8.5. Service menu

In the service menu of the local touch panel (Figure 4.85) the configuration, I/O modules and CCM Reset subpages can be found.

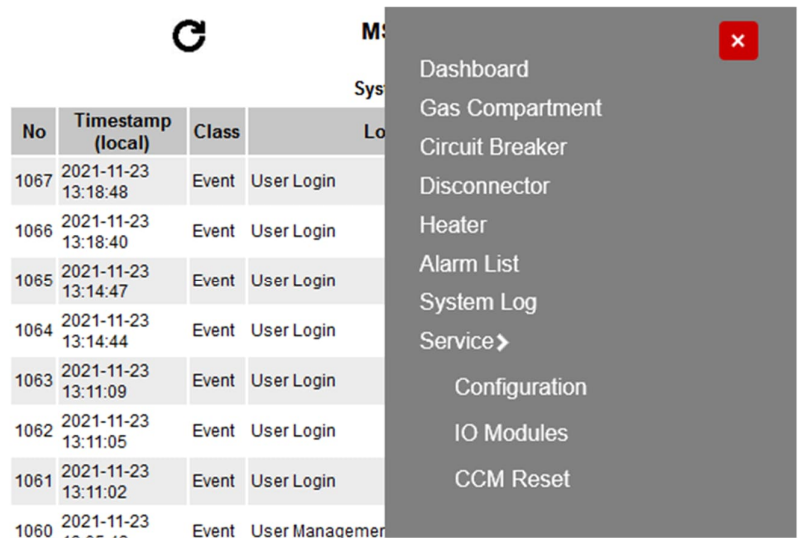


Figure 4.85: Service menu of the local touch panel

4.8.5.1. Configuration of CCM

On the subpage configuration in the service menu, detailed information like IP address, local time, and firmware version can be found (see Figure 4.86).

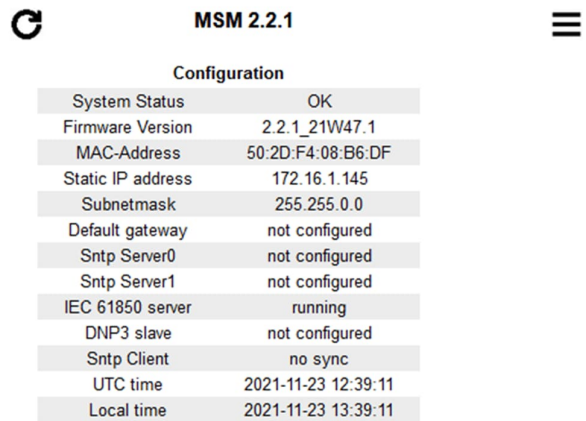




Figure 4.86: Configuration subpage of the local touch panel

4.8.5.2. I/O Modules of CCM

On the subpage I/O modules (Figure 4.87) in the service menu, detailed information's about the connected I/O modules can be found.



MSM 2.2.1




IO No.	IO type	Gas compartment	Value	Measurement type
Module 0 / CCM / 2.2.1 / Serial: 07158289 / Status ok				
0	bo	—	1.00	—
1	bo	—	1.00	—
Module 1 / AIM / 1.2.1 / Serial: 02140910 / Status ok				
1	Trafag hgdm	DemoStation_Q01_BD1	17.70 (ok)	mA
2	Trafag hgdm	DemoStation_Q01_BD2	17.76 (ok)	mA
3	Trafag hgdm	DemoStation_Q01_BD3	17.70 (ok)	mA
4	Current Sensor	DemoStation_Q01_BD0	17.68 (ok)	mA
5	Current Sensor	DemoStation_Q01_EB1	17.72 (ok)	mA
6	Temperature Sensor	DemoStation_Q01_EB1	17.76 (ok)	mA
Module 2 / CCM / 2.0.1 / Serial: 07146274 / Status ok				


Figure 4.87: I/O module subpage of the local touch panel

4.8.5.3. CCM Reset

On the subpage CCM Reset (Figure 4.88) in the service menu, the connected CCM can be reset.



MSM 2.2.1




CCM Reset

CCM Name :CCM1

Reset

Figure 4.88: CCM reset of the local touch panel




Note: Resetting a CCM clears the event list.

4.9. Local display

One local display can be connected to a CCM to display the monitored values locally, for example on the front panel of a local control cubicle.

The mapping of gas compartments to local display is done during the MSM engineering. For bay-wise stacks (see chapter 2.3.1) one local display can be connected to every bay.

 Note: Each local display can only display monitoring values of the CCM it is directly connected to.

4.9.1. Overview and startup

Local display component names used in the following chapters:

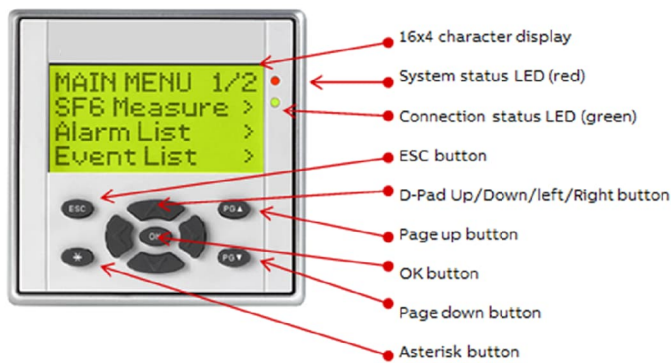
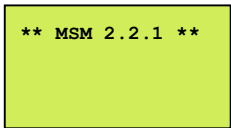
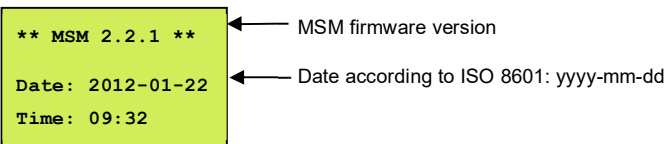


Figure 4.89: Local display component legend

After powering the local display, the preoperational page will be displayed if the connected CCM has not booted, yet. If the local display had been connected to a CCM before, the MSM firmware version will be displayed on the top line.



As soon as the CCM has booted, a connection to the local display(s) will be established and the startup page will be shown.



If a system error occurs, the explanation of the error code in the last row can be found in Table 5.4.

4.9.2. Status LEDs

4.9.2.1. Connection status LED (green)

The green connection LED indicates the connection between the local display and CCM.

Table 4.9: Description of green connection LED

LED state	Description and Solution
blinking 2s interval.	Local display is connected to CCM and was initialized
Static (on or off)	Local display connection to CCM is lost Check physical connection (CAN bus). Check Node ID if the pre-operational page is displayed (local display never connected to CCM)

4.9.2.2. System status LED (Red)

The red status LED indicates the system status and displays monitoring alarms.



Note: The red LED status can only be considered valid if the green LED indicates a working local display connection. This means the blink code of the red LED would remain in its current state if the connection between the local display and CCM is lost.

The Table 4.10 shows the mode of the red LED of the display.

Table 4.10: Red status LED of the display

LED state	Description and Solution
off	No alarm and no system error.
blinking	At least one pending alarm → Check the event list for details on pending alarms
flickering	System Error (I/O module defect, etc.). This blink code has a higher priority than the alarm blink code. → Check the error code on the main page. See Table 5.4 for error code details

4.9.3. Navigation

4.9.3.1. Button functions

When navigating the menu, the buttons have a default behavior which is displayed in the following table. If the user presses a button other than the default button is requested by the local display, this is clearly marked in the display (e.g., OK button for acknowledging date/time change)

Table 4.11: Local display navigation default functions

Button	Function
OK / Right	Enter the selected menu or jump to details of displayed entry in a list
Escape / Left	Go back to the previous (parent) menu or page.
Up / Down	Menu: Select the item above/below List: Switch to the next/previous page in a list. Push and hold the button to cycle through a list/menu faster.
Page up / Page down	Menu: Jump to the next/previous page (+-3 items) List: Jump up/down ten entries in. Hold the button Push and hold the button to cycle through a list/menu faster.

STATUS	SECURITY LEVEL	DOCUMENT ID	REV.	LANG.	PAGE
Approved	Public	2GHV045871	R	en	86/148

4.9.3.2. Content

Table 4.12 below shows the available information being displayed by the local display and the actions, which can be done by the local display.

Table 4.12: Local display content

Item	Description
Gas pressure per individual gas compartment (unit as shown on display)	Temperature compensated to 20°C, updated every 2 sec
leakage rate per individual gas compartment in % / year	Updated every 24 h. Available 14 days after the beginning of operation
Event list	Displays all monitoring alarms
Event history	
Configuration details	
IP settings	Shows the IP address of the connected CCM
Equipment	
Date / Time	
Reset MSM	

4.9.3.3. Menu structure

The Menu structure is shown in the following diagram. Dashed boxes are optional menus, depending on the configuration.

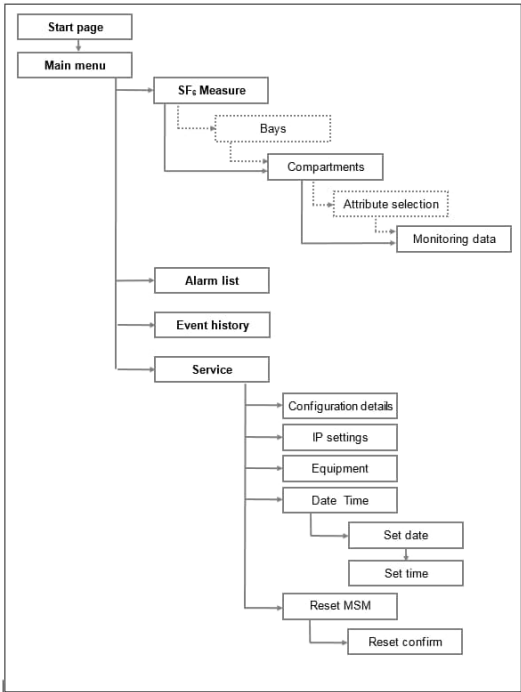



Figure 4.90: Menu structure

Note: The dashed bays menu is only shown if compartments of more than one bay are mapped to this local display. Otherwise, this menu is skipped, and the compartments menu is shown when entering gas measure. The dashed attribute selection menu is added if more than one attribute is configured for the selected compartment.

4.9.4. Reset trend calculation

Within the monitoring data menu, the trend calculation of gas pressure can be reset. The trend calculation includes the leakage rate, time to stage 1, and time to stage 2 calculations.

 Caution: Resetting of the trend calculation cannot be undone.

On the fourth page of the monitoring data menu, the trend can be started by pushing the Asterisk and the Page Up buttons.

B2034 / 4

Reset trend?

<^> -> to compt.

Compartment name

User hint, push '^' button to go to other details

User hint, push Asterisk button and Page Up button to reset trend

After pushing push Asterisk button and Page Up button a confirmation page is displayed. On this page, the trend reset can be canceled by pushing ESC button and confirmed by pushing the Asterisk and the Page Up button again.

Reset trend calc

in B203?

ESC -> cancel

Confirmation of trend reset with compartment name

User hint, push ESC to cancel

User hint, push Asterisk button and PgUp button to confirm trend reset

If the reset is confirmed the trend calculation will be reset and a reset successful result message will be shown. By pushing OK the monitoring data are displayed again.

B203

Reset trend calc

done successful

Compartment name

Result message of trend reset

4.9.5. Alarm management

4.9.5.1. Event list

Push the OK button or Right button to get more information about the alarm. Push the Left button to go back to the event list.

Every alarm page consists of an alarm state, an alarm type, and an alarm location. In the first line of an alarm page on the left side, the alarm state is placed. The alarm location is shown in the second line and is followed by the alarm type in the third line.

In the following example of the event list entry, there is a sensor status alarm in the gas compartment. This is the first of 20 entries in the event list.

ALARM001 / 020

Demo_E01_B200

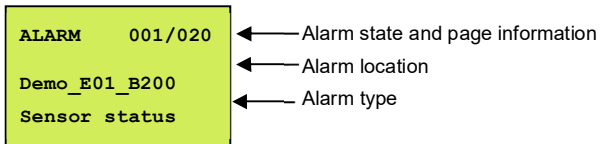
Sensor status


Alarm state and page information

Alarm location

Alarm type

If the alarm acknowledgement is activated, the acknowledge state is displayed in the last line of an event list entry page.



 **Note:** The event list is generated when opening the list, i.e., new alarms will not be added to the list while it is open. To get new alarms, close the list and open it again.

4.9.5.2. Alarm handling

The event list is reachable via two ways in the display (see Figure 4.91). If an alarm is pending, the list can be accessed directly from the start page and additional event list is entered in the menu structure.

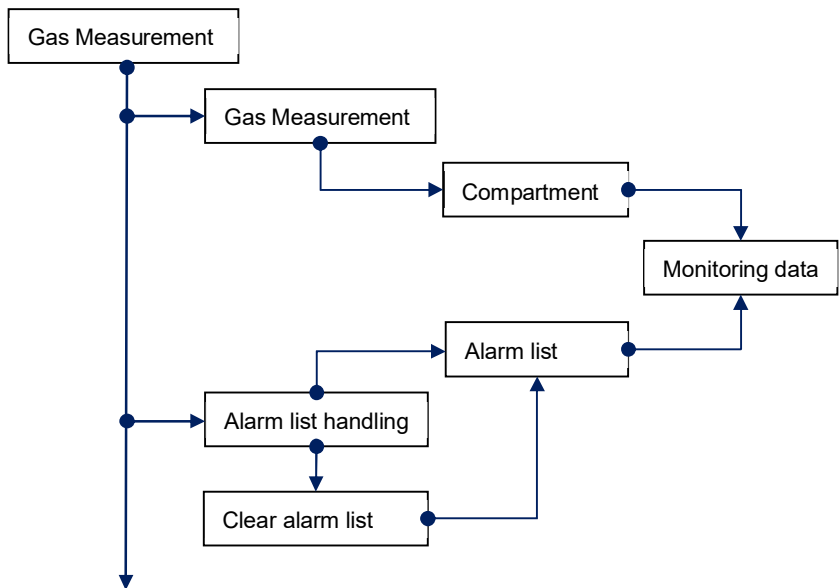
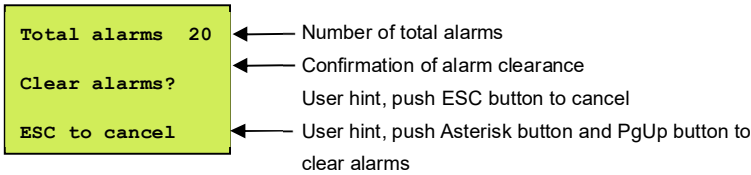
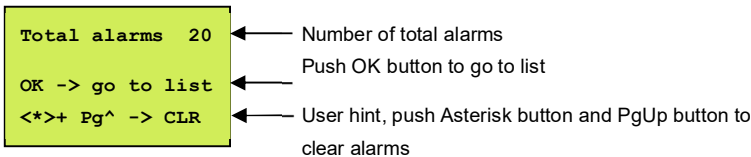
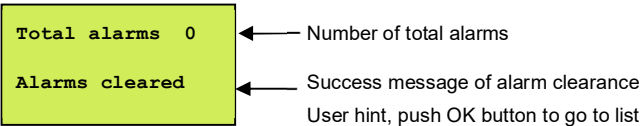


Figure 4.91: Event list in LCD display

The event list overview is updated cyclically and displays the number of pending alarms if they are not cleared. Push the OK button to navigate to the event list. To clear the alarms, push the Asterisk and the Page Up button and approve the alarm clearing by pushing the Asterisk and the Page Up button again at the confirmation page of alarm clearing.

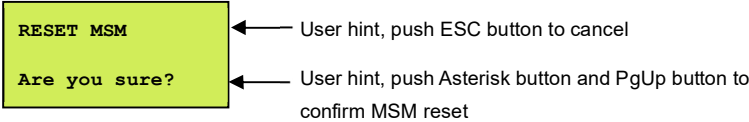


After the clearance of all alarms, a success message is shown at the local display with a link to the event list.



4.9.6. Reset MSM

In Service Menu, navigate to Reset MSM. The reset of the MSM must be confirmed by pushing the Asterisk button and Page Up button. During reset, an information page is displayed.



4.10. Substation communication protocols

MSM supports communication protocols as an interface to other devices, which can be i.e., a PC with a SCADA system. Depending on the ordered options, MSM provides IEC 61850 or DNP 3.0 interfaces.

Both protocols use TCP/IP as the base transmission protocol, which is based on Ethernet technology. See Table 4.13 to get an overview of the communication protocols provided by MSM.

Table 4.13: Communication protocol IEC 61850 and DNP3.0

Communication Protocol	Architecture	MSM role	Example
IEC 61850-8-1	Client-Server	Server	CCMs provide data via RCPs (Report Control Blocks) Device (i.e., PC/SCADA)
DNP3.0 (Distributed Network Protocol)	Master-Slave	Slave	Device (i.e., PC/SCADA) collects data from Slaves (MSM-CCMs) MSM-CCMs (one or several)

4.10.1. IEC 61850 interface

The MSM has an integrated IEC 61850 server.

Details about the used IEC 61850 nodes can be found in the IEC 61850 Communication Description for MSM [6].

An IEC 61850 client can use either the auto-detect function to receive the MSM node structure or import the station '.scd' file. The device's '.ccf' file can also be imported but must be renamed to '.cid' before.



Note: MSM has implemented an IEC 61850 MMS Server. GOOSE is not activated. In the following table, a comparison of MMS and GOOSE is given to get an overview of the purpose of both IEC 61850 parts.

Table 4.14: Comparison of IEC 61850 MMS and GOOSE

IEC 61850 part	Communication type	Support MSM	Example
IEC 61850-8-1 MMS (Manufacturing Messaging Specification)	Server-client communication → vertical communication	YES	Server: MSM, Bay controllers, Client: PC with SCADA
IEC 61850-8-1 GOOSE (Generic Object-Oriented Substation Events)	peer-to-peer → horizontal communication	NO	i.e. communication between several Bay Controllers

4.10.2. DNP3.0 interface

The MSM has an integrated DNP slave.

Details about the specified DNP data points for the MSM system can be found in DNP3.0 Communication Description for MSM [7].



Note: MSM provides the data as a Static Data function. Event-driven data functions are not supported.

4.11. Firmware update

- ! Note: It is recommended to update the configuration before a firmware update to version 2.1.0. Please contact MSM support for configuration updates.
- ! Note: The downtime of the MSM is minimized due to a fast and efficient update process and does not influence the substation or gas monitoring operation. Circuit breaker operations during the update process (about 5 minutes) will not be monitored.
- ! Note: The MSM Web Interface provides firmware updates for CCM and I/O modules.
- ! Note: Following descriptions depend on installed CCM firmware.
- ! Note: To update the firmware or configuration file, all CCMs shall be connected to a common Network Switch (see Figure 3.1).

4.11.1. Which Firmware is in use?

4.11.1.1. Checking Firmware version with Web Interface

The currently used firmware version can be seen on the main page at the right bottom

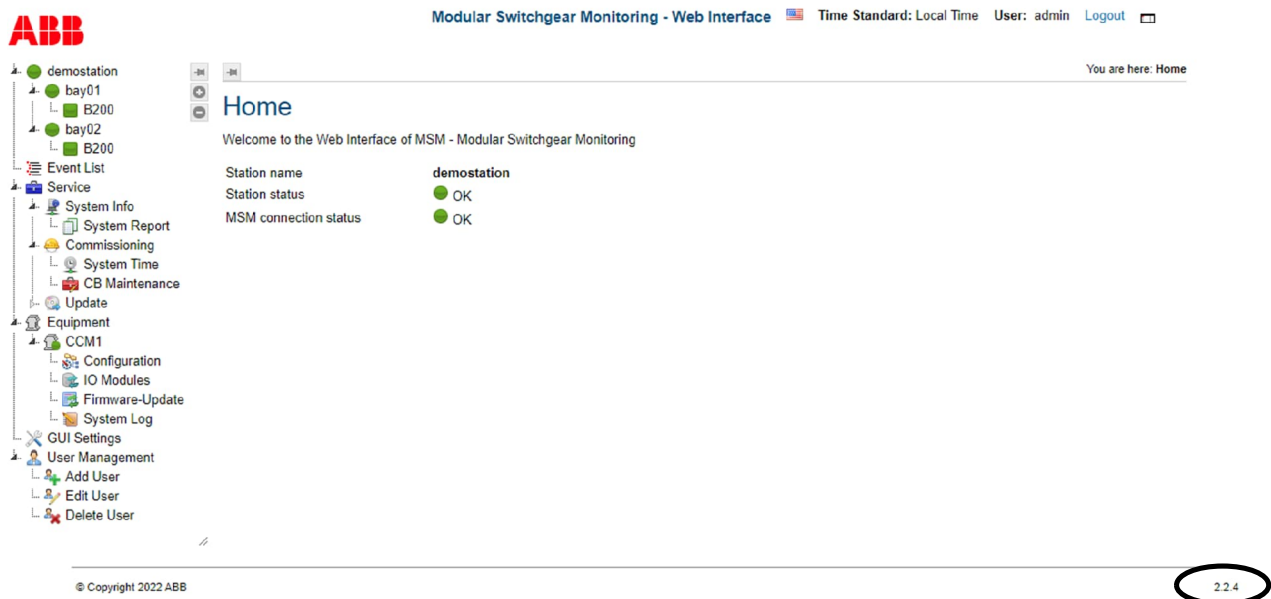


Figure 4.92: Firmware version via Web Interface

4.11.1.2. Checking Firmware version with Display (HMI)

The currently used firmware version can be seen on the HMI main page (see Figure 4.93). The first line on the main page shows the current firmware version. The version displayed on the HMI is only valid if the green LED blinks slowly (red circle). After a firmware update, the previous firmware version may be shown on the display. Leave the main page and return to it to see the current version.



Figure 4.93: Firmware version via HMI

4.11.1.3. Checking Firmware version with local touch panel

The currently used firmware version can be seen on the Dashboard of the local touch panel (see Figure 4.94).

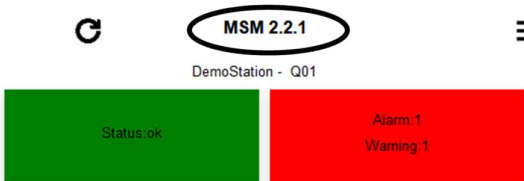


Figure 4.94: Firmware version in Dashboard of the local touch panel

4.11.2. Update of Firmware

From this firmware version on, the user interfaces differ from older versions.

The instruction starts at the Main page of the Web Interface.

Click on menu item "Service"

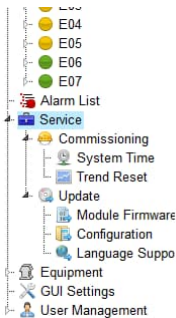


Figure 4.95: Service menu

Click on the menu item “Update” to expand this node for more menu entries.

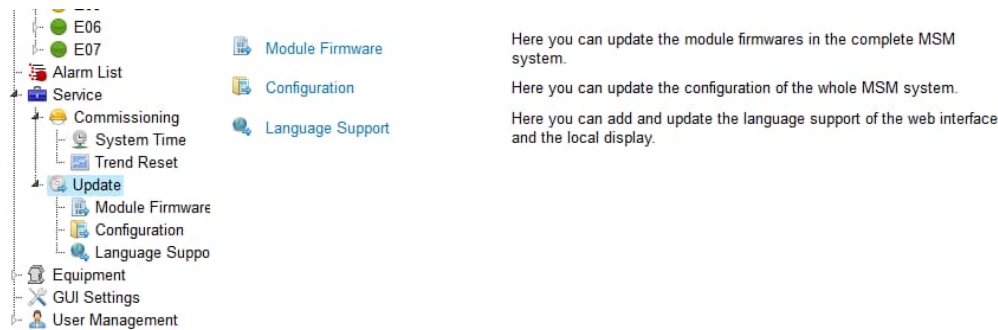


Figure 4.96: Overview of update option

Click on the menu item “Module Firmware” in the overview or directly in the tree view.

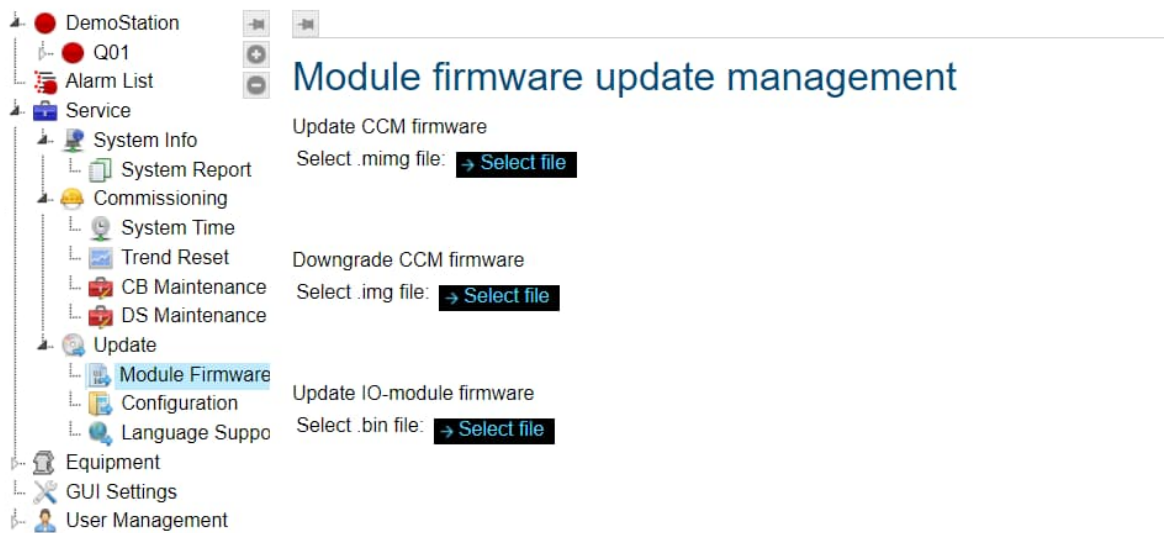


Figure 4.97: Firmware update Select file

Click on “→ Select File”. This opens a file open dialog. Navigate to your firmware image location and select the version you want to upload. When done, the file name is shown in Web Interface.

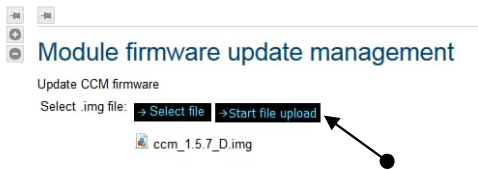


Figure 4.98: Firmware update with selected image file

Click on “→ Start file upload”. This opens a confirmation window.

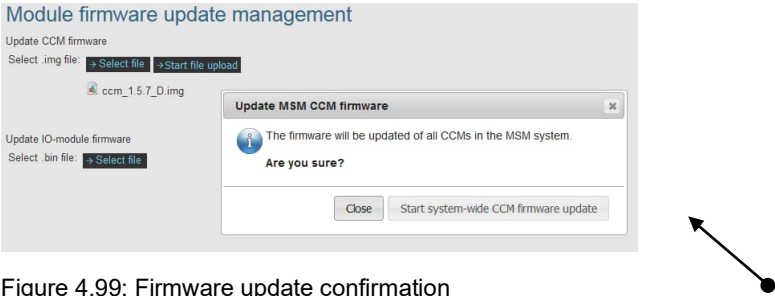




Figure 4.99: Firmware update confirmation

Click on “Start system-wide CCM firmware update”.

 **Note:** All CCM's of the MSM System will be updated one by one.

 **Caution:** Make sure that all CCMs are connected while doing a CCM firmware update. Different CCM firmware versions within one MSM system may result in communication issues.

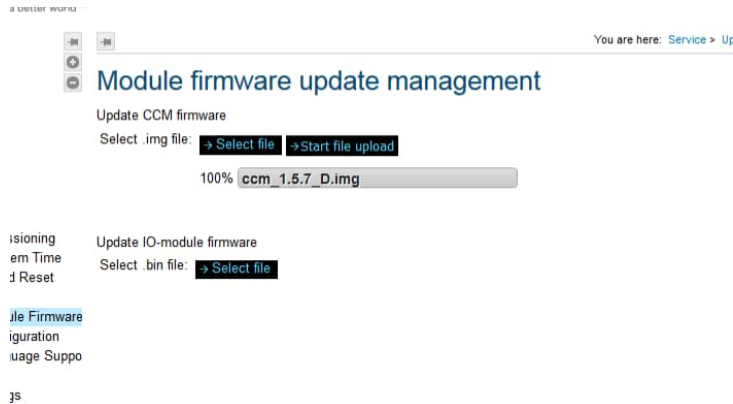


Figure 4.100: Selected firmware image file loaded

The file is loaded and the update process starts automatically.

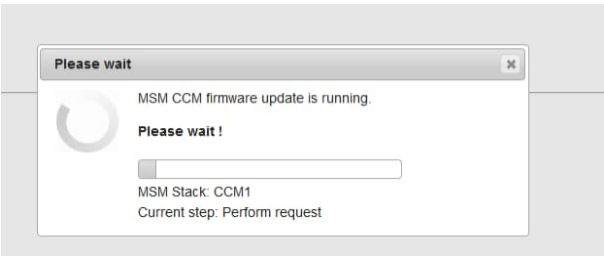


Figure 4.101: Selected firmware image in the upload process

 **Caution:** Do not turn off devices during the update process.

When done, a status window pops up and informs you about the current status.

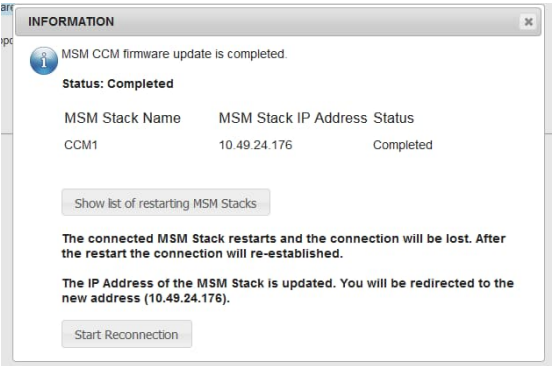


Figure 4.102: upload process finished

Before starting a reconnection, a list of all CCM's can be seen when clicking on the button “Show list of restarting MSM stacks”.

Click Button “Start Reconnection”

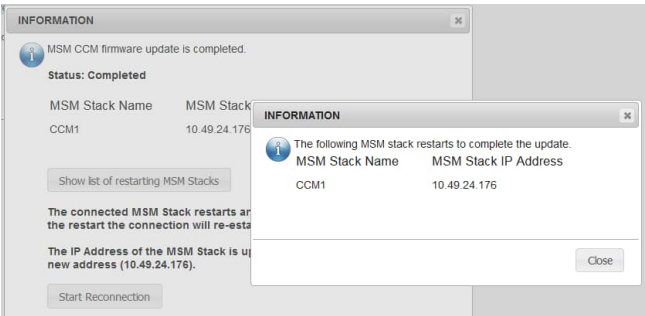


Figure 4.103: List of CCM's to be reconnected

ⓘ Note: All CCM's of the MSM System will be started again

ⓘ Note: After the reboot, a new login is required

When finished, the login screen appears



Figure 4.104: New Login after reconnection

5. Error and alarm handling

5.1. Gas leakage warnings and alarms

During operation, gas related alarms and warnings as shown in Table 5.1 can occur. All alarms compare an input value with a pre-defined threshold value. For the parameters “leakage rate” and “overpressure”, exceeding the threshold triggers an alarm/warning, for other parameters falling below the threshold triggers the alarm/warning. Threshold values are displayed in the Web Interface.

Table 5.1: Conditions triggering gas warnings or alarms. Conditions marked with * need to be activated in the configuration file.

Parameter	Notification level	Input and update frequency	Default (warning/alarm)	thresholds
Stage 0*	Warning	Pressure (30 min)	configured, shown in web-interface	
Stage 1	Warning	Pressure (2 s)	According to the gas scheme document	
Stage 2	Alarm	Pressure (2 s)		
Overpressure*	Alarm	Pressure (2 s)	configured, shown in web-interface	
Overpressure*	Warning	Pressure (2 s)	configured, shown in web-interface	
Leakage rate	Alarm	calculated rate (24 h)	1.6 % / year (alarm)	
Time to stage 1	Warning	calculated trend (24 h)	300 days (warning)	
Time to stage 2	Alarm	calculated trend (24 h)	100 days (alarm)	

When the system triggers a gas related warning or alarm, the relevant parameter should be identified first. This information can be found in the *event list* or *system log*, both accessible via the Web Interface.

Stage 0: A *true warning* without any previous warning may be caused by a very large leakage (>50 %/year), by a leakage below the leakage rate threshold value (<1.6 %/year), or by leakages which for various other reasons haven't been identified by the leakage rate algorithm, yet. A *false warning* may be caused by large temperature variation (driven by primary current or environmental temperature), e.g., for outdoor gas compartments, or direct solar irradiation. *Recommendation:* see generic recommendation below.

Stage 1 / 2: A *true warning/alarm* without any previous warning may be caused by an extremely large leakage (~500 %/year), by a leakage below the leakage rate threshold value (<1.6 %/year), or by leakages which for various other reasons haven't been identified by the leakage rate algorithm, yet. A *false warning/alarm* is unlikely but may be caused by large temperature variation, direct solar irradiation, or a defective sensor. *Recommendation:* see generic recommendation below.

Overpressure warning/alarm: A *true warning/alarm* may be caused by overfilling the GIS or hotspots. A *false warning/alarm* may be caused by large temperature variations, direct solar irradiation, or a defective sensor. *Recommendation:* exclude false warnings as root cause by reviewing the history chart; overfilling beyond the tolerance level as indicated in the gas scheme must be corrected and hotspot areas should be switched off and investigated thoroughly to avoid the risk of damage to the GIS.

Leakage rate: A *true alarm* is caused by leakages above the configured threshold value. It might be followed by Stage 0, 1, or 2 warnings. A *false alarm* may be caused by large temperature variation (more likely in the first year of operation than afterward), direct solar irradiation, or not doing the trend reset after gas maintenance. *Recommendation:* see generic recommendation below. *See also:* Paragraph 4.2.1.

Time to stage 1 / time to stage 2: A *true warning/alarm* is caused by a leakage. A *false warning* is may be caused by a combination of effects, e.g., gas compartment filled below nominal and temperature effect results in over-estimation leakage rate. *Recommendation:* see generic recommendation below. *See also:* Paragraph 4.2.3.

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Generic recommendation for data analysis:

To begin with, check the actual pressure and check if there is a visual decrease in the measurement. Second, analyze historic data of pressure and leakage rate. In comparison to the leakage rate, pressure values are not smoothed and thus reflect a leakage much faster. Thus, focus on pressure data analysis first and use leakage data to verify your conclusions.

If the pressure has been constant for more than 13 months (Part A in Figure 5.1) and then starts dropping steadily, there's a strong indication of gas leakage, and gas sniffing is recommended. After downloading the data, you can make a linear regression to Part B to estimate the leakage rate. The leakage rate displayed by the MSM system will converge to this rate.

If less than 13 months of data are available or if pressure signals vary strongly, both in Part A, Figure 5.1, a temperature or load variation could be the root cause of a false alarm. To exclude this option a gas compartment with similar volume, function, location in GIS and use pattern should be identified. For single-phase, encapsulated GIS gas compartments of the other two phases are potential candidates. Download the data for the suspicious gas compartments as well as for the similar gas compartments and compare the pressure history charts. Optimally this comparison is done by looking at the relative difference of the pressure to the starting pressure for the individual phases. A temperature or load effect usually occurs in several compartments in a similar way, whereas a leakage will occur most likely just in one gas compartment. To identify a leakage, it must create a pressure drop that can be well distinguished from signal variation.



Note: On indoor-outdoor connecting compartments: Some GIS compartments feed through the building walls and are therefore partially indoors/outdoors, resulting in an axial temperature gradient, i.e., along the axis of the compartment. Axial temperature gradients cause density gradients and distort the readings of true gas density sensors and pressure/temperature sensor combinations alike and therefore cause loss of information. For these compartments, algorithm sensitivity is reduced, and thus detailed data analysis as described above should be done.



Note: Small gas compartments: Each compartment in a gas-insulated switchgear substation (GIS) typically has the same seal lengths and number of sealing surfaces and access ports regardless of its size. Therefore, each compartment is likely to leak at nearly the same SF₆ or EconiQ mass flow rate. Hence smaller compartments lose pressure/density quicker in the presence of equivalent leaks, i.e., have a higher relative leakage rate.



Note: Voltage Transformer compartments: In voltage transformer gas compartments, energization of the voltage transformer alters the SF₆ density distribution. Consequently, energization and de-energization of VTs will result in a step-like pressure change monitored by the MSM. If it is not automatically corrected, it can easily be separated from leakage as it occurs simultaneously with an operational event and results in constant pressure, not a continuously decreasing pressure.

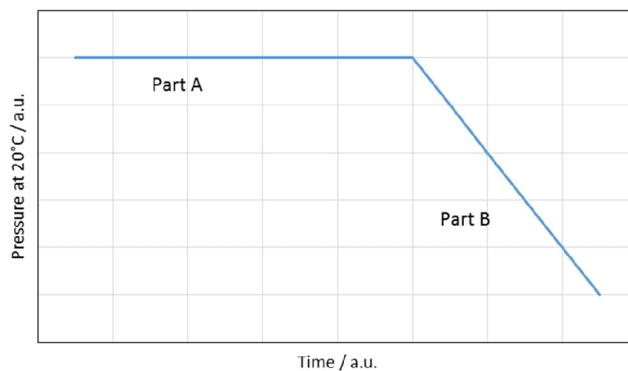


Figure 5.1: Pressure history schematic with a leakage occurring after a distinct time. For an error-free leakage indication, signal variability during Phase A must be small compared to the pressure decline observed during Phase B.

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5.2. Humidity warning and alarm handling

Once the sensor reading exceeds the warning/alarm limit, the MSM system triggers an alarm. Offline equipment for humidity measurement shall be used to verify the value. If the measured moisture level exceeds the limit, then follow the standard SF₆ handling process to lower the moisture level inside the switchgear.

5.3. Circuit breaker error and alarm handling

Table 5.2 lists the conditions to trigger an alarm or warning for the individual parameters. Exceeding those thresholds results in a warning/alarm of the parameter and thus can also trigger an MSM system alarm. The recommended reactions follow up a warning or an alarm depending on the urgency of a potential issue. The parameters in the list are

Unforced motor starts per day: A *true warning* may be caused by leakage in the high-pressure system of a hydraulic system. A *false warning* may be caused if signals from the auxiliary switch aren't picked up properly and parallel several breaker operations per day are done. If this parameter triggers a warning or alarm, the following steps are recommended:

- Review the data using the Web Interface, check motor current waveform (Unforce motor starts has shorter running time than motor starts with operations).
- Consult the manual of the operating mechanism for further instructions.
- Detailed analysis by Hitachi Energy is possible using MSM System Download (depending on service agreement).
- Plan maintenance on operating mechanism if a warning is triggered; Schedule maintenance on the operation mechanism as soon as possible if an alarm is triggered

Motor running time: A *true warning* may be caused by a worn-out motor. A *false warning* may be caused by a very low motor supply voltage or during maintenance of the operating mechanism. The runtime threshold will be defined reflecting the maximum stored operating sequence of the mechanism and not a full discharge. If this parameter triggers a warning or alarm, the following steps are recommended:

Check, if the alarm was triggered when the motor was following a standard operating sequence, i.e., no maintenance was currently ongoing.

- Review the data using the Web Interface, check motor current waveform.
- Consult the manual of the operating mechanism for further instructions.
- Check if the motor power supply is within its specified range.
- If the supply voltage is fine, plan maintenance on the mechanism when a warning is triggered, or schedule immediate maintenance on the mechanism when an alarm is triggered.

Total number of motor starts: A *true warning* may be caused if the technical service life of the breaker has been reached and each motor operation can be related to a breaker operation (i.e. spring-spring mechanism). If this parameter triggers a warning or alarm, the following steps are recommended:

To check data consistency, compare the total number of motor starts as measured by MSM with the operation counter at breaker;

- If the result above is suspicious, plan maintenance when a warning is triggered or schedule maintenance when an alarm is triggered.

Detailed analysis by Hitachi Energy is possible using MSM System Download (depending on service agreement).

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Last motor running time after close operation: Same as the parameter motor running time above, *A true warning* may be caused by a worn-out motor. *A false warning* may be caused by a very low motor supply voltage or during maintenance of the operating mechanism. The runtime threshold will be defined reflecting the maximum stored operating sequence of the mechanism and not a full discharge. If this parameter triggers a warning or alarm, the following steps are recommended:

- Check, if the alarm was triggered when the motor was following a standard operating sequence, i.e., no maintenance was currently ongoing.
- Review the data using the Web Interface, check motor current waveform.
- Consult the manual of the operating mechanism for further instructions.
- Check if the motor power supply is within its specified range.
- If the supply voltage is fine, plan maintenance on the mechanism when a warning is triggered, or schedule immediate maintenance on the mechanism when an alarm is triggered.

Last motor running time without operation: Together with the parameter unforced motor starts above, the motor running time without preceding circuit breaker operation reflects the integrity of the hydraulic system. *A true warning* may be caused by serious leakage of the hydraulic system. *A false warning* may be caused by a very low motor supply voltage. The runtime threshold will be defined reflecting the restored process of the operating mechanism in case of pressure drop internally. If this parameter triggers a warning or alarm, the following steps are recommended:

- Check, if the alarm was triggered without operating sequence, i.e., no maintenance was currently ongoing.
- Review the data using the Web Interface, check motor current waveform.
- Consult the manual of the operating mechanism for further instructions.
- Check if the motor power supply is within its specified range.
- If the supply voltage is fine, plan maintenance on the mechanism when a warning is triggered, or schedule immediate maintenance on the mechanism when an alarm is triggered.

Peak motor current: *A true warning* may be caused by a worn-out motor. *A false warning* may be caused by a low motor supply voltage. The threshold will be defined reflecting the method used to limit the instantaneous current while the motor starts. If this parameter triggers a warning or alarm, the following steps are recommended:

- Review the data using the Web Interface, check motor current waveform.
- Consult the manual of the operating mechanism to further instruction.
- Check if the motor power supply is within its specified range.
- Consult Hitachi Energy for further suggestions.

Closing time/Opening time: *A true warning* may be caused by the deteriorating operation performance of a circuit breaker. *A false warning* may be caused by an operation voltage out of a specified range. The threshold will be defined reflecting the specified range of operation voltage of a circuit breaker. If this parameter triggers a warning or alarm, the following steps are recommended:

- Review the data using Web Interface.
- Check recent operations if the time continuously exceeds the limit over past operations.
- When a warning is triggered, check if the time is continuously exceeding. Do a trend analysis on the data set to estimate the time until alarm level will be reached and as such the urgency of an on-site investigation.

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- When an alarm is triggered, perform two more operations to confirm the results sustain if the alarm was triggered for the first time (with no load).
- If confirmed, check speed using circuit breaker analyzer on-site and consult OEM manual or manufacturer of the monitored asset.

Close velocity / open velocity: A *true warning* may be caused by the deteriorating operation performance of a circuit breaker. A *false warning* may be caused by the energy storage status of an operating mechanism (in particular, the hydraulic mechanism). The threshold will be defined reflecting the maximum and minimum velocity with different energy storage situations of the operating mechanism. If this parameter triggers a warning or alarm, the following steps are recommended:

- Review the data using Web Interface.
- Check recent operations if the velocity continuously exceeds the limit over past operations.
- When a warning is triggered, check if the velocity is continuously exceeding, do a trend analysis on the data set to estimate the time until alarm level will be reached, and as such the urgency of an on-site investigation.
- When an alarm is triggered, perform two more operations to confirm the results sustain if the alarm was triggered for the first time (with no load).
- If confirmed, check speed using circuit breaker analyzer on-site and consult OEM manual or manufacturer of the monitored asset.

Contact wear: A *true warning* may be caused by the worn-out interrupter (especially arcing contact). A *false warning* may be caused by the measured phase current (e.g., unexpected offset and sign of signal noise). If this parameter triggers a warning or alarm, the following steps are recommended:

- Verify integrity of measured signal: Ideally, this is done by comparing a phase current curve as measured by the MSM during fault interruption with a curve measured in the SCADA system. If such a curve in the SCADA system is not available, check if the measured curve is plausible, e.g., is it oscillating with grid frequency, are there unexpected offsets or signs of signal noise.
- Verify overall plausibility: compare the recorded faults with the logs in the SCADA system as a plausibility check for overall contact wear, e.g., are fault events in the MSM system also logged in the SCADA system; Verify phase current trace (protection) is sinusoidal (possible with DC component), some noise is normal for load current magnitudes.
- If both are yes, plan maintenance for the interrupter in case of a warning, or schedule immediate maintenance for the interrupter in case of an alarm.

Total number of close operations: A *true warning* may be caused by the worn-out circuit breaker. A *false warning* may be caused during the commissioning/maintenance of the operating mechanism. The threshold will be defined reflecting the maximum admissible operations of a circuit breaker. If this parameter triggers a warning or alarm, the following steps are recommended:

- Compare the total number of close operations as measured by MSM with the operation counter at the breaker.
- In case of a warning, plan maintenance of circuit breaker if the high number of operations is verified.
- In case of alarm, schedule immediate maintenance of circuit breaker if the high number of operations is verified.

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Table 5.2: Conditions triggering operating mechanism related warnings or alarms.

Parameter	Notification level	Input and update frequency	Default (warning/alarm)	thresholds
Unforced motor starts per day	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	
Motor running time	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured according to stored operating sequence;	
Total motor starts	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	
Last motor running time after the close operation	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	
Last motor running time without operation	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	
Peak motor current	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	
Closing time	Warning Alarm	/ Per close operation of circuit breaker	Shown in Web Interface, configured or disabled according to circuit breaker type	
Opening time	Warning Alarm	/ Per open operation of circuit breaker	Shown in Web Interface, configured or disabled according to circuit breaker type	
Close velocity	Warning Alarm	/ Per close operation of circuit breaker	Shown in Web Interface, configured or disabled according to circuit breaker type	
Open velocity	Warning/Alarm	Per open operation of circuit breaker	Shown in Web Interface, configured or disabled according to circuit breaker type	
Contact wear	Warning/Alarm	Per open/close operation of circuit breaker	Shown in Web Interface, configured or disabled according to circuit breaker type	
Total number of close operations	Warning/Alarm	Per close operation of circuit breaker	Shown in Web Interface, configured or disabled according to circuit breaker type	

5.4. Disconnecter error and alarm handling

Motor running time: A *true warning* may be caused by a worn-out motor. A *false warning* may be caused by a very low motor supply voltage or during maintenance of the operating mechanism. If this parameter triggers a warning or alarm, the following steps are recommended:

Check, if the alarm was triggered when the motor was following a standard operating sequence, i.e., no maintenance was currently ongoing.

- Review the data using the Web Interface, check motor current waveform.
- Consult the manual of the operating mechanism for further instructions.
- Check if the motor power supply is within its specified range.

If the supply voltage is fine, plan maintenance on the mechanism when a warning is triggered, or schedule immediate maintenance on the mechanism when an alarm is triggered.

Total number of motor starts: A *true warning* may be caused if the technical service life of the disconnecter has been reached and each motor operation can be related to a disconnecter operation. If this parameter triggers a warning or alarm, the following steps are recommended:

To check data consistency, compare the total number of motor starts as measured by MSM.

If the result above is suspicious, plan maintenance when a warning is triggered or schedule maintenance when an alarm is triggered.

- Detailed analysis by Hitachi Energy is possible using MSM System Download (depending on service agreement).

RMS motor current: A *true warning* may be caused by a worn-out motor. A *false warning* may be caused by a low motor supply voltage. The threshold will be defined reflecting the method used to limit the instantaneous current while the motor starts. If this parameter triggers a warning or alarm, the following steps are recommended:

- Review the data using the Web Interface, check motor current waveform.
- Consult the manual of the operating mechanism to further instruction.
- Check if the motor power supply is within its specified range.
- Consult Hitachi Energy for further suggestions.

Table 5.3: Conditions triggering operating mechanism-related warnings or alarms.

Parameter	Notification level	Input and update frequency	Default (warning/alarm)	thresholds
Motor running time	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured according to stored operating sequence;	
Total motor starts	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	
RMS motor current	Warning Alarm	/ Per motor operation	Shown in Web Interface, configured or disabled according to mechanism type	

5.5. Heater alarm handling

A *true alarm* may be caused by a defect heater or a defect or wrongly set thermostat. A *false alarm* may be caused by a high heater voltage supply. The threshold will be defined according to heater type. If this parameter triggers an alarm, the following steps are recommended:

- Check the voltage supply of the heater
- Check functionality of the heater
- Check the functionality of the thermostat (if thermostat-controlled heater)

Consult Hitachi Energy for further suggestions.

5.6. Internal arc localization handling

A *true alarm* will be caused by dielectric breakdown of passive gas compartment. A *false alarm* may be caused by malfunction of gas sensor. The threshold has a pre-defined value 5kPa as default. If the gas pressure change triggers an alarm, the following steps are recommended.

- Check the connection status of gas sensor;

- Check protection system to see if there is any recording;

Consult Hitachi Energy for further suggestions.

5.7. Internal (watchdog) alarms and warnings

If the MSM system has an internal error, e.g., defective module or communication error, an internal alarm is triggered. A pending internal alarm can be seen at:

Local display: The red LED starts blinking at ~2 Hz.

CCM LED starts flickering at 5 Hz.

Web Interface: Affected CCMs in the equipment tree node are flagged yellow (warning) or red (alarm).

Details about the event triggering the internal alarm are provided as an error code. The error code can be found in the Web Interface: go to affected CCM in equipment brunch, Figure 4.48, and open configuration window,

system error code will be shown on hardware tab in the system status field (Figure 4.49). Alternatively, error codes are accessible on the main page of the local display.

A system error that affects the loading of the system configuration is only displayed on the local display with Node ID 1 (if physically existing). In this case, the Web Interface cannot be reached due to the missing IP address configuration of the MSM.

Only one error code is displayed, even though multiple errors may exist at the same time. When resolving the pending error code, additional errors can be displayed.

Individual CCMs will be flagged with an internal warning, i.e., a yellow icon in the equipment branch, if the configuration file mismatches with the configuration file of the connected CCM.

Table 5.4: System Error Code table

Error Code	Description and Solution
5	<i>Memory allocation error</i> →A serious system error occurred, contact service
10	<i>The .mscf system config file was not found.</i> This error is displayed only on local display with Node ID 1. →Use the MSM config tool to upload a config file*. Restart required.
11	<i>Errors in the .mscf config file.</i> An event log entry is generated which shows the number of errors. →Use the MSM config tool to validate the config file on the device and upload the updated config file*. Restart required.
50	The .ccf file for the IEC 61850 ISS stack was not found. The ISS stack was activated in the config file, but its configuration is missing. →Use the MSM config tool to upload a config file with a deactivated ISS stack OR upload the .ccf file for the ISS stack config*. Restart required.
51	Errors in the .ccf file. The ISS configuration file has errors. The errors can be shown by downloading the ISS report log from "/ram" via ftp/sftp →Correct the errors in the MSM config tool and upload the new configuration*. Restart required.
52	Wrong file extension of IEC 61850 stack configuration The configuration file of the ISS stack has got an invalid file extension. Files are ignored with an invalid file extension and the ISS stack does not start. The file must be updated, and a restart is required.

Error Code	Description and Solution
100	<p><i>An I/O module was disconnected from the MSM interconnection bus.</i></p> <p>The I/O module is either defective or not present. A defect module can be located by its blink code (see Table 2.4, Table 2.6, Table 2.12) or via Alarm/Event list.</p> <p>→ Exchange the defect module or add the missing module to the stack.</p>
101	<p><i>An I/O module on the stack has the wrong type.</i></p> <p>A module type on position x differs from the module that should be on this place according to the MSM config file.</p> <p>→ Exchange the module with the correct module type</p>
102	<p><i>An I/O module was not found when trying to initialize.</i></p> <p>This is the same error as error code 100 but is thrown at startup, see error code 100.</p>
103	<p><i>CAN bus configuration error.</i></p> <p>The Module ID of an I/O module exceeds the maximum module number</p> <p>→ Use the MSM config tool to validate the config file on the device and upload the updated config file*. Restart required.</p>
104	<p><i>Duplicate IP Addresses in the network (supported by version 1.3.7 – 1.4.2)</i></p> <p>The CCM resets IP address settings because another device has got the same settings</p> <p>→ Check IP addresses of other devices in the network and restart CCM</p>
110	<p><i>Data sanity failure</i></p> <p>A data sanity check detected some wrong values (e.g., parameter value out-of-range)</p>
150	<p><i>LCD display is disconnected or defective.</i></p> <p>The LCD display failed or was disconnected from the CCM</p> <p>This error is only shown if the local display supervision is activated in the config</p> <p>→ Check CAN bus connection and local display refer to chapter 3.4.1 of the commissioning manual [11]</p>
200	<p><i>SD card initialization failure.</i></p> <p>The MicroSD card in the CCM was not found or is defective.</p> <p>This error is displayed only on local display with Node ID 1.</p> <p>→ Check if the µSD card is installed or replace the µSD card.</p>
201	<p><i>SD card timeout during read/write.</i></p> <p>The µSD card stopped working and is defective.</p> <p>→ Exchange the µSD card in the CCM.</p>
202	<p><i>SD card initialization process error</i></p> <p>The SD card does not respond to the initialization command CMD0.</p> <p>→ Exchange the µSD card in the CCM.</p>
203	<p><i>SD card initialization process error</i></p> <p>The SD card does not support the voltage range.</p> <p>→ Exchange the µSD card in the CCM.</p>
204	<p><i>SD card compatibility failure</i></p> <p>The card is not a valid SD card for example an MMC card</p> <p>→ Exchange the µSD card in the CCM.</p>
205	<p><i>SD card access failure</i></p> <p>The response of a CMD8 command is invalid.</p> <p>→ Exchange the µSD card in the CCM.</p>
206	<p><i>SD card activation failure</i></p> <p>The SD card cannot be activated by an ACM41 command.</p>

Error Code	Description and Solution
	→ Exchange the μ SD card in the CCM.
207	<i>SD card CMD failure</i> A generic CMD error occurs. → Exchange the μ SD card in the CCM.
208	<i>SD card ACMD failure</i> A generic ACMD error occurs. → Exchange the μ SD card in the CCM.
209	<i>SD card timeout during special command</i> The SD card does not send a special command response. → Exchange the μ SD card in the CCM.
210	<i>SD card reading packet error</i> The SD card does not react on a packet read command. → Exchange the μ SD card in the CCM.
211	<i>SD card command/parameter error</i> The SD card does not support a command or parameter set. → Exchange the μ SD card in the CCM.
212	<i>SD card CRC7 error</i> Invalid CRC7 check sums in packets. → Exchange the μ SD card in the CCM.
213	<i>SD card CRC16 error</i> Invalid CRC16 check sums in packets. → Exchange the μ SD card in the CCM.
214	<i>SD card address error</i> The address parameter of a request is not supported by the SD card. → Exchange the μ SD card in the CCM.

6. Maintenance

6.1. Maintenance of MSM system

The MSM system is self-supervising, and the hardware does not require any maintenance. System errors reflecting hardware failures are logged in the history log facility which can be accessed via the Web Interface.

The designed life of the MSM system and the connected sensors is at least 15 years. After the expiry of this time, a replacement of the hardware components is recommended. The end of the lifetime of each CCM is configurable (per default 15 years). As soon as this time is reached a message will be generated in the Web Interface (see Figure 6.1).



Figure 6.1: End of life message in Web Interface

Please contact the Hitachi Power Grids Service department to replace the module.

For the MSM software, cybersecurity relevant firmware updates may be available. Information on updates is provided in the documents section [Modular Switchgear Monitoring \(MSM\) | Hitachi Energy](#)

6.2. Gas related works on monitored compartments

Works, which alter the amount of gas in the gas compartment (e.g., fill-up or removal of gas) distort the calculation of the leakage rate. After the trend reset, the leakage rate algorithm will provide no output for two weeks. Then, the first displayed value will be 0 % / year. If the gas compartment has a leakage rate above 0 % / year, it will require several weeks to months until this leakage rate is correctly reflected by the MSM system (see Figure 4.6). When a jump in the pressure is detected the leakage rate value will be frozen for 3-5 days. If it is a very noisy signal it can take up to 30 days.

If humidity monitoring is also used in the compartment a reset of the humidity calculation, refer to chapter 4.2.5, shall be done.



Caution: For a proper calculation of the leakage rate a trend reset after a gas fill-up is obligatory.

6.3. Replacing or re-attaching a sensor

If a sensor is re-attached, the appropriate process depends on the sensor type. For those density sensors which are standardly used with MSM, the sensor signal will be distorted after the sensor has been exposed to ambient air. 10 min after re-attaching the sensor to the gas compartment signal distortion can be in the range of 20 %. Four days later, sensor accuracy is at a level of 1.8% again. During this period, MSM stage 1 / stage 2 alarms may have been triggered due to the distorted signal and the leakage rate may be shifted in the range of 1%/year. If resulting false alarms are unacceptable, the sensor can either be disconnected for 4 days, or a normal trend reset can be done.

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6.4. Recycling

Hitachi energy attempts to minimize environmental impact during the entire service life of the product. Environmental aspects are in focus during technical and product development. An eco-cycle approach is attained and the impact on the environment and possibilities of recycling are observed. Manufacturing processes are selected that are as gentle as possible on the environment. The modules contain elements that are suitable for recycling and components that need special disposal. You are therefore requested to make sure that the components will be recycled at the end of their service life. In some countries, there might be an obligation by law to dispose of the parts correctly. Please observe the current legislation in your country.

Taking care of used equipment: Worn-out products should be taken out of service in an environmentally correct manner according to the following instructions. After discarding used equipment, plenty of materials, or the energy content of materials, can be recycled after sorting and cleaning. The degree of recycling varies depending on the technical resources and experience available in respective countries. Non-recyclable components should be taken to an approved recycling center for destruction or disposal.

Electronics: Leave electronic equipment with an approved recycling company or sort its components and take care accordingly.

Metals: Sort metals according to type and surface treatment and leave them to an approved recycling company. After removal of any paint or other surface treatment, the metal can generally be melted down and used in new products.

Plastics: Leave plastics at an approved recycling center or recycling company.

Other materials: Sort and leave other materials at an approved recycling center.

7. FAQ – Frequently asked questions

7.1. Hardware, cables, and connections

Q: Why is the red LED on the local display blinking?

A: The red LED on the LCD always signalizes alarms and errors. A slow (2 Hz) blinking signalizes a warning or an alarm. A fast (10 Hz) blinking signalizes a system error (see chapter 5.1).

Q: Why are one or more I/O modules on the stack blinking differently than others?

A: Check, if all modules are configured in the MSM Configuration Tool. If I/O modules are not configured, the CCM will not initialize those modules and they stay in their initialization mode. (See blink codes in chapter 2.2)

Check, if the MSM has a system error code 1xx (see chapter 5.1 for details). This signalizes a defect module or a wrong module type.

Q: How do I find defective cables?

A: If a cable is damaged, it causes a short circuit or an open connection. You can test this with the internal measurement circuit. When the connection is below 2mA there should be an open circuit, when it is over 20,79 mA there is a short circuit, which is both displayed as an error in the Web Interface.

Q: How do I find out; which sensor is connected to which port of the AIM?

A: Follow the steps as described in chapter 5.4.3 in [11].

Q: Why does the AIM not startup?

A: Two or more sensors have a short circuit. Disconnect all sensors, the AIM will restart automatically. Connect one sensor after the other to identify the sensor with a short circuit. When the AIM still doesn't start up although all sensors are disconnected, replace it.

Q: Is it required to take an outage of the bay during the replacement of MSM modules?

A: Replacing for MSM Modules is NO needed of GIS bay de-energizing, however, there are small safety concerns as follows, and the final decision needs to be taken based on a safety analysis by the operator.

- The power supply source (MCB) must be opened and check no incoming voltage.
- It may trigger alarms (MSM watchdogs) at the local cabinet/remote control room. The relevant local worker may need to be informed.
- The replacement needs careful work inside LCC by a Hitachi Energy certified worker. Please note that GIS is live!

7.2. Data Transfer

Q: Is it allowed to connect the MSM to an edge gateway?

A: MSM can be connected to an Edge gateway through a Local Area Network (LAN) only (e.g., LAN of an electrical utility), not through the internet.

Q: Is it allowed to connect to a VPN?

A: It is not allowed to directly connect to a remote server by establishing a VPN i.e. when the two VPN endpoints are "MSM" and "Remote Server". But, when the VPN gets established by a differently distinct device on behalf of MSM, i.e., the VPN endpoints are "Differently distinct device" and "Remote Server", this deployment arrangement is fine.

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Q: I cannot connect to the MSM via FTP/SFTP or web client, what is wrong?

A: This can have one of the following reasons:

- Wrong network settings of PC – double-check the IP address and subnet mask match with MSM system.
- Wrong IP address in browser address line – ensure, the IP address in browser address line corresponds to actually configured IP address of one CCM (using the local display, stickers on the CCM, system documentation, or an IP address scanner).
- The physical network connection between the PC, network devices, and CCM is damaged – check by direct connection to the CCM at the local control cubicle.
- Network device internal settings prevent proper communication – check by direct connection to the CCM at the local control cubicle and if successful, investigate the local network.
- Hardware defect – check MSM CCMs and network devices for proper operation, e.g., by reading the status LED or by replacing hardware.

7.3. Operation and gas leakage dependencies

Q: How does temperature affect the displayed SF₆/gas pressure?

A: Compare chapter 4.2

Q: How is the leakage calculated and what does it mean?

A: Compare chapter 4.2.1.

Q: What is the accuracy of displayed pressure values?

A: For Trafag sensors connected to the MSM-AIM the uncertainty of the displayed pressure values is usually 2% full scale (rarely 2.5 % full scale).

Q: Why can the pressure value as shown on the display/webpage and the value on the gauge differ?

A: The gauge and the compensated pressure sensor, which are used for monitoring, are two independent measuring systems. Thus, measured values from these systems will usually differ within the combined accuracy level, which is ~ 3 % at 500 kPa (~2% at full scale).

Q: I forgot to do a trend reset. How does this impact the leak rate calculation?

A: In most cases, the trend algorithm detects and corrects the pressure jumps done by gas works. If no trend reset is done after fixing a gas leak the algorithm will take longer to reach a high accuracy (see chapter 4.2.4).

Q: When do I need to reset the leakage rate/trend algorithm?

A: A trend reset must be done after maintenance work at a gas compartment. Situations requiring a trend reset are described in chapter 4.2.4.

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7.4. Data storage

Q: Which data is stored on the internal μ SD card?

A: The μ SD-card stores the following data: system firmware, system configuration files, system log of CCM (see section 4.6.11.3), day mean values of pressure, and calculated leakage rate of every gas compartment (monitoring data). The monitoring data can also be downloaded (see section 4.6.5.2).

Q: How long is the monitoring data stored on the internal μ SD card?

A: MSM stores the data permanently on the internal μ SD card and is not deleted. Storage capacity is enough for the complete system lifetime.

7.5. Software and visualization

Q: What is the MSM Web Interface? Do I need Internet for it?

A: No, you don't need the Internet! "Web Interface" itself does not stand for the Internet. "Web" simply means that the MSM software uses Web technologies for visualization. The Web Interface can be used by connecting the MSM system to a PC/Laptop via Ethernet cable, running a standard web browser

Q: In a cluster of several MSM stacks, which is the Master-CCM, and on which CCM is the Web Interface installed?

A: There is no Master-CCM and on all CCMs a web server is installed, which provides the MSM Web Interface. Because all MSM-stacks know about each other, it doesn't matter to which CCM the user connects.

Q: The connection to the MSM is established. But after several seconds the Web Interface does not react to any user actions like opening the event list. Why is the connection interrupted?

A: Reload the page without using existing data in the cache (e.g., Ctrl + r).

Q: After opening the compartment subpage the gas pressure and leakage history charts are not shown. Why are they missing?

A: Gas pressure history chart will be shown 4 days after operation started; leakage rate history chart will be shown approx. 3 weeks after the operation started. Both charts require at least 3 valid data points before displaying any data.

Q: How can I change the name of the substation, bay, or gas compartment?

A: Please request an updated configuration file at MSM Support (see chapter 8).

Q: The full name of a gas compartment isn't shown in the display, why?

A: The maximum length of the name as shown in the display is nine letters.

The system can be used to monitor the operating mechanisms of the single-pole as well as gang-operated breakers. The system architecture for this feature is bay-wise, only (section 2.3.1). To monitor the performance of the circuit breakers and operating mechanisms, motor voltage, as well as auxiliary switch NO or NC (indicating the position of the circuit breaker), are connected to the BIM. Coil current (close coil and open coil), phase current, and motor current are connected to the FAIM.

Q: Is it required to take an outage of the bay during the installation of new MSM firmware?

A: For MSM firmware updates, no outage is required.

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8. Support

Frequently asked questions (FAQ) can be found in chapter 7.

If further support for MSM is needed, please contact the following e-mail address:

MSM Support: de-support.msm@hitachienergy.com

Information about new firmware releases and more can be found at:

[Modular Switchgear Monitoring \(MSM\) | Hitachi Energy](#)

9. References

- [1] 1HDG838015 MSM - CCM - Datasheet
- [2] 1HDG8380616 MSM - AIM – Datasheet
- [3] 1HDG8380617 MSM - SIM – Datasheet
- [4] 1HDG837033 MSM - BIM -Datasheet
- [5] 2GHV049550 MSM - FAIM - Datasheet
- [6] 1HDG818022 – MSM IEC61850 Communication Description for MSM
- [7] 1HDG818026 – MSM DNP3.0 Communication Description for MSM
- [8] MN05002001Z –Moeller Eaton – Manual for MFD-80-B LC Display HMI
- [9] MN05013014Z – Moeller Eaton – Manual for MFD-CP4-CO HMI CANopen communication unit
- [10] IEC 62271-100 High-voltage switchgear and control gear – Part 100: alternating-current circuit breakers
- [11] 2GHV043814 MSM - System - Commissioning manual
- [12] Power Panel T30 – User Manual

10. Abbreviations and Definitions

AES	Advanced Encryption Standard
AC	Alternating current
AIM	Analog Input Module
BIM	Binary Input Module
CB	Circuit Breaker
CSV	Comma-separated values
CCM	Control & Communication Module
CAN bus	Controller Area Network
CRC	Cyclic redundancy check
DES	Data Encryption Standard
DC	Direct current
DNP	Distributed Network Protocol
DS	Disconnecter
EMC	Electromagnetic compatibility
FTP	File Transfer Protocol
FAQ	Frequently asked questions
GIB	Gas-insulated Busbar
GIL	Gas-insulated Transmission Line
GIS	Gas-insulated Switchgear
GOOSE	Generic Object-Oriented Substation Event
GUI	Graphical User Interface
HMI	Human Machine Interface
HGDM	Hybrid Gas Density Monitor
HTTP	Hypertext Transfer Protocol
ID	identifier
I/O	Input / Output
IP address	Internet Protocol address
LED	Light-emitting diode
LCD	Liquid Crystal Display
LCC	Local Control Cubicle
MD5	Message-Digest Algorithm
μSD	microSD, Micro Secure Digital Memory Card
MSM	Modular Switchgear Monitoring
MCT	MSM Configuration Tool
PC	Personal Computer
RC4	Rivest Cipher 4
SFTP	Secure File Transfer Protocol
SHA	Secure Hash Algorithm
SIM	Serial Interface Module
SSH	Secure Shell
SNTP	Simple Network Time Protocol
SFTP	SSH File Transfer Protocol
SF ₆	Sulfur hexafluoride

11. Open source components and attributions

This chapter contains the list of open source components and respective licenses as used in the MSM's firmware.

Components:

Blob.js 1.0.0 : MIT License

carhartl/jquery-cookie 1.0 : MIT License

cpp-base64 V2.rc.08 : zlib License

crypto-js 3.1.2 : BSD 3-clause "New" or "Revised" License

curl 7.81.0 : curl License

Cyan4973/xxHash 0.6.5 : BSD 2-clause "Simplified" License

DataTables 1.9.0 : BSD 3-clause "New" or "Revised" License

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flot.github.com 0.8.2 : MIT License

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jqdoublescroll 1.0.0 : MIT License

jQuery 1.7.1 : MIT License

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jquery-dateFormat : MIT License

jquery-iframe-transport 1.0.0 : MIT License

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jQuery-Timepicker-Addon v0.9.8 : MIT License

jquery.sparkline 2.1.2 : BSD 3

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libexpat V20000512 : MIT License

minizip 0.15 beta : zlib License

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TinyXML 2.5.3 : zlib License

Tom Wu RSA 1.1 : PG Custom License: Tom Wu License

zlib 1.1.4 : zlib License

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(Cyan4973/xxHash 0.6.5)

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(jquery.sparkline 2.1.2)

Upstream-Contact: <https://github.com/gwatts/jquery.sparkline/issues>

Source: <http://omnipotent.net/jquery.sparkline>

Files: *

Copyright: 2012 Splunk, Inc

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Files: debian/*

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