USER MANUAL - EXTERNAL

Safe Digital

Intelligent solution for secondary switchgear

- Greener
- Smarter
- Safer
- More reliable

At ABB, we believe in a world in which nature and technology go hand in hand. A world in which powering your operations also means powering positive change – for your business and our planet.

We strive to create products and solutions that make a difference. Our philosophy is that greener is smarter, and smarter is greener. That’s the thinking behind our latest medium-voltage, secondary gas insulated switchgear (SGIS) - Safe Digital.

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1. Introduction

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Figure 1A Definition of ABB MV Digital GIS

1.1 Digital Gas Insulated Switchgear (GIS)

ABB's Digital solutions make our GIS switchgear smarter, safer, and more efficient. The definition of GIS Digital is based on two pillars:

- Smart Automation & Control (A&C)
- Monitoring & Diagnostics (M&D)

With the help of Smart Automation & Control efficient action and quick reaction can be enabled for safe and efficient operation as well as increased availability of power supply by integrating grid automation solutions as well as current and voltage sensors. Bus communication is realized via IEC 61850.

Monitoring & Diagnostics ensures that the switchgear is in a good condition for highest reliability by continuously monitoring its condition and initiate maintenance the switchgear only when really needed. Part of the M&D portfolio is ABB Ability ™, the Asset Health Monitoring (locally and remotely via cloud systems).

1.2 Manual scope

This manual contains brief instructions and engineering guidelines for ABB's Secondary Gas Insulated Switchgear (SGIS) - Safe Digital. It provides details about its main components as well as M&D features for products listed below[a]:

- SafeRing/SafePlus 12 kV, C/F/V/V20/V25 modules
- SafeRing/SafePlus 24 kV, C/F/V/V20/V25 modules
- SafeRing/SafePlus 40.5 kV, C/V modules
- SafeRing/SafePlus Air 12kV, C/V modules

a: Functions and configurations may vary depending on product type.

Before applying the Safe Digital M&D functions, it is recommended to go through the content of this manual. Special attention shall be paid to various precautions and use restrictions mentioned in the manual.

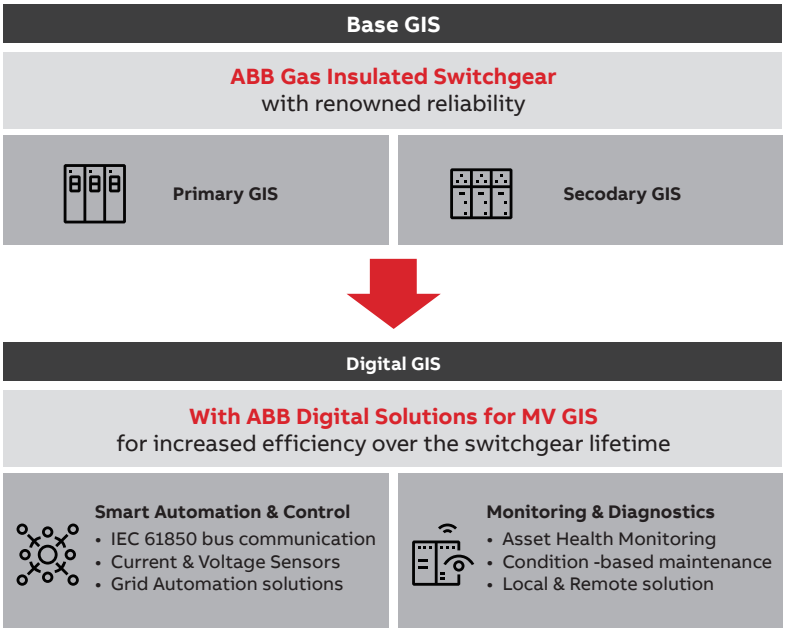

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Figure 1A

1.3 Abbreviations and Terminology

Some terminology will be frequently used in this document and their definitions are listed as below Table 1A.

Table 1A Abbreviations and Terminology

Term	Description
GIS	Gas Insulated Switchgear
PGIS	Primary Gas Insulated Switchgear
SGIS	Secondary Gas Insulated Switchgear
M&D	Monitoring and Diagnostic
MRC	MyRemoteCare
EAM	Energy Asset Management
IED	Intelligent electronic device
IEC	International Electrotechnical Communication
GB	China National Standard
3PS	Three Position Switch
IoT	Internet of Things
VPIS	Voltage Presence Indicating System
TR	Temperature Rise
STR	Static Temperature Rise
DTR	Dynamic Temperature Rise
P20	Gas pressure compensated at 20 °C
VI	Vacuum Interrupter
CB	Circuit Breaker
HMI	Human Machine Interface
LHMI	Local Human Machine Interface
AC	Alternative Current
DC	Direct Current
T&H	Temperature and Humidity
IO	Input/Output
CT	Current Transformer
MV	Medium voltage
VT	Voltage Transformer
LVC	Low Voltage Compartment

2. Safe Digital system structure

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Figure 2A System structure of Safe Digital

2.1 Logic topology

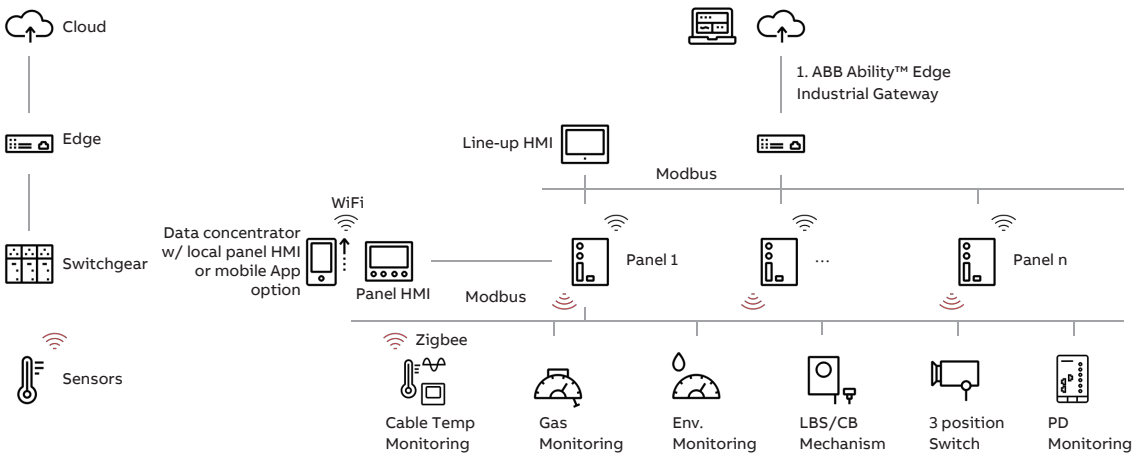
Safe Digital mainly including 5 function blocks:

- Cable bushing temperatures rise monitoring
- Gas tank pressure monitoring
- Operation mechanism mechanical characteristic monitoring
- 3PS position video monitoring
- Partial discharge monitoring

Also, including 4 common blocks:

- Data concentrator (MDC4-M)
- Gateway and Cloud Platform (EAM, MRC)
- Local Human-Machine Interface (LHMI)
- Mobile APP (for on-site used only, MDC4-M)

A comprehensive Safe Digital system structure is shown in Figure 2A.



1. The cloud connectivity is optional

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Figure 2A

2.2 List of components

The electronic components used in Safe Digital solution are listed in Table 2A.

Table 2A Safe Digital electronic components

No.	Icon	Component Name	Model Number
1		Data concentrator	MDC4-M
2		Ambient air T&H sensor	THS01
3		Intelligent temperature sensor	STE202
4		Intelligent temperature sensor 3-in-1	STE203
5		Intelligent current sensor	SEC201
6		Current transformer sensor	--
7		Gas density sensor	DM60R
8		Mechanical charact. sensor	SMX202
9		Hall current sensor	--
10		Resistance rotation angle sensor	--
11		Hall rotation angle sensor	--
12		Intelligent web camera	SAC40-R
13		Ethernet switch	TL-SF1008 (Industrial)
14		PD data recorder	HTR02-6AWA-PDD
15		PD monitoring antenna	AN-F1
16		Gateway	--
17		LHMI (advanced)	IP touch 7
18		LHMI (standard)	MP58B

3. Data concentrator

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Figure 3A Data Concentrator MDC4-M

3.1.MDC4-M

The data concentrator MDC4-M (as shown in Figure 3A) is a key device for data recording, communication and algorithm implementation on site which is normally installed on the DIN-rail inside the LV compartment. The pin definitions of MDC4-M are listed in Table 3A.

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Table 3A MDC4-M pin definition

Port	Pin	Function	Safe Digital Application
X1	1 – PE	Power input	Power supply
	2 – AC220 L		
	3 – AC220 N		
	4 – R-NO	Digital outputs	Alarm output
	5 – R-NC		
	6 – R-COM		
	7 – DIN-COM	Digital input	Reserved
	8 – DIN1		
	9 – DIN2		
X2	1 – RS485-B1	Upstream communication RS485-1	Local HMI
	2 – RS485-A1		
	3 – RS485-B2	Upstream communication RS485-2	PC Configuration or Gateway
	4 – RS485-A2		
	5 – GND	Power for sensors Downstream communication RS485-3	Power supply and communication for sensors
	6 – RS485-B3		
	7 – RS485-A3		
	8 – +12V		

Figure 3B LED and QR code of MDC4-M

Figure 3C Welcome screen of MConfig

The LEDs located on the front panel (as shown in Figure 3B) are used for indicating the working/ communication/alarm status. Detailed definition of LED and QR code are explained in Table 3B.

Detailed information regarding MDC4-M please refer to the latest version of MDC4-M user manual.

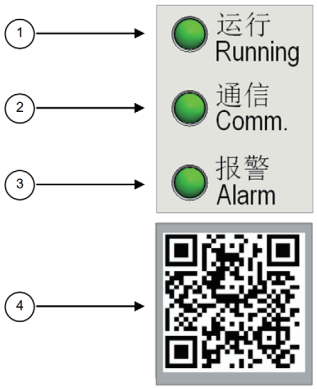

Figure 3B

Table 3B LED and QR code definition

Name	Position	LED state	Description
Running LED Indicator	1	OFF	Auxiliary power supply is disconnected
		Flashing	Normal operation
Comm. LED Indicator	2	ON	No TR wireless communication
		Flashing	TR wireless communicating
Alarm LED Indicator	3	OFF	No alarm presents
		ON	Alarm triggered
Wi-Fi QR code	4	--	WIFI ID to setup communication with MDC4-M

3.2 MConfig

ABB's manufacture and service can install MConfig, a configuration tool, which runs on PC or laptop to test the product or modules, store production data and set related parameters. MConfig provides two working modes: online and offline. When it is in offline mode, the configuration parameters can be stored locally and can be downloaded to the device once it is in online mode. Data can be exported for other application purpose.

The starting up screen of MConfig is shown in Figure 3C. Product key is required to login MConfig.

Figure 3C

For Product Key application, you need to provide your PC MAC address and send to MConfig development team (Andy-Kaiming.Lin@cn.abb.com).

3.3.Mobile APP

ABB engineers and users can install a special mobile application to view local data and set related parameters.

The mobile APP support both iOS and Android environment and can be connected with MDC4-M via Wi-Fi by scanning the QR code on the front panel of MDC4-M.

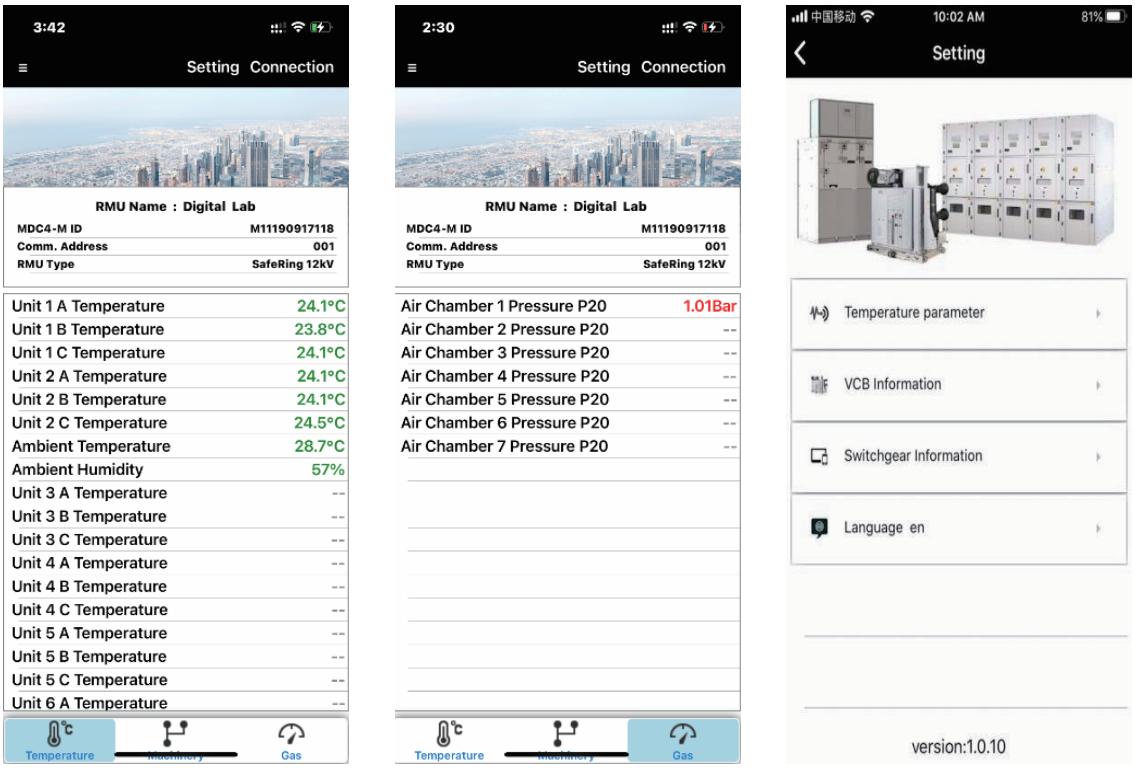

Figure 3D Typical user interface of MDC4-M APP

Figure 3D

The MDC4-M APP can be downloaded by simply scan the QR code below using your smart phone.

Figure 3E QR code for iOS/Android MDC4-M APP download

Figure 3E

4. Temperature rise monitoring

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Figure 4A Hierarchy chart of temperature rise monitoring function
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Figure 4B Ambient air T&H sensor THS01

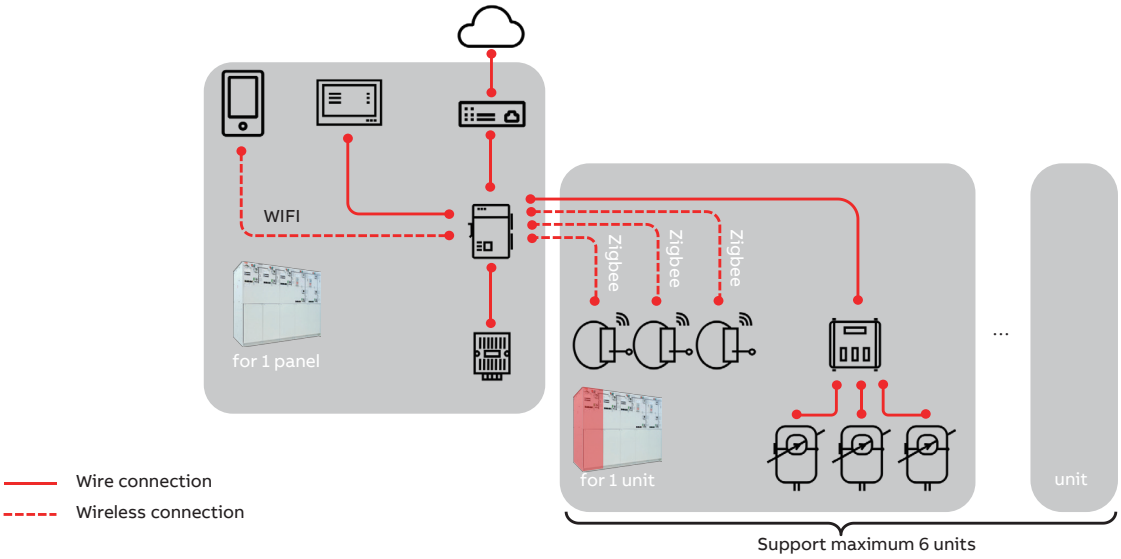

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Figure 4A

The system hierarchy chart of temperature rise monitoring function is shown in Figure 4A. Take MDC4-M as the core of the system, various devices/sensors are connected:

- Ambient air T&H sensor – THS01 (Figure 4B)
- Cable bushing TR sensor – STE202 (Figure 4D)
- Current sensor – SEC201[b]
- Current transformer connected to SEC201[b]

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Figure 4B

4.1 Ambient air T&H sensor THS01

Ambient air T&H sensor is used to measure the environmental temperature and humidity. The environment temperature is used for TR and gas pressure M&D algorithms. THS01 is connected to MDC4-M Modbus port via RS485 interface. Its appearance is shown in Figure 4B, terminals are defined in Table 4A.

—
Table 4A Ambient air T&H sensor terminal definition

Pin number	Pin number connected to	Function
A	MDC4-M: X2 – 7	Communication
B	MDC4-M: X2 – 6	
V+	+12/24VDC	Power supply
V1	GND	

b: For DTR only.

Figure 4C Recommended install position of THS01 for SGIS

4.1.1 Cable Compartment Installation (Recommended)

THS01 can be mounted on the inner side of sideboard behind the cable compartment as shown in Figure 4C. If there is potential heat/cooling source around, the install position should be carefully evaluated by ABB's engineer.

4.1.2 LV Compartment Installation

THS01 can also be installed on the din-rail inside the LV compartment. It shall be kept at a necessary distance from any potential heat source and cooling source to ensure the accurate acquisition of ambient temperature. If a heating device is set in or near the LV compartment, THS01 shall be moved to cable compartment (Figure 4C) or consult ABB R&D team.

⚠ **The ambient air T&H sensor THS01 should be kept away from any potential heat/cooling source!**

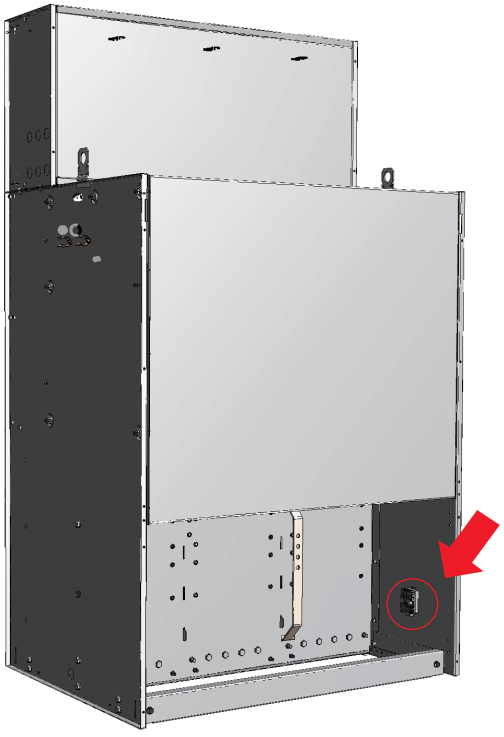


Figure 4C

— Figure 4D TR sensor STE202 and its installation demonstration
— Figure 4E Installation of TR sensor STE202 for SGIS

4.2 Temperature rise sensor

Temperature monitoring devices STE series are key components in ABB's switchgear and apparatus condition assessment solutions. The devices are battery-free, self-powered smart temperature sensors, utilizing wireless communication technology for connecting to ABB's monitoring and diagnostics data concentrators.

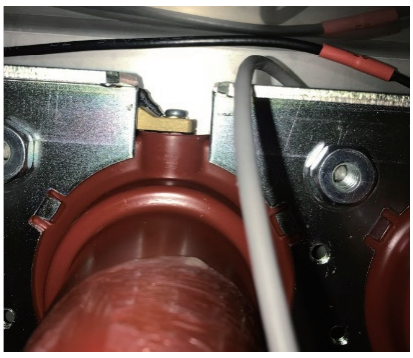
4.2.1 STE202

STE202 can be installed directly on high-voltage parts of medium-voltage switchgear as shown on the right-hand side of Figure 4D. The sensor probe needs to be in direct contact with the measured point. The strap needs to be tightened and fastened to prevent slipping off.

— Figure 4D

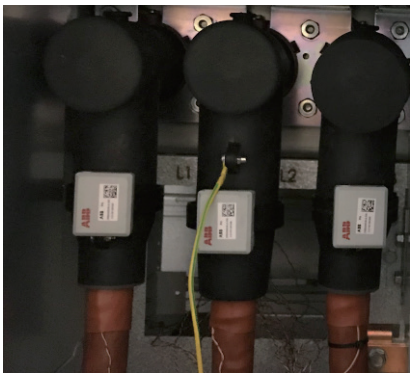
The installation of TR sensor including 3 steps as listed below and illustrated in Figure 4E:

1. Install the sensor probe on the bushings together with the VPIS cable for each phase.
2. Connect the sensor probe with the grey box.
3. Wrap the data acquisition and communication module around the cable surface and press the buckle of the strap to ensure the module is tightly fixed as shown in Figure 4E (d).



(a) Sensor probe and bushing

(b) Connection between sensor probe and gray box



(c) Gray box on cable

(d) Gray box buckled

— Figure 4E

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Figure 4F Waterproof connectors of STE202
—
Figure 4G TR sensor STE203 (3-in-1)
—
Figure 4H Parts of STE203

The STE202 is designed as waterproof. If disconnecting/reconnecting of the sensor cable from gray box, make sure the red sealing ring is inside the connector and the waterproof joint is tightened up as shown in Figure 4F.

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Figure 4F

The TR sensor is only applicable to the accessories (T-head) with cable skin grounded.

4.2.2 STE203

STE203 is a new type of TR sensor which can combine 3 sensor probes with 1 gray box, as show in Figure 4G.

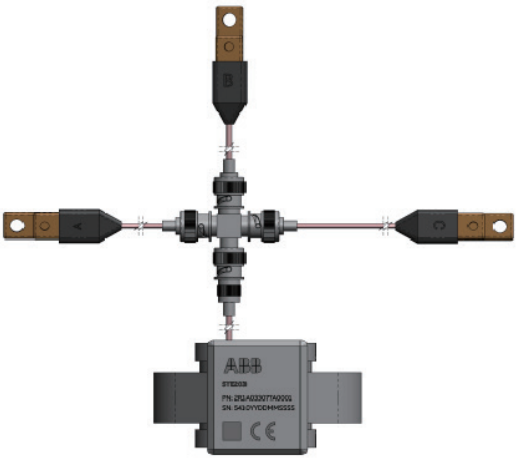

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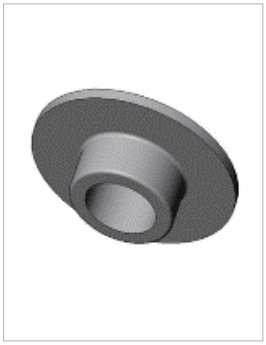
Figure 4G

STE203 consist of 4 parts: main gray box, sensor probe, insulation washer and 4-way BNC adaptor, as shown in Figure 4H.

(a) Main gray box

(b) Sensor probe



(c) Isolation washer

(d) 4-way BNC adaptor

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Figure 4H

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Figure 4I STE203 insulation washer on sensor probe
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Figure 4J SEC201 and installation on din-rail

The installation of TR sensor STE203 including 5 steps as listed below:

1. Plug a total of 6 insulating washers in the round mounting holes of three (phase A, B and C) STE203 sensor probes, as shown in Figure 4I.

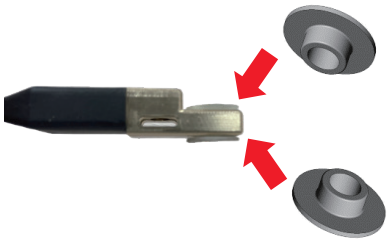

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Figure 4I

2. Fasten the metallic end of the STE203 sensor probe at the VPIS connections of the bushings in the cable compartment.
3. Connect the female connector of four-way BNC connector with the male connectors of sensors probes of A, B and C respectively, and connect the only male connector with the female connector of gray box.
4. Wrap the gray box around the surface of cable accessories. Then, lock the buckle to ensure that the installation is stable .
5. Fix the four-way BNC connector to the left side of the type T cable accessories.

4.3 Primary current sensor SEC201

SEC201 is a smart sensor for switchgear primary current measurement using split-core current transformer sensors. They are key components in ABB's switchgear and apparatus condition assessment solutions. They can be opened and snapped around on the secondary side of the primary current CT, then utilizing RS485 communication for connecting to data concentrators.

—
Figure 4J

For dynamic temperature rise (DTR) monitoring solution, SEC201 are required to obtain the primary current information. In this case, primary CT in switchgear cable compartment is a compulsory element. The ratio of primary CT coils should be configured.

Primary CT and SEC201 are compulsory when DTR is enabled!

—
Figure 4K Configuration interface of STR/DTR using MConfig for SGIS

4.4 Configuration of STR/DTR M&D with MDC4-M

The configuration of TR sensor and setting up the connection with MDC4-M can be done via MConfig. The type of TR sensor (1-in-1 STE202 or 3-in-1 STE203), ID code of TR sensor, and the ratio of primary CT coils need to be input in the corresponding text box of each unit as shown in Figure 4K.

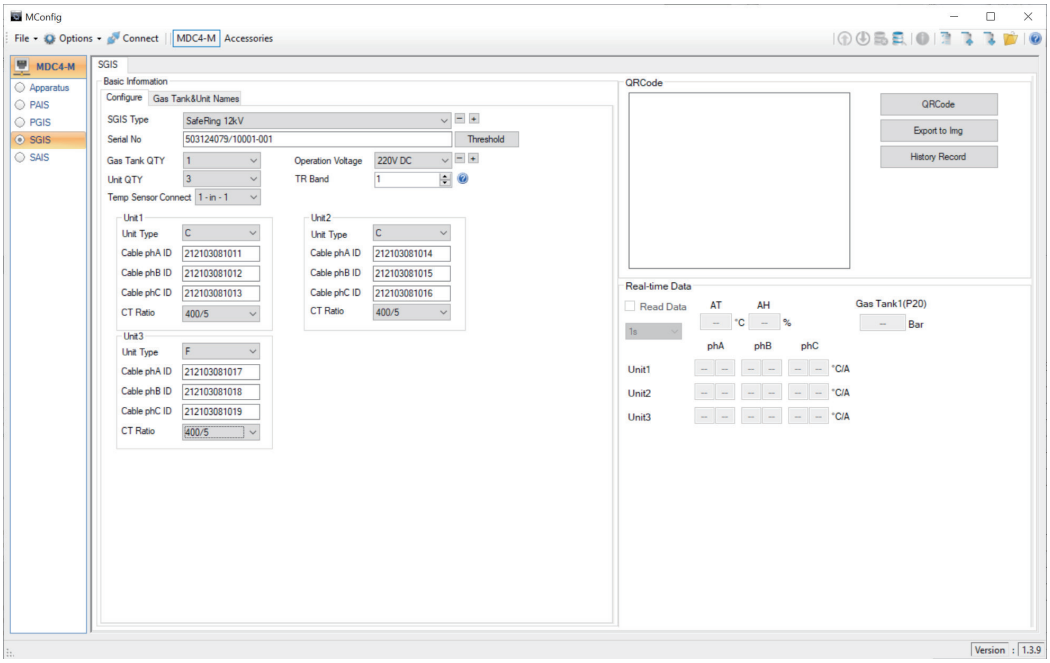

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Figure 4K

Different TR bands shall be selected for different MDC4-M within 20m distance in the same space!

5. Gas pressure monitoring

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Figure 5A Hierarchy chart of gas tank pressure monitoring function
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Figure 5B Installation of gas density sensor

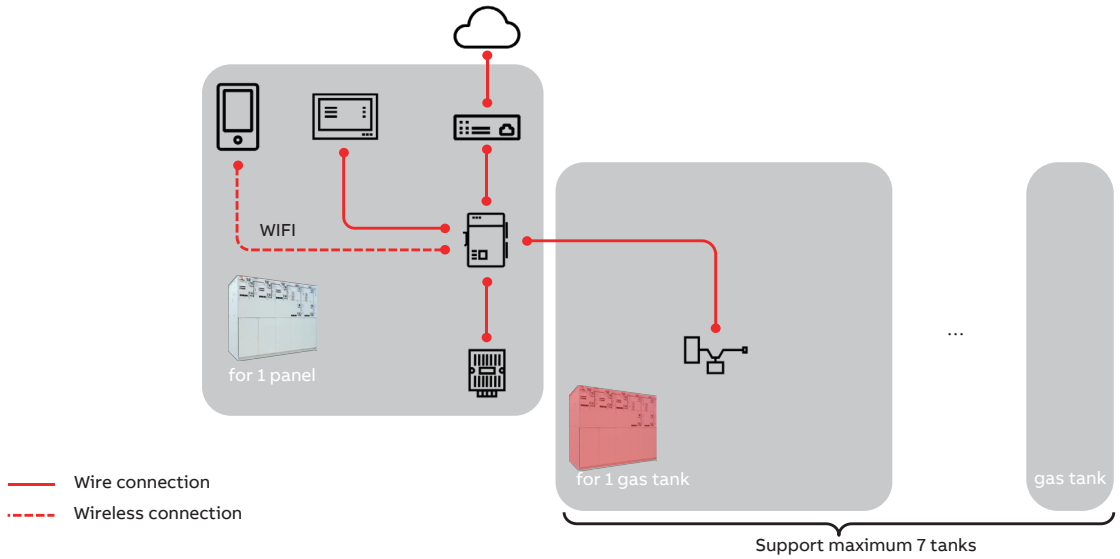

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Figure 5A

The system hierarchy chart of gas tank pressure monitoring function is shown in Figure 5A. Take MDC4-M as the core of the system, various devices/sensors are connected:

- Ambient air T&H sensor – THS01 (Figure 4B)
- Gas density sensor – DM60R (Figure 5B)

5.1.Ambient air T&H sensor THS01

THS01 is compulsory for gas tank pressure monitoring to compensate the environment temperature. Details of THS01 and its installation please refer to chapter 4.1.

5.2.Gas density sensor DM60R

The gas tank pressure can be monitored using gas density sensor DM60R, as shown in Figure 5B. DM60R is connected with MDC4-M via RS485 port. The terminal definition is listed in Table 5A

—
Figure 5B

—
Table 5A Terminal definition of gas density sensor DM60R

Terminal No.	Color	Definition	Function
1	Red	+12V DC	Power supply
2	Black	GND	
3	Yellow	RS485-A+	Communication
4	Blue	RS485-B-	

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Figure 5C Modbus address configuration of DM60R via MConfig

5.3.Configuration of DM60R

The Modbus address of DM60R can be configured via MConfig which is shown as below.

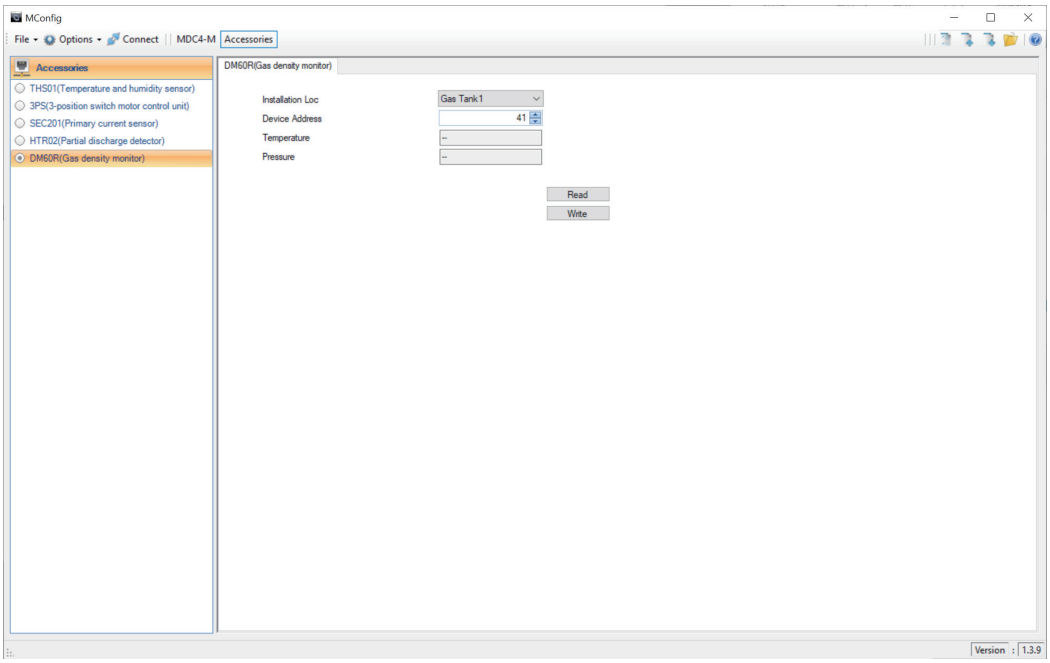

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Figure 5C

6. Mechanical characteristics monitoring

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Figure 6A Hierarchy chart of mechanical characteristics monitoring function
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Figure 6B Mechanical characteristics monitoring sensor SMX202

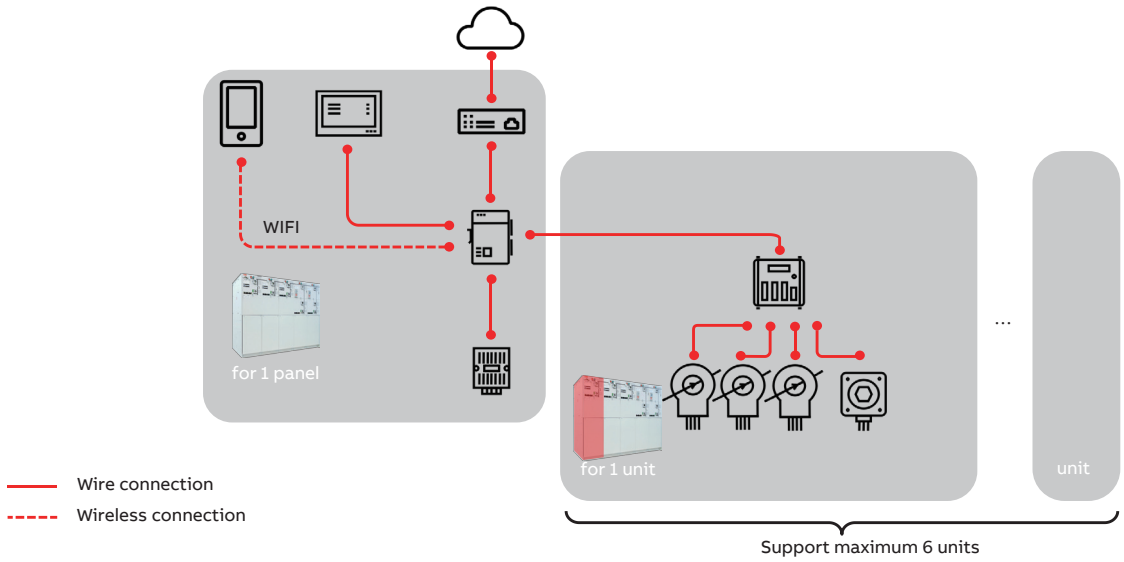

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Figure 6A

The system hierarchy chart of mechanical characteristics monitoring function is shown in Figure 6A Hierarchy chart of mechanical characteristics monitoring function. Take MDC4-M as the core of the system, various devices/sensors are connected:

- Mechanical characteristics monitoring sensor – SMX202 (Figure 6B)
- Resistive rotation angle sensor (Figure 6C)
- Hall* rotation angle sensor (Figure 6D)
- Hall current sensor (Figure 6E)

—
Figure 6B

6.1 Mechanical character sensor (SMX202)

The mechanical characteristics sensor is the core component for mechanical monitoring of the switchgear mechanism. As shown in Figure 6B, it has five ports. The functions and terminal definition of each port are shown Table 6A. SMX202 is installed on the customized DIN-rail beside the operating mechanism in the mechanism compartment and connected with MDC4-M using RS485 port.

*: For EL mechanism only.

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Figure 6C Resistive rotation angle sensor
—
Figure 6D Hall rotation angle sensor
—
Figure 6E Hall current sensor

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Table 6A SMX202 Port Definition

Port	Pin	Function
COM	1 - 12/24VDC	Power supply and communication ports
	2 – RS485-A	
	3 – RS485-B	
	4 – GND	
	5 - EARTH	
T	1 – GND	Ports for angle sensor
	2 – Output	
	3 – VCC	
M C O	1 – GND	PPorts for motor current sensor for close coil current sensor for open coil current sensor
	2 – Output	
	3 – Vref	
	4 – VCC	

The configuration of SMX202 is handled by ABB manufacturing or service only as special calibration is required!

6.1.1 Resistive rotation angle sensor

The resistive rotation angle sensor is shown in Figure 6C. It is installed on the hexagonal shaft of the indicator flag and has a special buffering design for installation.

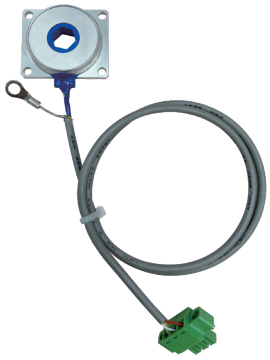

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Figure 6C

6.1.2 Hall rotation angle sensor

Hall rotation angle sensor is applicable to EL mechanism, as shown in Figure 6D. It is installed on EL mechanical sleeve.

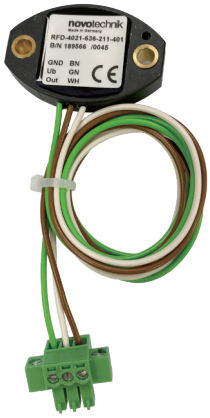

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Figure 6D

6.1.3 Hall current sensor

Hall current sensor is used to measure the current of charging motor, opening coil, and closing coil, as shown in Figure 6D.

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Figure 6E

7. 3PS position video monitoring

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Figure 7A Hierarchy chart of 3PS position video monitoring function
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Figure 7B IP camera
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Figure 7C Installation of IP camera
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Figure 7D Demonstration snap screens of IP camera

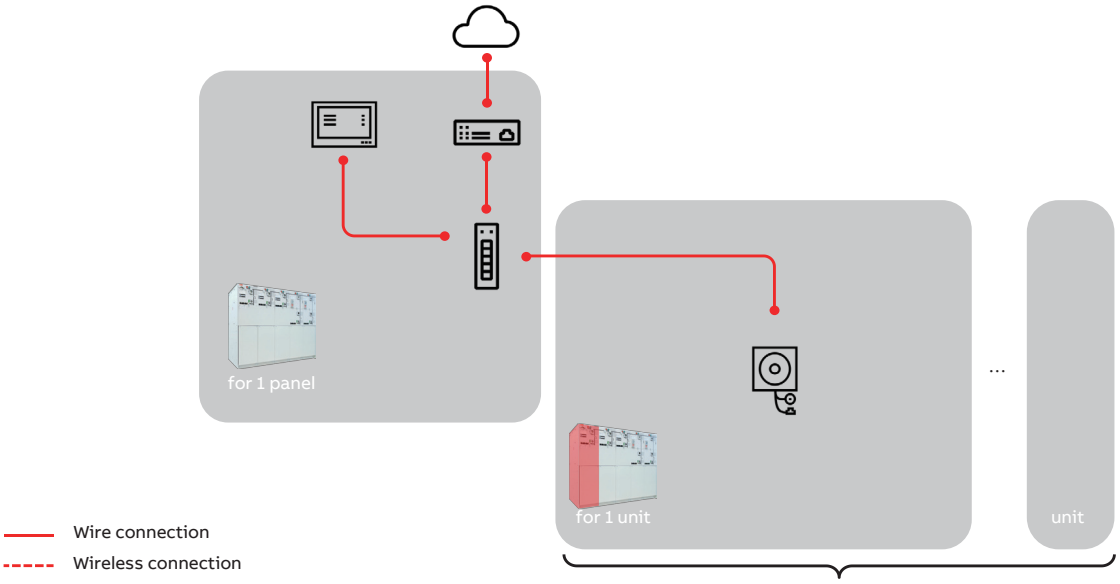

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Figure 7A

The system hierarchy chart of 3PS position video monitoring function is shown in Figure 7A. IP cameras (Figure 7B) are connected to local display (IP touch 7) and/or gateway via ethernet switch.

The IP camera is installed on the back of gas tank, as shown in Figure 7C, and demonstration snap screens are in Figure 7D.

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Figure 7B

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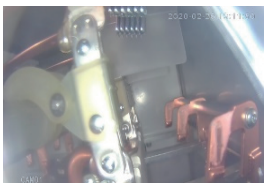
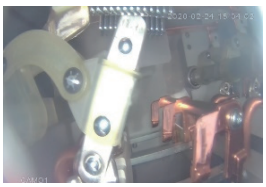
Figure 7C



Close position

Open position

Earthing position



Fault position

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Figure 4H

8. Partial discharge monitoring

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Figure 8A Hierarchy chart of partial discharge monitoring function
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Figure 8B PD data transceiver HTR02-6AWA-PDD

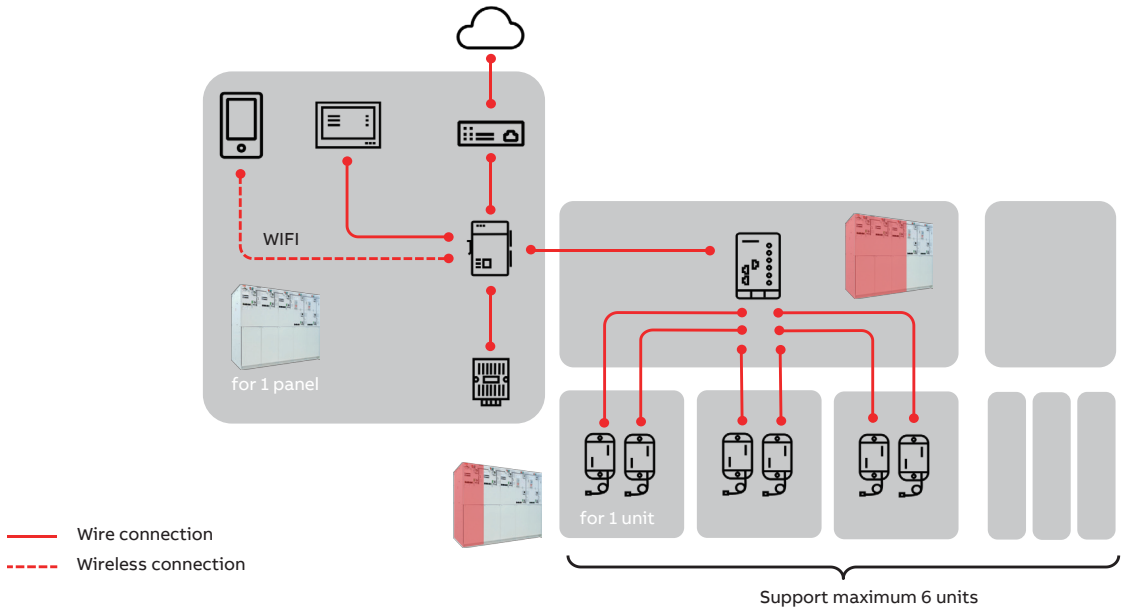

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Figure 8A

The system hierarchy chart of partial discharge monitoring function is shown in Figure 8A. Take MDC4-M as the core of the system, various devices/sensors are connected:

- PD data recorder – HTR02-6AWA-PDD (Figure 8B)
- PD UHF antenna – AN-F1 (Figure 8D)

8.1 PD data transceiver HTR02-6AWS-PDD

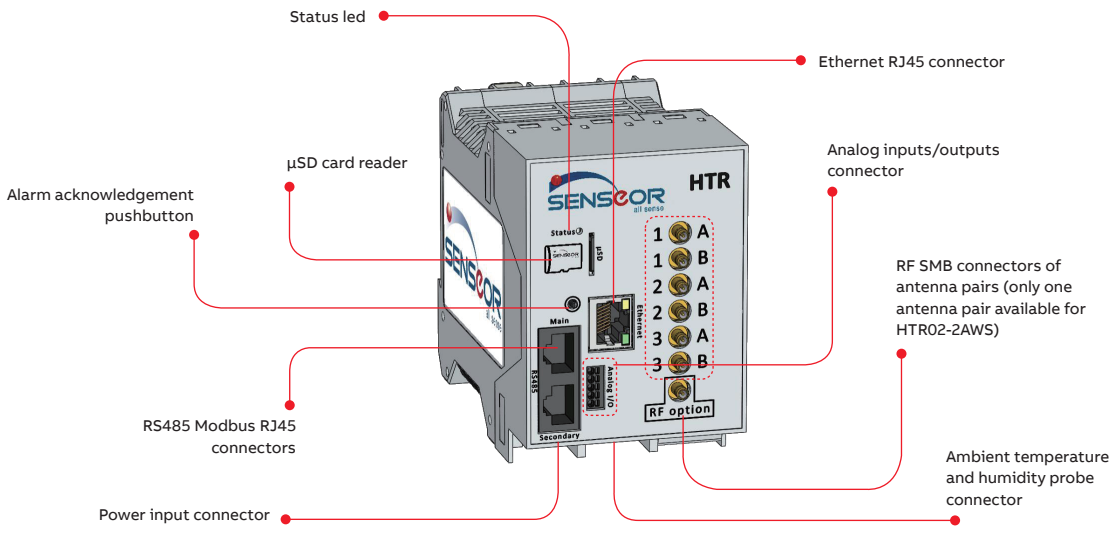

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Figure 8B

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Figure 8C HTR02 connection
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Figure 8D PD UHF antenna AN-F1
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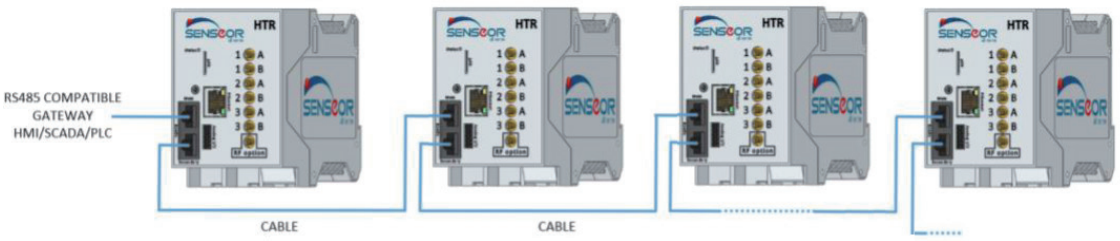
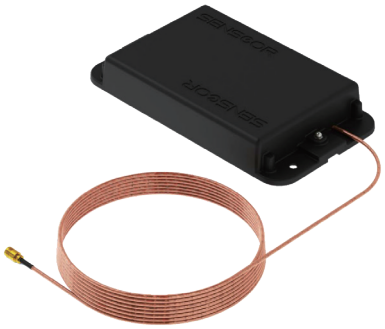
Figure 8E SENSeOR Configuration Tool

HTR02-6AWA-PDD can be connected to MDC4-M via RS485 port. If multiple HTR02-6AWA-PDD are used, the they can be connected in series as shown in Figure 8C.



—
Figure 8C

8.2 PD UHF antenna AN-F1



—
Figure 8D

8.3 Configuration of PD data transceiver

The HTR02-6AWA-PDD is configured via PC by using SENSeOR Configuration Tool, as shown below. Detailed instruction of configuration of HTR02-6AWA-PDD please refer to SENSeOR user manual.

—
Figure 8E

The outputs of HTR02-6AWA-PDD are gathered by MDC4-M (advanced M&D algorithms are implemented in MDC4-M), providing a comprehensive evaluation of dielectric health status and score of SGIS.

9. Local Human Machine Interface (LHMI)

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Figure 9A Local HMI LV compartment door installation
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Figure 9B LHMI MP58B
—
Figure 9C Typical screen shots of LHMI MP58B

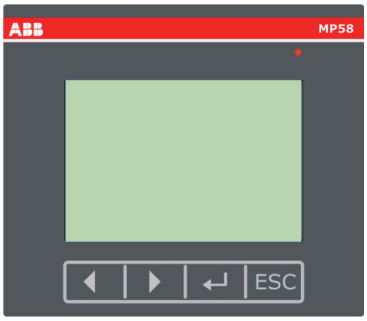
The local HMI is installed on the low-voltage compartment door as an option, as shown in Figure 9A.

—
Figure 9A

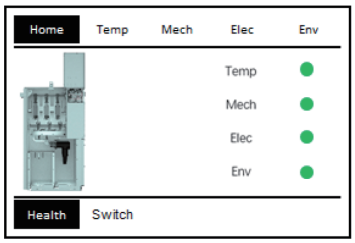
9.1 MP58B

MP58B is a LHMI for MDC4-M which is fully compatible with existing Safe Digital solutions with color display. It is a plug-and-play device requiring no additional configuration.

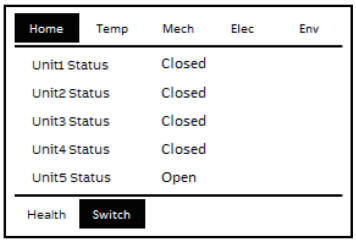
Typical screen shots of MP58B are shown in Figure 9C.



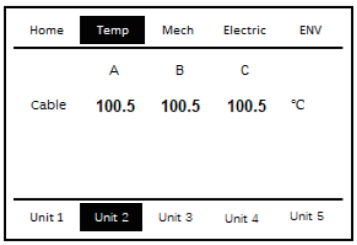
—
Figure 9B



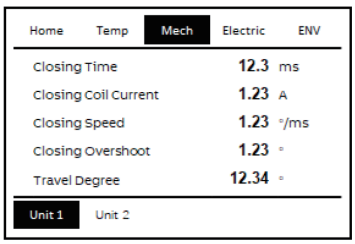
Home screen



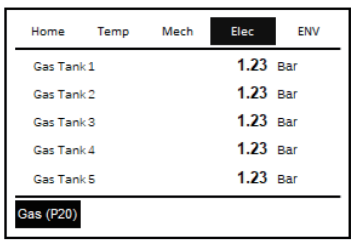
Switch status



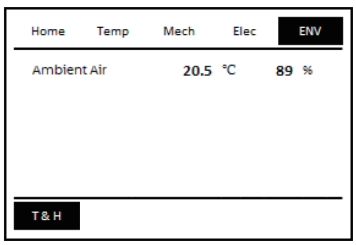
Temperature



Mechanical



Gas pressure



Environment

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Figure 9C

—
Figure 9D LHMI IP Touch 7
—
Figure 9E Typical screen shots of LHMI IP Touch 7

9.2 IP touch 7

IP touch 7 is shown in Figure 9D and the detailed information can refer to its user manual. Typical screen shots of IP touch 7 are shown in Figure 9E.

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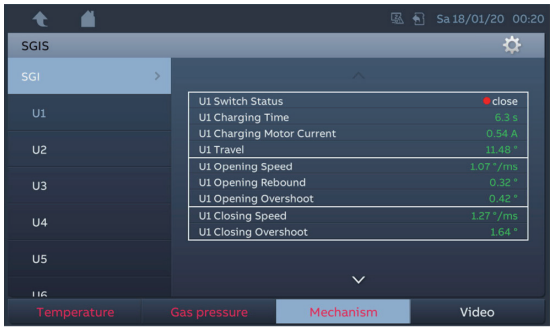
Figure 9D

The surface of IP touch 7 is made of glass. Pay attention to protection during installation and configuration in case of physical damage!

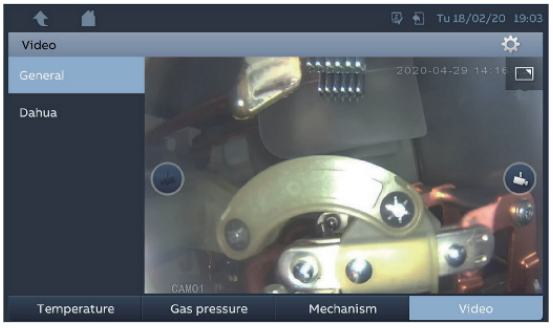
Home screen

Temperature

Gas pressure



Mechanism



Video

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Figure 9E

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