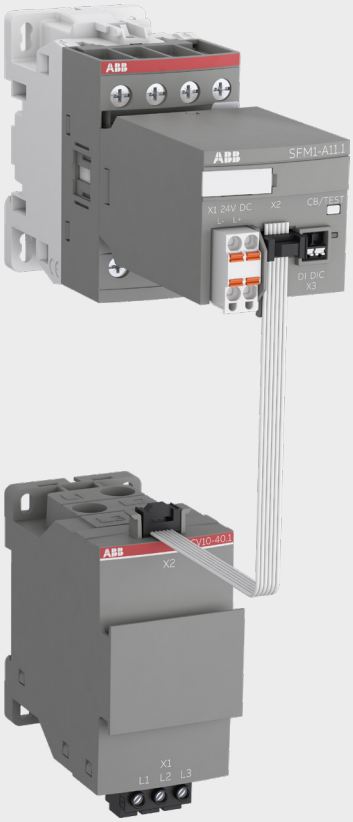
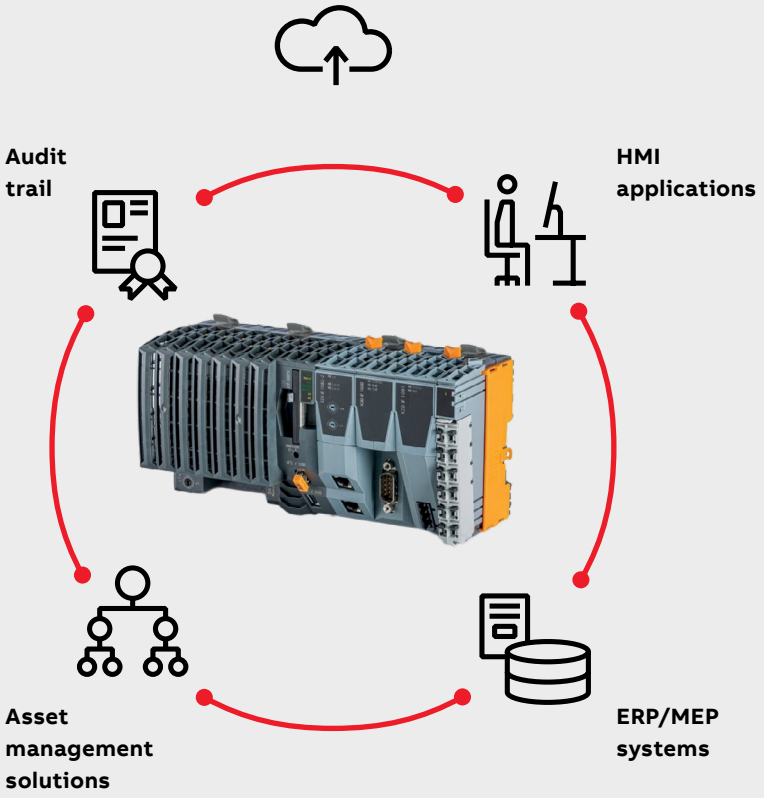
MANUAL

# Novolink™ – smart function and sensor modules for AF contactors

Integrated into the B&R X20 system



**The all-new ABB Novolink™ devices help digitalize your motor starting solutions and gain insights into the connected loads. They're easy to design into existing wiring plans and connect to standard AF contactors.**

**Installation is fast and simple, thanks to reduced wiring and fewer components, so your engineering efforts are minimized.**

**Novolink™ devices enable predictive maintenance to reduce downtime, as well as increasing efficiencies and boosting cost savings. They're fully integrated into the B&R automation system. And the possibilities open up even more with full remote access to your data, creating new maintenance service and revenue opportunities.**

**So to simplify engineering, optimize operations, save time and cut costs, think Novolink.**

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# 1. Important notice

**Target group**
This description is intended for use by trained specialists in electrical installation and control and automation engineering who are familiar with the applicable national standards.

**Safety requirements**
The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

**Symbols used in this handbook**

| | |
|---|---|
|  | Symbol to indicate a potentially dangerous situation that can cause damage to the Smart Function Module or connected devices or to the environment |
|  | Symbol to indicate important information and conditions |
|  | Symbol to indicate a potentially dangerous situation that can cause human injury |

**Cyber Security Statement**
This product is designed to be connected to and to communicate information and data via a network interface. It is your sole responsibility to provide and continuously ensure a secure connection between the product and your network or any other network (as the case may be). You must establish and maintain any appropriate measures (such as, but not limited to, the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information.

ABB Ltd and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

# 2. Abbreviations

| | |
|---|---|
| SCV | Smart Current and Voltage Sensor Module |
| SC | Smart Current Sensor Module |
| SFM | Smart Function Module |
| MS… | Manual Motor Starter |
| MO… | Manual Motor Starter Magnetic Only |

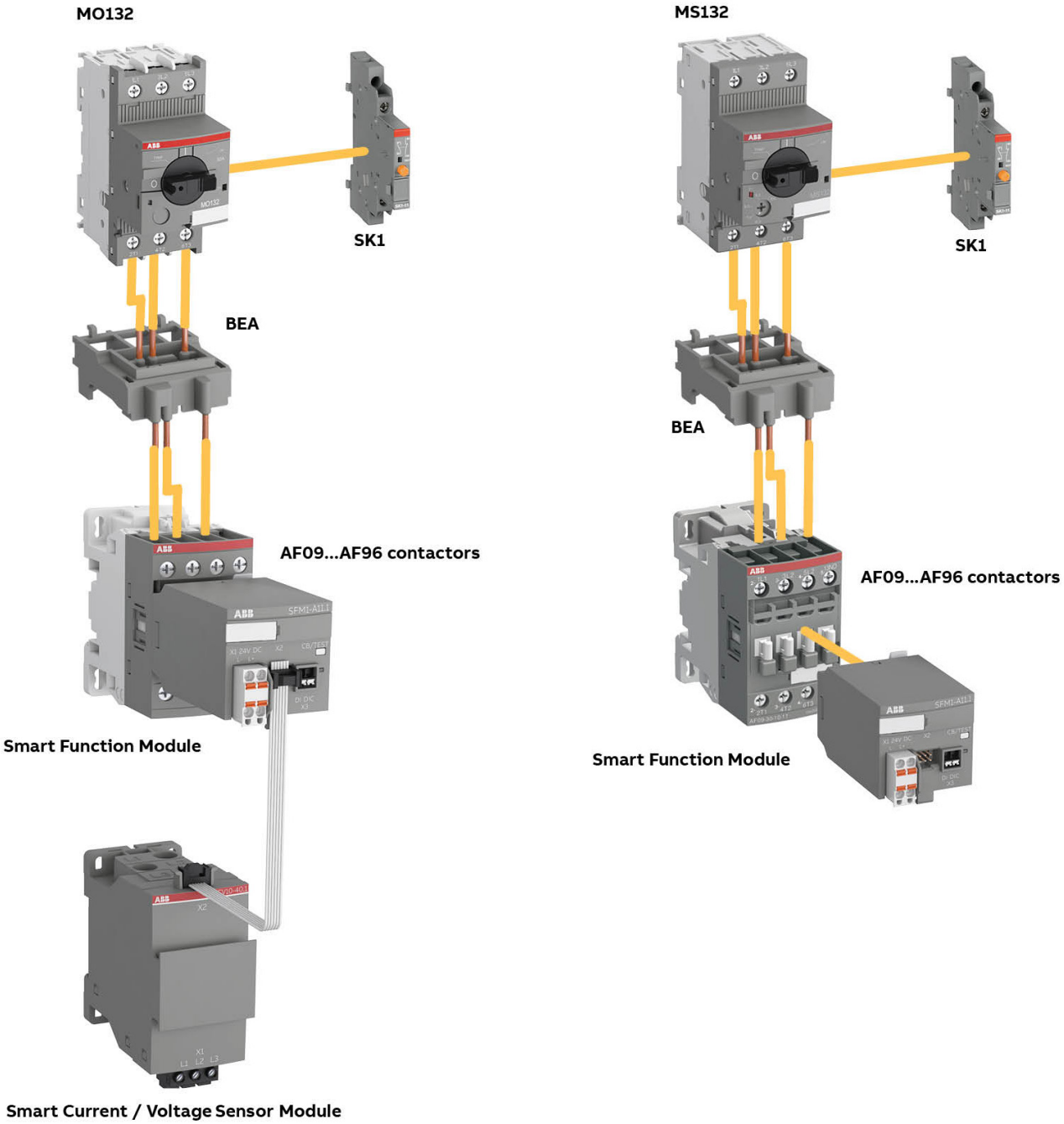
# 3. System description

## 3.1 Overview

This handbook describes the Smart Function Module SFM1 and the optional sensor module SCV10-40/SV10-40.1. The SFM1 allows the remote control and monitoring of AF contactors via X20 bus from within a B&R PLC. The optional voltage and current sensor module SCV10-40/SV10-40.1 can be connected to the SFM1 module and provides functions for motor and application protection.

**Important Notice**
In this document, the SCV sensor module is representative of the two modules SCV10-40 and SC10-40. The SC10-40 module only provides a current measurement. Therefore, if this module is connected to the SFM1, no voltage information and information derived from it (e.g. active power) are available.

The figure below shows the main components and how they can be combined for complete motor starting solutions.




01: A full-featured solution is shown on the left, consisting of a Direct Online Starter (DOL) with a MO132 as short circuit protection device, AF contactor, (SK1), Smart Function Module (SFM) and Smart Current / Voltage Sensor Module (SCV) including the complete motor protection functions. On the right, a basic solution is shown, with MS132 for motor protection and a Smart Function Module (SFM) for remote control.

### 3.2 Order codes

| Type description | Description | Order code |
|---|---|---|
| SFM-CAB-RJTB.1-500 | Connection cable RJ45 - X20 Terminal Block of X20BT9400, 5m | 1SVM823000R0500 |
| SFM-CAB-S.1-50 | Connection cable SFM to Sensor 0.5m | 1SVM811000R0050 |
| SFM-CAB-S.1-25 | Connection cable SFM to Sensor 0.25m | 1SVM811000R0025 |
| SCV10-40.1 | Current – Voltage Sensor | 1SVM320010R0000 |
| SC10-40.1 | Current Sensor | 1SVM310010R0000 |
| SFM1-A11.1 | Advanced Function Module with X2X | 1SVM120012R0000 |

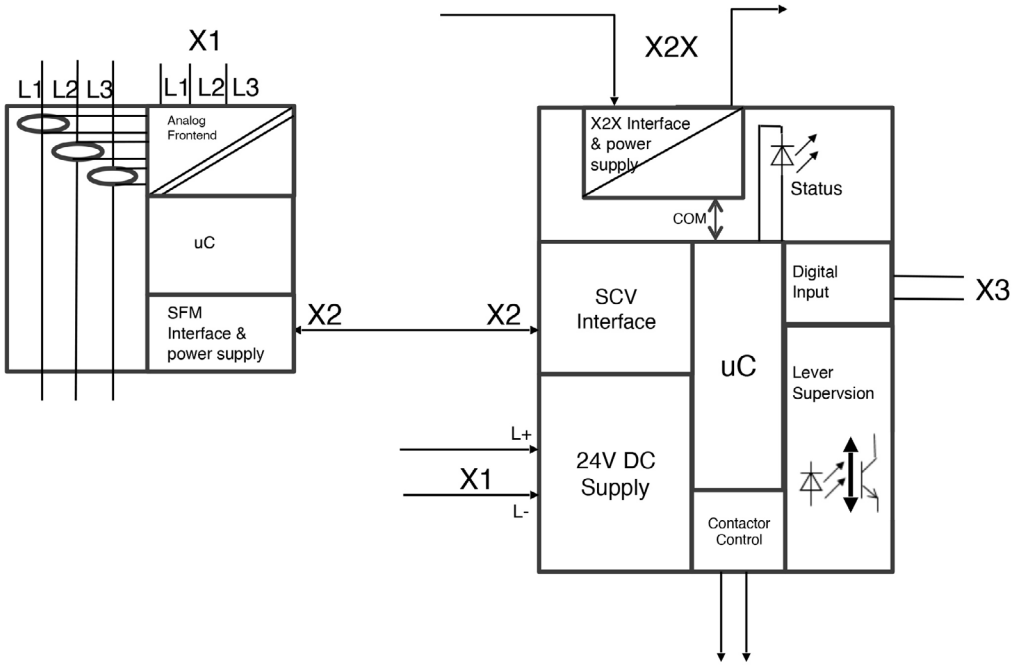
### 3.3 Smart Function Module (SFM)

The Smart Function Module SFM1 can be snapped onto AF09 – AF96 contactors with 24 V coil voltage. The module is equipped with two X2X interfaces for incoming and outgoing connections. The module and contactor are supplied via 24 V DC that are supplied to the SFM1 module.

One digital input makes it possible to pick up an auxiliary signal, e.g. from a short circuit protection device such as the MO132. The auxiliary signal can be read out from the PLC and used for various purposes. A sensor module can be optionally connected to the SFM1 via flat cable.

The AF contactor is mechanically linked with a lever, which in turn provides visual feedback of the contactor position on the front of the SFM. The lever also allows to operate the contactor for test purposes. The status LED displays the operation state of the SFM1 itself.

SFM is fully integrated into the B&R Automation studio, which makes using the SFM/SCV easy. The HWX file offers the possibility to configure both modules and select the process values that should be transmitted cyclically between the SFM1 and the PLC. Values can also be requested as acyclic by the PLC.

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02: Block diagram of SFM1 and SCV. Both devices are connected with a serial interface to exchange data.

### 3.4 Smart Current and Voltage Sensor Module (SCV)

The SCV10-40 is an intelligent sensor unit for measuring voltage, current, frequency and further derived physical quantities such as cos phi, real power, etc. (please refer to section 8.3 for details).

It is equipped with feed through current sensors to measure the current in all three phases of the connected load. It also offers the option to measure the line to line voltage of the three phases up to 690 V AC. A ribbon cable connects the SCV10 with the SFM1 module and is also supplied from there.

The SCV10-40 offers thermal overload protection according to IEC/EN 60947 for 1/3 phase induction motors. Relevant parameters like the trip class and nominal current can be configured from within the PLC.

# 4. Installation

## 4.1 Assembly and disassembly

**Assembly**

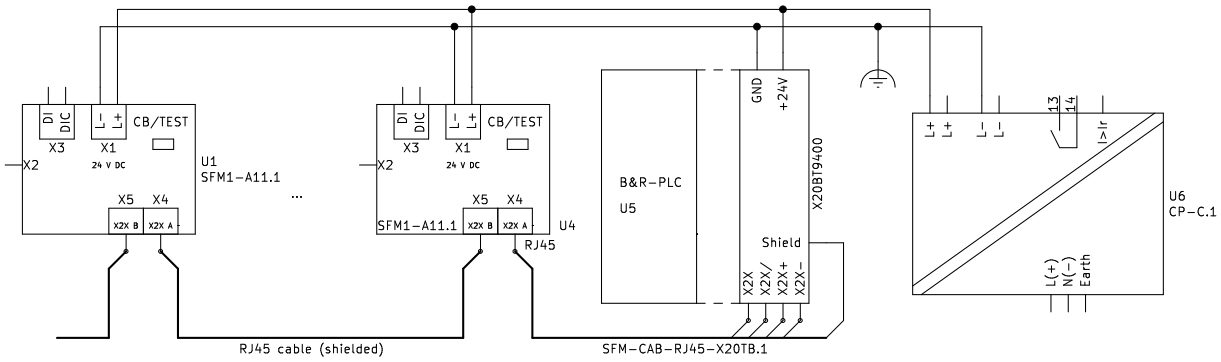
The SCV10-40 can be mounted on any standard DIN rail. No tools are required. Alternatively, it can be mounted on a mounting place using screws. See dimensional drawing in the appendix for details. The SFM1 must be snapped on an AF contactor until a click is heard.

**Disassembly**

The white lock must be pulled before unmounting the SFM1 from the contactor. Ensure contactor is voltage free. Bus connection to subsequent devices is interrupted.

## 4.2 Connecting the SFM modules with the X20 system

The following diagram shows the general wiring concept of a system of SFM1 modules. It only focuses on the fieldbus part.

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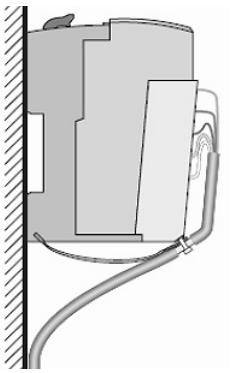
03: To connect the X20BT9400 to the first SFM1 module, use the readymade cable SFM-CAB-RJTB.1.

On one side, the SFM-CAB-RJTB has a cable shield clamp which is latched to the terminal block. All the required wires are already connected to the X20 terminal block. Cable ties are used to press the shield against the grounding plate. The other side of the cable has a RJ45 plug which can be directly connected to the SFM1 module.

Mount the terminal block to the bus module.

Connect the shield to the foreseen bus module's ground connection using the cable lug as shown in the following figure



Only the communication interface of the SFM1 module is powered with the supply provided by the X20BT9400 module. The contactors are supplied with via X1 of the SFM1 module. See block diagram above for details

Check the connection examples of the X20BT9400 module on how to supply the X2X bus. Adjust the readymade SFM-CAB-RJTB wring according to your needs.

For the SFM to SFM module, use a shielded RJ45 cable. For details, see the chapter on technical data. It is not required to terminate the bus after the last module.

### 4.3 Supported AF contactors and accessories

The SFM1 module can be mounted on all 24V supplied AF09 to AF96 contactors as described in the table below.

| Size 1 | Size 2 | Size 3 | Size 3.5 |
|---|---|---|---|
| AF09ww-xx-yy-zz | AF26ww-xx-yy-zz | AF40ww-xx-yy-zz | AF80ww-xx-yy-zz |
| AF12ww-xx-yy-zz | AF30ww-xx-yy-zz | AF52ww-xx-yy-zz | AF96ww-xx-yy-zz |
| AF16ww-xx-yy-zz | AF38ww-xx-yy-zz | AF65ww-xx-yy-zz | |
| zz= coils 11, 21 and 30 | zz= coils 11, 21 and 30 | zz= coil 11 | zz= coil 11 |
| Terminal: Screw, Push-in | Terminal: Screw, Push-in | Terminal: Screw | Terminal: Screw |

ww: Denotes NEMA products
xx: 22, 30
yy: Number and type of auxiliary contacts
.

Contactor coil is supplied via X1 of the SFM1 module. There must be no voltage supplied via A1/A2 to the contactor.

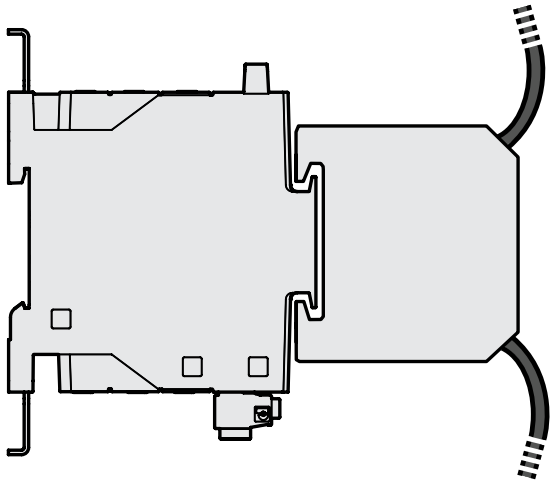
### 4.4 Connecting the SFM1 to 24 V supply

The SFM1 must be supplied with 24 V DC. The 24 V DC are used to power the contactor coil as well as to power the module itself (excluding the communication part). It is possible to loop through the 24 V DC to the next module to simplify the overall wiring.

The polarity of the 24 V DC is important. In case of the wrong polarity, the contactor switches on without any bus command.

### 4.5 Using the DIN-rail at the front of the Sensor Module

It is possible to mount lightweight devices such as terminal blocks on front of the sensor module.



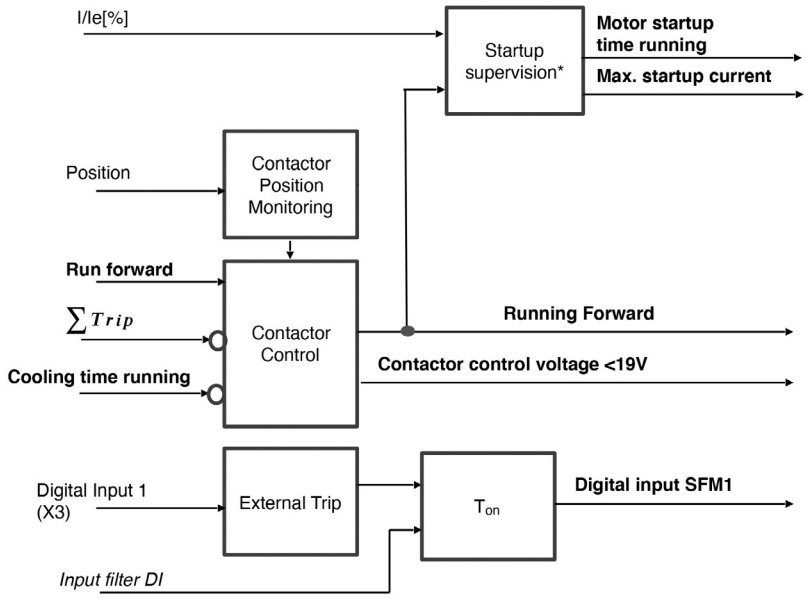
The maximum weight of the devices mounted on the SC/SCV module must not exceed 50 grams.

# 5. Description of functions

This chapter provides an overview of the various functions and how to configure them.

## 5.1 Motor management functions

This subsection describes the motor management related functions. The following figure provides an overview of the general function.

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04: General dataflow of the motor management related functions. The parameters are shown in italics. The command and monitoring signals are shown in bold.
*) The startup time supervision function is only available if the SCV module is present.

### 5.1.1 Mechanical switching test

On the front face of the SFM1, the plunger indicates the mechanical position of the AF contactor. This plunger is directly mechanically interlocked with the AF contactor and makes it possible to mechanically operate the contactor for test purposes. To operate the contactor, push down the lever with a screwdriver.

Pushing the plunger to operate the contactor can be done at any time by a person with access to the SFM1 module. Prevent unintended motor starts with safety measures, e.g. locking the panel door.

Recommended screw driver for test:

| Screwdriver type | | |
|---|---|---|
| | 0.6 x 3.5 mm | 0.4 x 2.5 mm |

### 5.1.2 Remote control of the AF contactor / switching the motor on or off

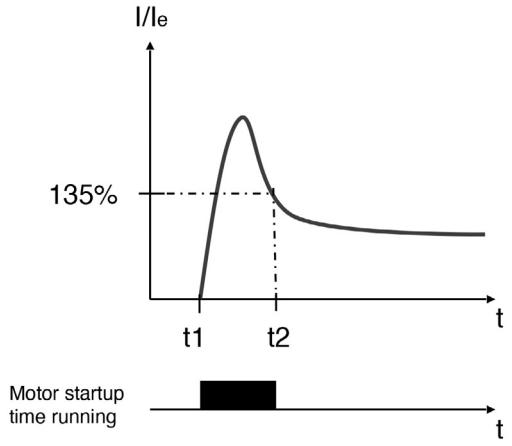
The AF contactor can be remotely switched on and off from the PLC. The switching operation is supervised with the help of the built-in lever supervision, and the mechanical checkback information is available via a bus. On the PLC, a suitable reaction for a mismatch between the actual command and the actual checkback must be implemented.

### 5.1.3 External trip input

The digital input is intended to monitor the status of an external short circuit protection device (fuse, MO, etc.). The status of this input is available in the PLC and a suitable reaction can be implemented (e.g. reset ON command bit and log a diagnosis message in the system event log). The DI filter time can be adjusted.

### 5.1.4 Startup time supervision

This function supervises the motor startup time, and is only available if the SCV module is present. The real motor startup time is considered as the time t2-t1 in seconds, i.e. the time when the motor was started (t1), and the current falls below 135% (t2) again. In case the defined threshold is not reached, a replacement value is set, depending on the trip class (5E ->1.5s, 10E -> 3s, 20E -> 6s, 30E -> 9s).




The motor startup time can be used to realize monitoring or protection functions in the PLC that should only be active during motor startup, or after motor startup.

## 5.2 Monitoring and protection functions

The SFM1, together with the SCV module, provides the protection functions listed in the table below. In order for the monitoring and protection functions to work, the network type and the nominal network frequency must be set.

### 5.2.1 Thermal overload protection

The SFM1 together with the SCV protects single- and three-phase AC motors in compliance with IEC 60947-4-1. The tripping class can be set to class 5E, 10E, 20E or 30E. The advanced thermal motor model considers both the copper and iron parts of the motor, thus providing the best protection of the motor. The thermal overload protection can be switched on and off.

Before an overload trip occurs, a pre-warning can be generated in the PLC by monitoring the thermal load in %. During high overload situations, this prewarning might be raised just a few seconds before the actual trip happens.

The thermal model calculates an estimate of the ‘time to trip’ under the current load conditions. If the motor is switched off, the time to trip shows 6,553 seconds (in which case it never trips). If the motor is running, the predicted trip time is updated regularly. The smaller the value the earlier the trip occurs.

After an overload trip, the remaining cooling down time (i.e. time to restart) is calculated regularly and is available to the user. The motor can be restarted if the cooling time is 0 seconds.

After a trip has occurred, the ‘time to cool’ is calculated. Restarting of the motor is either possible after fixed time or after the thermal load has fallen below a configured threshold. An automatic restart of the motor can be activated once the motor has cooled down sufficiently.

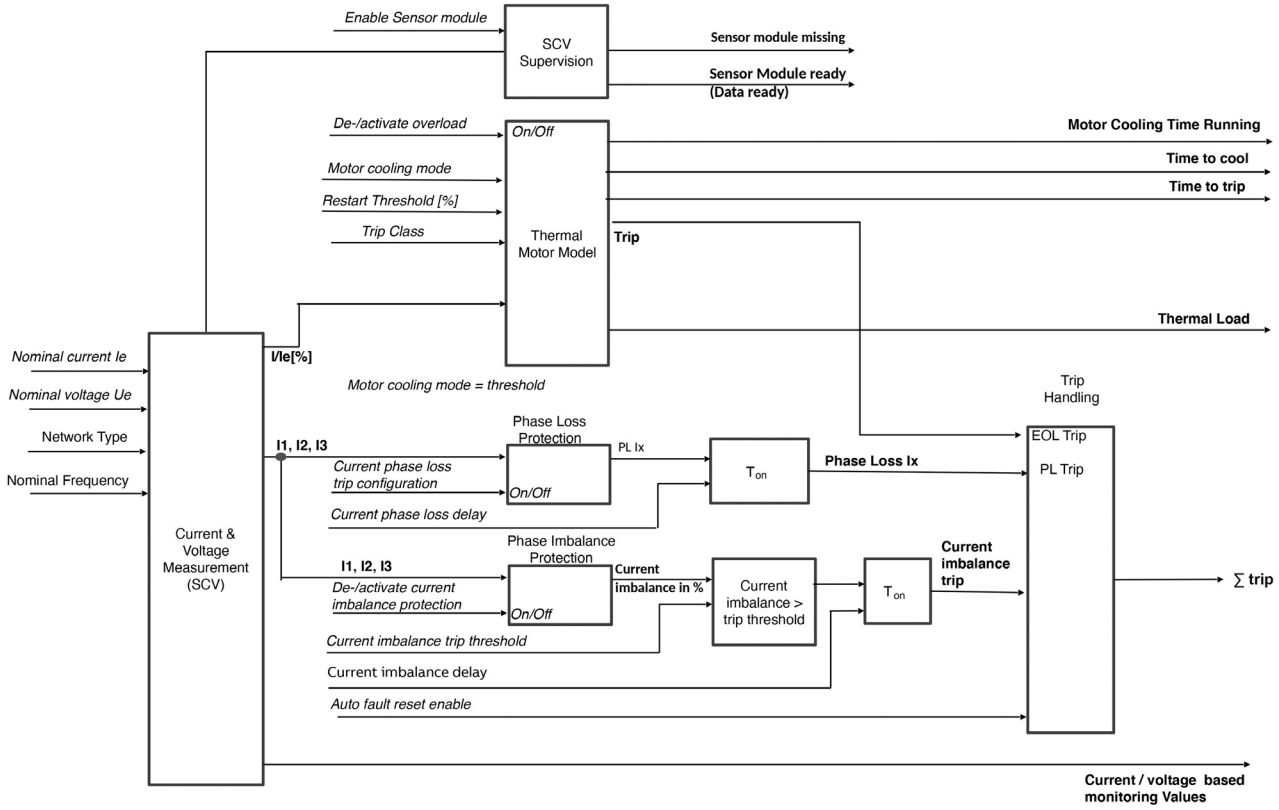
### 5.2.2 Phase loss protection

This function protects motors against the extreme situation where a complete phase is lost. An undetected phase loss can cause motor damage because of the sudden increase of current in the two remaining phases. This function is based on the motor current and detects a phase loss while the motor is running. If enabled, the thermal overload protection performs an accelerated trip during phase loss.

### 5.2.3 Current imbalance protection

The current imbalance protection protects the motor against a current imbalance between the different phases. The imbalance trip level must be carefully adjusted to protect the motor windings against overheating. Observe any rules or guidelines provided by the motor manufacturer.

If activated, the SFM trips the contactor as soon as the measured imbalance is above the configured trip threshold for longer than a configurable delay time.

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05: block diagram showing the signal flow of the thermal overload protection as well as the current and voltage-based measurement values. Parameter are shown in italics. Measured values available on the X2X bus are shown in bold.

Related parameters:

- Trip Class
- Nominal current $I_e$
- De-/activate overload protection
- Motor cooling mode
- Motor cooling time
- Restart threshold
- Auto fault reset
- Current phase loss trip configuration
- Current phase loss delay
- Activate/deactivate current imbalance protection
- Current imbalance trip threshold
- Current imbalance delay

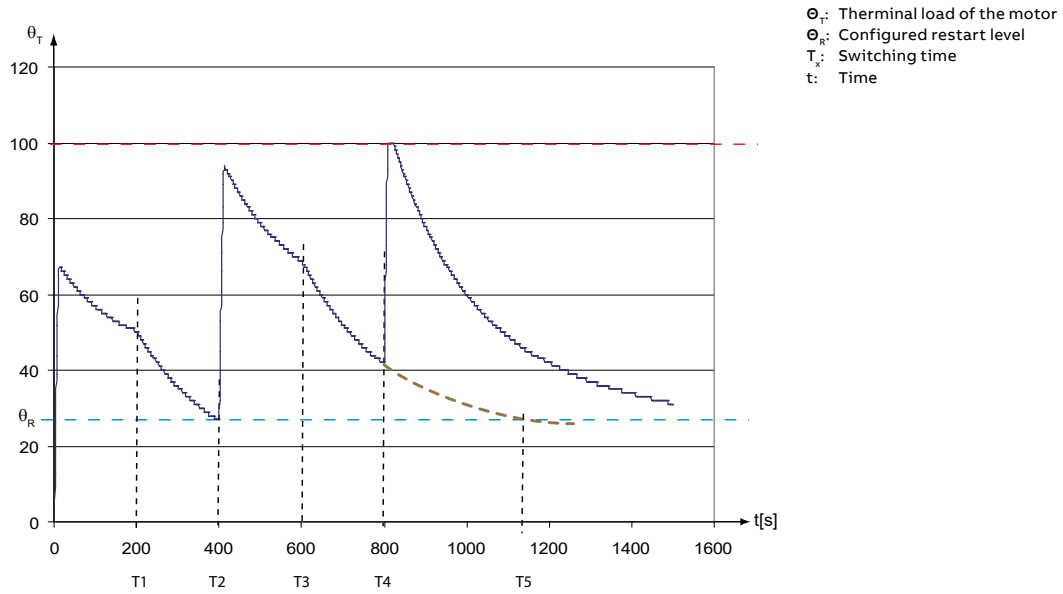
### 5.2.4 Phase sequence monitoring

This monitoring function can be used to prevent connected equipment from rotating in the wrong direction. The reaction to an incorrect phase sequence must be programmed in the PLC. Phase sequence information is not available in single phase operation mode.

### 5.2.5 Cyclic motor starting

Some applications require periodic start/operation/stop cycles. Setting up such applications requires care when selecting the cooling down times or defining the shortest possible start period. In the next diagram, three successive start cycles are displayed. In each cycle, the motor starts at 700 % Ie. This high load lasts for about 7 seconds. Then the current goes back to Ie within 6 seconds and stays at 100 % Ie for about 180 seconds. At T1 the motor is switched off and cools down for 200 seconds. The next start takes place at T2. During this cycle the motor also cools down for 200 s, but the calculated thermal motor load is already above 40 %. The third start at T4 leads, as expected, to a thermal overload trip.

For cyclic operation modes it is important to keep the cycles long enough to allow the motor to cool down sufficiently. For cyclic start patterns it is better to select the cooling mode option ‘Restart Level’, which allows a restart based on the thermal load level. In the case shown below, the third start would then be allowed at T5 at the earliest.




06: Trend of the calculated motor temperature after several starts. The motor trips after the third start because the motor was started too frequently within the given time

### 5.2.6 Protection of connected equipment

Measured values are available for further processing in the PLC. Equipment problems that can be detected based on significant changes of electrical quantities are as follows:

| Monitored equipment | Observed change | Potential problem |
|---|---|---|
| Pump | Cos phi / active power too low | Dry running pump |
| Pump | Motor current too high | Clogged filters, closed valve |
| Conveyor belt | Cos phi / active power too low | Belt broken |
| Conveyor belt | Current / active power too high | Belt overloaded / locked |
| Fan | Cos phi / active power too low | Fan idling, fan defective |
| Crusher, mixer | Motor current / active power too high | Blocked equipment |
| Gearboxes | Motor current / active power too high | Jamming, locking, missing lubrication |
| Heaters | Active power too low, current too low | Heating not working, heating coil broken |

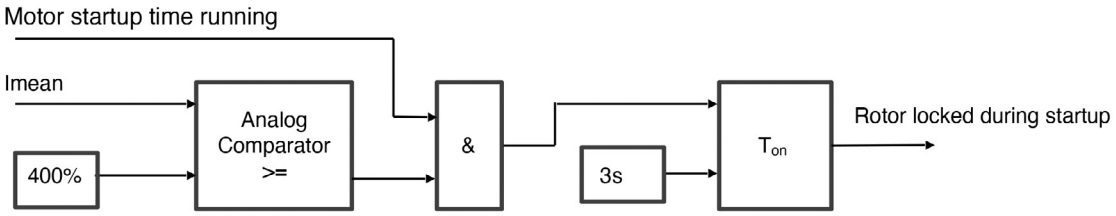
Typically, one or more measured values will be compared against application specific threshold values. In case the values are out of range, a signal is generated which then might be delayed for some time and be used to trigger further actions, such as the creation of an event log entry, or stopping or starting the motor.

Not related to specific equipment functions like listed below can be implemented based on available process data:

| Function in PLC | Required process data | Description |
|---|---|---|
| Stall protection | Motor current<br>Motor startup time running | Equipment sensitive against locked rotors (e.g. agitators) can be protected by supervising the motor startup current during the startup phase. If the current is too high for a longer time, the motor can be stopped faster than the thermal model would otherwise react |
| Jam protection | Motor current<br>Motor startup time running | If the motor is in normal operation (startup time over) the current can be monitored to not reach a critical value. |
| Prevent frequent starts | Time between starts | Some equipment sensitive against too frequent starts can be protected by ensuring a minimum time passed before a new start is possible. Alternatively, the number of starts is limited to certain number per hour. |
| Load shedding in case of instable supply | Voltage | If voltage is below a certain threshold, loads that are not required can be switched off to stabilize supply |
| Idle load detection | Cos phi / active power | In some cases, idle loads can be simply switched off to save energy or for other process-related reasons. |
| Voltage phase imbalance | Voltage imbalance | If the phase imbalance is above a defined threshold load, user-defined actions may be triggered. |
| Voltage / Current threshold | Line voltages<br>Currents | If the average voltage or current is above or below threshold a user defined actions can be triggered. |

Because such tasks are mostly application-specific, the raw electrical values are provided to the PLC and the application programmer can implement the required behavior in the PLC.

A principal PLC program to detect a locked rotor during motor startup could be implemented as follows:

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07: Simplified program to detect a locked rotor based on process data delivered from the SFM1 + SCV module.
Functionality must be implemented in a PLC program, and thresholds must be adjusted to application-specific needs.

| Value | Description |
|---|---|
| Current | The current in all three phases is measured using a true RMS measurement algorithm.<br><br>Available measurement values:<br>• Current L1, L2, L3 as % of $I_e$ or in absolute value<br>• Mean current of all three values in % of $I_e$ or as absolute value<br>• Mean current at last trip in in % of Ie or as absolute value<br>• Current imbalance in %.<br>$I_{avg} = \frac{I_1 + I_2 + I_3}{3}$<br>$Unbalance\ \% = 100\ \frac{max(\lvert I_1 - I_{avg}\rvert, \lvert I_2 - I_{avg}\rvert, \lvert I_3 - I_{avg}\rvert)}{I_{avg}}$<br>• Total Harmonic Distortion (THD) in % based on current. THD is calculated as the ratio between the rms amplitude of the N harmonics and the rms amplitude of the fundamental frequency.<br>$THD = \frac{\sqrt{I_2^2 + I_3^2 + ... + I_N^2}}{I_1}$<br>Where I1 is the fundamental, I2 the second harmonic, I3 the third harmonic and so on.<br>• Earthfault in % of $I_c$. It is calculated as follows:<br>$Ifault\ [\%] = 100 * \frac{\lvert \vec{i_1} + \vec{i_2} + \vec{i_3} \rvert}{\sqrt{2} \bullet I_n}$<br>Where $\vec{i_1}, \vec{i_2}, \vec{i_3}$ are the current Phasors on each phase. $I_c$ is the sensors configured nominal current.<br>• Frequency as absolute value<br><br>Motor related values:<br>• Thermal load in %. In case the value reaches 100 % the motor will be tripped.<br>• Time to trip in seconds if the motor continues to operate under the current load conditions<br>• Time to cool in seconds until a motor restart is possible. |
| Voltage | The voltage between the three phases is measured using a true RMS measurement algorithm.<br><br>Available measurement values:<br>• Phase to phase voltage $U_{L1/L2}$, $U_{L2/L3}$, $U_{L3/L1}$ as absolute values<br>• Voltages $U_{L1/N}$, $U_{L2/N}$, $U_{L3/N}$ measured between a phase and the virtual star point created internally in the SCV module.<br>• Voltage imbalance in multiples of 0.1 %<br>$V_{avg} = \frac{V_1 + V_2 + V_3}{3}$<br>$Unbalance\ \% = 100\ \frac{max(\lvert V_1 - V_{avg}\rvert, \lvert V_2 - V_{avg}\rvert, \lvert V_3 - V_{avg}\rvert)}{V_{avg}}$<br>• Total Harmonic Distortion (THD) in % based on voltage. THD is calculated as the ratio between the rms amplitude of the N harmonics and the rms amplitude of the fundamental frequency.<br>$THD = \frac{\sqrt{V_2^2 + V_3^2 + ... + V_N^2}}{V_1}$<br>Where V1 is the fundamental, V2 the second harmonic, V3 the third harmonic and so on |
| Power / cos phi | Based on current, voltage and phase angle further electrical quantities are provided:<br><br>Available measurement values:<br>• Cos phi in phase 1, 2 and 3<br>• Active power for phase 1, 2 and 3<br>• Apparent power for phase 1, 2 and 3 |

### 5.3 Communication-related functions

This section describes parameters related to the communication behavior itself.

| Function | Description |
|---|---|
| Module supervised | In case a module is missing, the PLC service mode is entered |
| OSP mode | See B&R manuals |

### 5.4 Maintenance data

The SFM1 and/or the SVC module offer the following features:

| Value | Description |
|---|---|
| Operating hours | The operating hours of the load (i.e. when the contactor was switched on). The counter can be reset from the PLC e.g. in case the motor was replaced. |
| Standstill hours | The stand-still hours of the load (i.e. when the contactor was switched off). The counter can be reset from the PLC, e.g. in case the motor was replaced. |
| Switching counter | The number of operations of the AF contactor are counted. In the case of a motor load, this counter is equal to the number of motor starts. The counter can be reset from the PLC, e.g. in case the contactor was replaced. |
| Number of overall trips | The counter can be reset from the PLC, e.g. after maintenance. |
| Number of thermal overload trips | The counter can be reset from the PLC, e.g. after maintenance. |

# 6. Error handling, maintenance and service

Within this chapter, you will find the following information
- Error handling of the SFM1 and SCV
- Detailed explanation of all error and diagnosis messages
- Functions related to maintenance and service

**Error handling of the SFM1**
When the SFM1 detects a trip condition, the trip becomes latched. Once a trip becomes latched, it remains latched even if the underlying fault condition is eliminated until acknowledged by a fault reset command via X2X bus. The setting of the 'Auto fault reset' parameter determines how the SFM1 manages protection trips.
- Off (the default setting): A protection trip must be acknowledged by the user. This can be done via fieldbus only.
- On: A protection trip, current phase unbalance trip and a current phase loss trip is automatically acknowledged without intervention of either a human operator or the remote PLC if the trip condition has gone (e.g. cooling time over).

**Fault history**
No fault history is stored in the SFM1. Event logs must be built in the PLC.

**SFM1 fault indication**
The SFM1 offers the following possibilities for indicating a trip or fault.
- Indication via LEDs on the SFM.1. The red fault LED is switched on in the event of a trip and remains on until the trip is acknowledged.
- Signaling via X2X: In the event of a trip the related bit in the cyclic communication telegram is set to logical 1.

**Fault messages**
The following table lists all diagnosis and fault messages and potential root causes for the fault. It gives a first indication of where to look for a fault and how to fix it.

| Indication | Created in | Source / root cause | Possible cause / suggested action |
|---|---|---|---|
| Thermal overload (leads to trip) | SFM+SCV | Load side | Trip due to thermal overload of the motor.<br>Check process conditions<br>Check if the cooling time is too short<br>Check Ie and trip class settings |
| Phase loss (leads to trip) | SFM+SCV | Supply side<br>Load side<br>Contactor | At least one phase current is below the phase loss threshold<br>Check for blown fuse<br>Check for loose contacts<br>Check contact wear |
| Current unbalance above threshold (leads to trip) | SFM+SCV | Load side<br>Supply side | Unsymmetrical load or network<br>Bad wiring, loose contacts<br>Check supply/load side. Check wring |
| Thermal model reached warning level | PLC[1] | Load Side | Thermal model reached warning level. If the overload condition persists, a trip soon follows.<br>Check motor load condition<br>Check for mechanical problems |
| Check-back error | PLC[1] | Wiring,<br>Contactor | Expected feedback from a contactor is missing after the checkback time was over.<br>Check wiring of auxiliary contact to the correct SFM input.<br>Check contactor Increase checkback time |
| Motor current below low current threshold | PLC[1] | Process<br><br>Load side<br>Load side mechanics | Motor current is below user-defined threshold, e.g. in the case of the motor running idle, a dry-running pump, or broken conveyer belt.<br>Check motor load and motor / process conditions. Wait until cooling time is over |
| Motor current above high current threshold | | Load side | Motor current above threshold caused e.g. by jammed equipment<br>Check process conditions (remove blocking cause).<br>Wait until cooling time is over. |
| Earth fault (external or internal sensor) above trip threshold | PLC[1] | Load side electrical | Connection between one or more phases and ground<br>Check wiring / motor (isolation problem)<br>Increase trip delay time at startup to overcome condensation problems |
| Line frequency not detected | SFM+SCV | Supply side | Frequency out of range. Check supply side. |

| Indication | Created in | Source / root cause | Possible cause / suggested action |
|---|---|---|---|
| Self-test HW<br>(leads to trip) | SFM+SCV | Electronics | Hardware fault detected.<br>SmartFunctModuleHWFault<br>SensorModuleHWFault<br>Replace module |
| SCV module missing<br>(leads to trip) | SFM | Electronics | Communication cable not connected.<br>Cable break or SCV module hardware error |
| Underload Power | PLC[1] | Load side mechanics | The motor load is too low. Check the load, e.g. if a pump is running dry or a conveyer load is broken. |
| Overload Power | PLC[1] | Load side mechanics | The motor load is too high. Check if the load is blocked or tight. |
| Voltage Out of Spec | PLC[1] | Load side | The supply voltage is too low or too high. Check the motor supply. |
| THD too high | PLC[1] | Supply side | The harmonics on the supply side are too high. Check your network. |
| Cooling time running | SFM+SCV | Process, Load side | Motor was tripped due to thermal overload. Restart is possible after cooling time is over |
| Parameter out of range<br>(leads to trip) | SFM+SCV | Electronics,<br>Configuration | Someone tried to write a parameter which is outside the specifications<br>Check the parameter number that is causing the problem and change the value. |
| Motor operation hour exceeded | PLC[1] | Load side mechanical | Max. motor operation hours reached.<br>Perform motor maintenance. Reset counter |
| Motor stand still hours exceeded | PLC[1] | Load side | Motor did not run for a long time<br>Start motor to check everything is still fine |
| Line frequency out of range | PLC[1] | Supply side | Check supply |
| Wrong phase sequence (reversal) | PLC[1] | Supply side, Load side | Phase order is not L1/L2/L3. |
| Contactor control voltage <19V | SFM | Contactor | 24 V supply too weak<br>Bad wiring, too small wire diameter<br>Check mounting of SFM1 |
| Contactor output short circuit<br>(leads to trip) | SFM | Contactor | Contactor failure<br>SFM coil connectors shorted |

[1] Fault detection and handling within the PLC are not implemented by default. They are application-specific and need to be developed as a part of the B&R automation project.

—

## LED on front of SFM1 module

| | |
|---|---|
| Green | |
| Off | No power to module |
| Single flash | RESET mode |
| Blinking | PREOPERATIONAL mode |
| On | RUN Mode |
| Red | |
| Off | Module supply not connected or everything OK |
| Double flash | Bus supply is too low or not connected |
| Orange (Red + Green) | Protection Trip |
| Red, Orange single flash | Invalid firmware |

# 7. Parameters and data structures on the communication bus

All the data listed below is defined in the HWX file and can be configured in the B&R Automation Studio.

## 7.1 Monitoring data

| Word | Byte | Bit | Description | Parameter name | Register / access |
|---|---|---|---|---|---|
| 0 | 0 | 0 | Digital input X3 | DigitalInputX3 | 0 / r |
| | | 1 | Running Forward (DOL) | RunningForward | |
| | | 1 | Reserved | | |
| | | 3 | Reserved | | |
| | | 4 | Data ready (sum status) | SumStatusDataReady | |
| | | 5 | Summary fault | SumFault | |
| | | 6 | Contactor control voltage < 19V | ContactorVoltageLow | |
| | | 7 | Parameter out of range | ParameterOutOfRange | |
| | 1 | 0 | HW Error Smart Function Module | SmartFunctionModuleHWFault | 1 / r |
| | | 1 | Contactor output driver short circuit (i.e. current >2 A for >2 s) | ContactorOutputSortCircuit | |
| | | 2 - 7 | Reserved | – | |
| 1 | 0 | 0 | Sensor Module ready (data ready) | SensorModuleReady | 30 / r |
| | | 1 | Sensor module missing | SensorModuleMissing | |
| | | 2 | Current imbalance trip | CurrentImbalanceTrip | |
| | | 3 | Current phase loss | CurrentPhaseLossTrip | |
| | | 4 | Overload trip (thermal model) | OverloadTrip | |
| | | 5 | Motor cooling time running | CoolingTimeRunning | |
| | | 6 | Motor startup time running | StartupTimeRunning | |
| | | 7 | Phase sequence I status | PhaseSequenceCurrent | |
| | 1 | 0 | Phase sequence U status | PhaseSequenceVoltage | 31 / r |
| | | 1 | Current phaseloss trip L1 | CurrentPhaseLossTripL1 | |
| | | 2 | Current phaseloss trip L2 | CurrentPhaseLossTripL2 | |
| | | 3 | Current phaseloss trip L3 | CurrentPhaseLossTripL3 | |
| | | 4 | HW Fault Sensor Module | SensorModuleHWFault | |
| | | 5 | Line frequency not detected | LineFrequencyNotDetected | |
| | | 6 | Reserved | – | |
| | | 7 | No voltage measurement sup-ported by this sensor module | NoVoltageMeasurementSup-ported | |

## 7.2 Command data

| Word | Byte | Bit | Description | Parameter name | Register / access |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0: Contactor OFF | RunForward | 2 / w |
| | | | 1: Contactor ON | | |
| | | 1 - 3 | Reserved | | |
| | | 4 | Trip Reset | ResetErrors | |
| | | 5 | Reset switching counter contactor A | ResetCounterContactorA | |
| | | 6 | Reset motor run hours | ResetMotorRunHours | |
| | | 7 | Reset Motor stand still hours | ResetMotorStandStillHours | |
| | 1 | 0 | Reset number of thermal trips | ResetNoOfThermalTrips | 3 / w |
| | | 1 | Reset number of all trips | ResetNoOfAllTrips | |
| | | 2-4 | Reserved | | |
| | | 5 | Testposition. If set to 1 (true) there will be no trip in case of phase loss or phase imbalance. | Test Position | |
| | | 6,7 | Reserved | | |

*) Reserved bits should be set to zero

## 7.3 Parameters and measured values

### Parameters

| Group | Parameter | Options | Datatype | Min. | Max. | Default | Register / access |
|---|---|---|---|---|---|---|---|
| B&R standard parameter | Module supervised | 0: Off,<br>1: On | BOOL | 0 | 1 | 0 | |
| OSP (operator set predefined) | OSP configuration | 0: hold last valid value<br>1: replace by static value | BOOL | 0 | 1 | 1 | |
| I/O module | Select sensor module | 0: Off,<br>1: SCV10-40<br>2: SC10-40 | BOOL | 0 | 1 | On | ModulOnOffPar<br>400 / w |
| Control function | Control function | DOL | UINT8 | 0 | 0 | DOL | ControlFunctionPar<br>404 / w |
| Network Type | Network type | 0: 3 phase<br>1: 1 phase | UINT8 | 0 | 1 | 3 phase | Measure3PPar<br>408 / w |
| Frequency | Frequency | 0: 50 Hz,<br>1: 60 Hz | UINT8 | 0 | 1 | 50 Hz | BaseFrequencyPar<br>412 / w |
| Overload protection | Setting nominal current $I_e$ | [0.01 A] | UINT16 | 20 | 4000 | 0.05 A | SettingIePar<br>420 / w |
| Motor overload protection | Trip class | 0: 5E,<br>1: 10E,<br>2: 20E,<br>3: 30E | UINT8 | 0 | 3 | 10 E | TripClassPar<br>424 / w |
| | Trip configuration | 0: Off,<br>1: On | BOOL | 0 | 1 | Trip | ConfigOverloadPar<br>416 / w |
| Current imbalance | Trip threshold | [%] | UINT8 | 0 | 100 | 50 | CurrImbalancePar<br>432 / w |
| | Trip delay | [0.1s] | UINT8 | 0 | 255 | 0.5 s | CurrImbalanceDelayPar<br>436 / w |
| | Trip configuration | 0: Off,<br>1: On | BOOL | 0 | 1 | Trip | ConfigCurrImbalancePar<br>428 / w |
| Current phase loss | Trip delay | [0,1 s] | UINT8 | 0 | 255 | 0.5 s | CurrPhaseLossDelayPar<br>442 / w |
| | Trip Configuraton | 0: Off,<br>1: On | BOOL | 0 | 1 | Trip | ConfigCurrPhaseLossPar<br>440 / w |
| Motor cooling | Cooling mode | 0: Time,<br>1: Load | BOOL | 0 | 1 | Time | MotorCoolingModePar<br>472 / w |
| | Cooling time | [s] | UINT16 | | | 120 | MotorCoolingTimePar<br>476 / w |
| | Restart level in % (of thermal load) | [%] | UINT8 | | | 30 | MotorRestartLevelPar<br>480 / w |
| Auto fault reset | Auto failure reset | 0: Off,<br>1: On | BOOL | 0 | 1 | Off | AutoFaultResetAllowedPar<br>488 / w |

### Measured values

| Value | Physical unit | Data type | Register |
|---|---|---|---|
| Current I_L1 (RMS) | [mA] | UDINT32 | IrmsL1Abs<br>112 (r) |
| Current I_L2 (RMS) | [mA] | UDINT32 | IrmsL2Abs<br>116 (r) |
| Current I_L3 (RMS) | [mA] | UDINT32 | IrmsL3Abs<br>120 (r) |
| Current Imean (RMS) | [mA] | UDINT32 | IrmsMeanAbs<br>128 (r) |
| Startup current Imax average (RMS) | [mA] | UDINT32 | Max. startup current [mA]<br>134 (r) |
| Current at last trip (RMS) | [mA] | UDINT32 | Max. startup current [mA]<br>138 (r) |
| Current I_L1 (RMS) | [% * Ie] | UINT16 | IrmsL1<br>100 (r) |
| Current I_L2 (RMS) | [% * Ie] | UINT16 | IrmsL2<br>104 (r) |
| Current I_L3 (RMS) | [% * Ie] | UINT16 | IrmsL3<br>108 (r) |

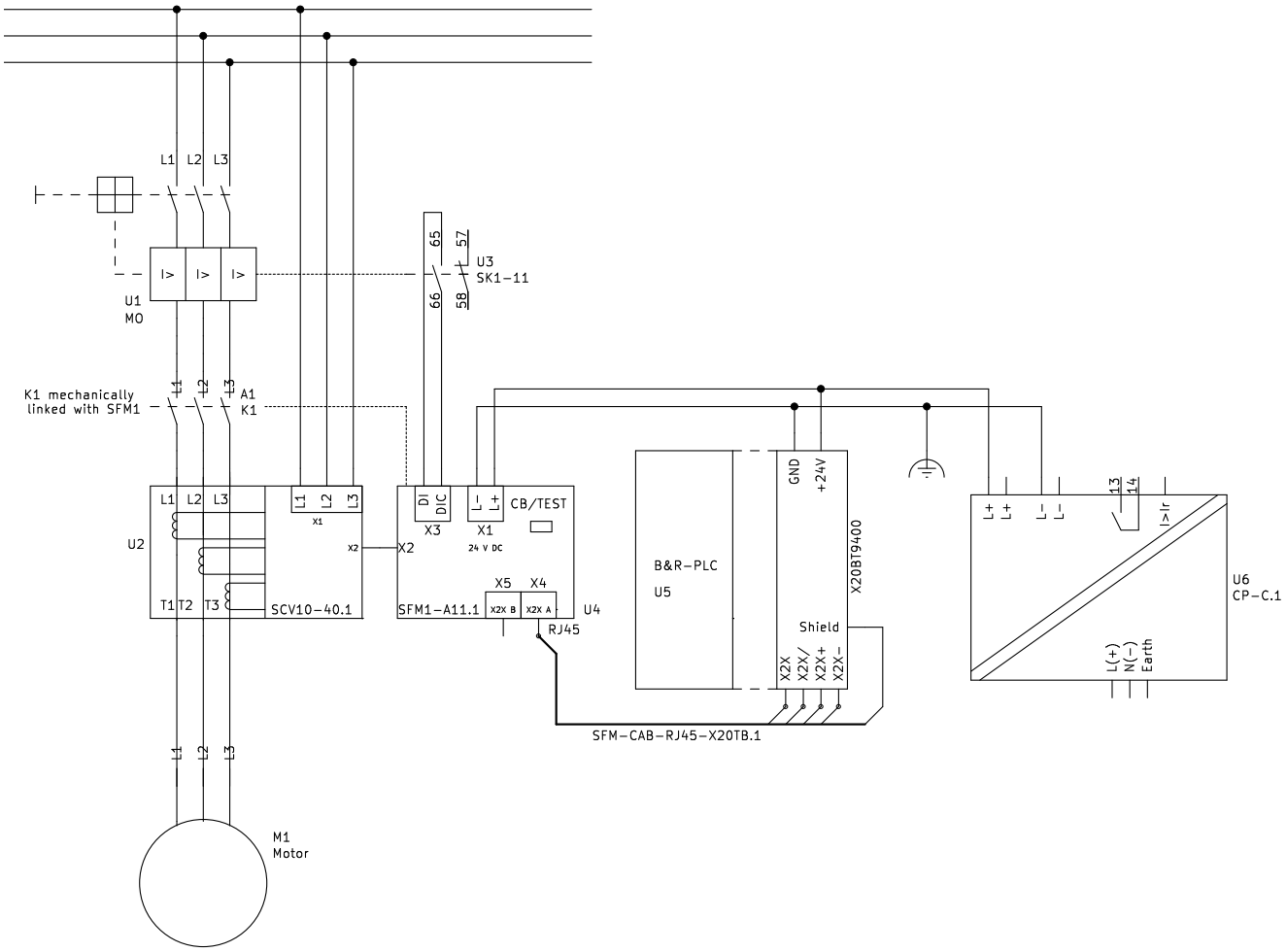
| Value | Physical unit | Data type | Register |
|---|---|---|---|
| Current Imean (RMS) | [% * Ie] | UINT16 | IrmsMean<br>124 (r) |
| Startup current Imax average (RMS) | [% * Ie] | UINT16 | ImaxStartup<br>132 (r) |
| Current at last trip (RMS) | [% * Ie] | UINT16 | IatLastTrip<br>136 (r) |
| Phase to phase $U_{L1\_L2}$ (RMS)*) | [0.1 V] | UINT16 | UrmsLineToLineUG12<br>148 (r) |
| Phase to phase $U_{L2\_L3}$ (RMS)*) | [0.1 V] | UINT16 | UrmsLineToLineUG23<br>152 (r) |
| Phase to phase $U_{L3\_L1}$ (RMS)*) | [0.1 V] | UINT16 | UrmsLineToLineUG31<br>156 (r) |
| Phase to N $U_{L1\_N}$ (RMS)*) | [0.1 V] | UINT16 | UrmsPhaseVoltageUG1<br>160 (r) |
| Phase to N $U_{L2\_N}$ (RMS)*) | [0.1 V] | UINT16 | UrmsPhaseVoltageUG2<br>164 (r) |
| Phase to N $U_{L3\_N}$ (RMS)*) | [0.1 V] | UINT16 | UrmsPhaseVoltageUG3<br>168 (r) |
| Cos Phi / Phase L1*) | [0.01]*) | INT8 | PF_L1<br>180 (r) |
| Cos Phi / Phase L2*) | [0.01] | INT8 | PF_L2<br>184 (r) |
| Cos Phi / Phase L3*) | [0.01] | INT8 | PF_L3<br>188 (r) |
| Current imbalance in % | [%] | UINT16 | Iimbalance<br>140 (r) |
| Voltage imbalance in %*) | [0.1 %]*) | UINT16*) | Uimbalance<br>176*) (r) |
| Active power L1*) | [W] | DUINT32 | ActivePowerL1<br>192 (r) |
| Active power L2*) | [W] | DUINT32 | ActivePowerL2<br>196 (r) |
| Active power L3*) | [W] | DUINT32 | ActivePowerL3<br>200 (r) |
| Apparent power L1*) | [VA]*) | DUINT32 | ApparentPowerL1<br>204 (r) |
| Apparent power L2*) | [VA]*) | DUINT32*) | ApparentPowerL2<br>208*) (r) |
| Apparent power L3*) | [VA] | DUINT32 | ApparentPowerL3<br>212 (r) |
| THD current | [0.1 %] | UINT8 | CurrentTHD<br>220 (r) |
| THD voltage *) | [0.1 %] | UINT8 | VoltageTHD<br>221 (r) |
| Frequency | [0.1 Hz] | UINT16 | Frequency<br>177 (r) |
| Earthfault current in % | [% * Ie] | UINT16 | EarthFaultCurrent<br>222 (r) |
| Thermal load in % | [%] | UINT16 | ThermalLoad<br>216 (r) |
| Time to trip in seconds | [s] | UINT16 | TimeToTrip<br>217 (r) |
| Time to cool in seconds | [s] | UINT16 | TimeToCool<br>218 (r) |
| Mechanical switching counter contactor A (DOL) | # | UDINT32 | MechSwitchCountA<br>224 (r) |
| Number of thermal trips | # | UINT16 | NoOfThermalTrips<br>225 (r) |
| Number of all trips | # | UINT16 | NoOfAllTrips<br>226 (r) |
| Motor startup time | [100 ms] | UINT16 | MotorStartupTime<br>144 (r) |
| Motor run hours | [s] | UDINT32 | MotorOperationHours<br>145 (r) |
| Motor stand still hours | [s] | UDINT32 | MotorStandStillHours<br>146 (r) |
| Wrong parameter number | # | UINT16 | WrongParameterNumber<br>20 (r) |

*) Only available if the SCV10-40 module is connected. Otherwise zero is returned.

# 8. Applications and sample circuit diagrams

### 8.1 Three phase motor application with SFM1 + SCV, AF contactor and MOx

This application shows the usage of the SFM1 and SCF10 module to control and protect a 3-phase motor. Set motor protection-related parameters according to the motor nameplate.

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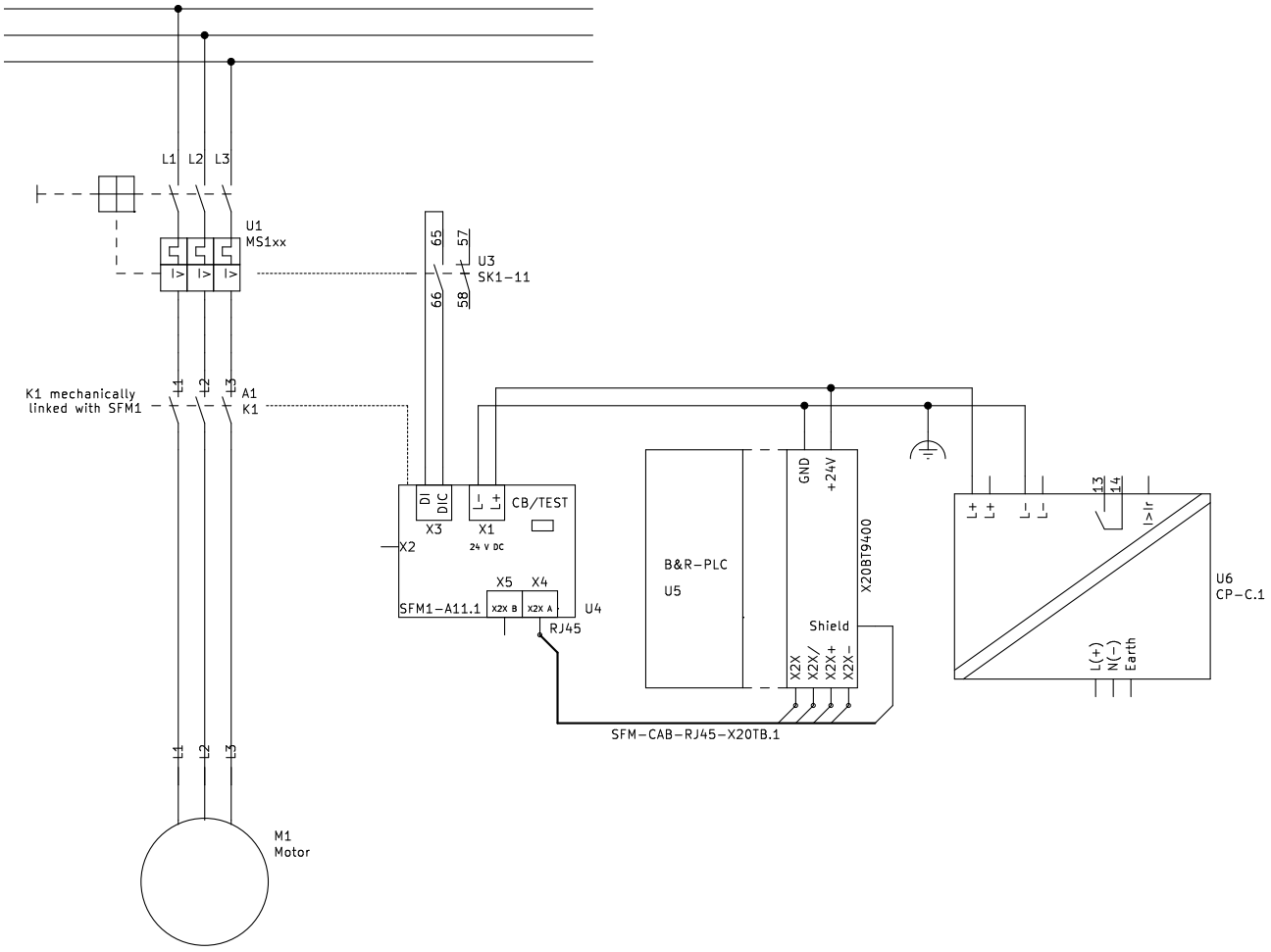
08: Direct online starter with voltage/current measurement and short circuit protection with MO1xx.

## 8.2 Three phase motor application with SFM1, AF contactor and MS... for motor protection

This application shows the usage of the SFM1 module to control the motor and a standard MS... to protect a 3-phase motor. Disable the motor model for this application.

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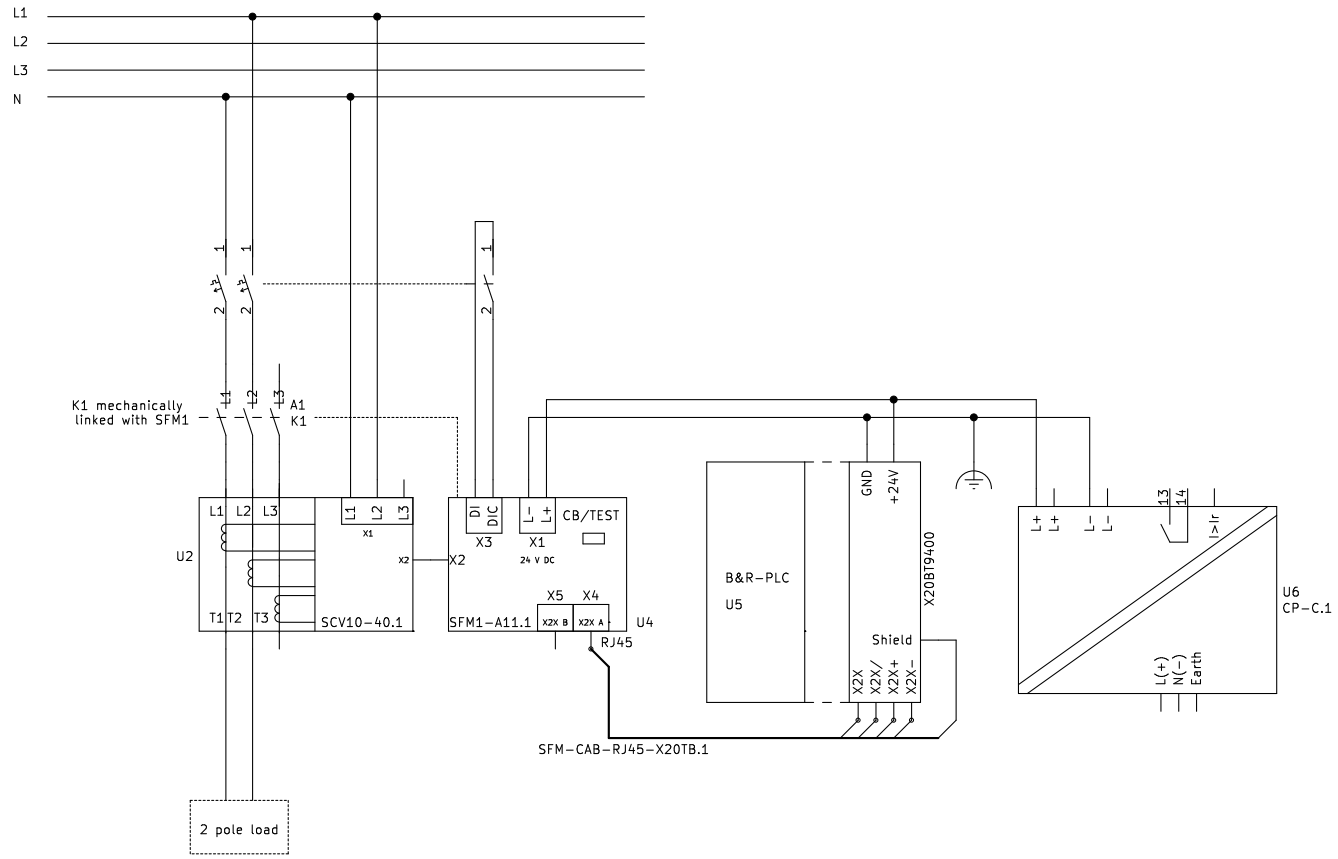
09: Direct online with thermal overload protection and short circuit protection realized by MS1xx. SFM1 is basically used as remote control and monitoring unit of the AF contactor.

### 8.3 Two-pole loads with SFM1, AF contactor and MCB

This application shows the usage of the SFM1 and SCV10 module to control and protect a single-phase load. Set load related protection parameter according the application needs. Disable the phase loss protection and set parameter ‘network type’ to 1 phase mode. Alternatively, also a MO13x or any other short circuit protection solution can be used for short circuit protection.

The voltage and current connection of the SCV10 must be connected to the same phase (here L1 shown) to ensure correct operation.

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10: Principle circuit diagram for a two-pole load.

# 9. Technical data

Data at Ta = 25 °C and rated values, unless otherwise indicated

## 9.1 Smart function module

| | | |
|---|---|---|
| **X2X Interface (X4, X5)** | | |
| Rated control supply voltage $U_s$ | according to B&R X20 system specification | |
| Rated control supply voltage $U_s$ tolerance | according to B&R X20 system specification | |
| Typical current / power consumption<br>(delivered by X2X link power supply output from X20BT9400) | 30 mA / 600 mW | |
| Recommended RJ45 cable | Cat 5e SF/UTP AWG 26 / 1:1 connection<br>Cat 6 S/FTP AWG 27 / 1:1 connection | |
| Max. distance between nodes<br>Max. distance from X20-BT9400 to first SFM1 | 20 m | |
| Max. number of nodes on one X20-BT9400 | 8 | |
| Max. length of total network from start to last module with 8 modules | 160 m | |
| Grounding | according to B&R X20 system specification, the accessory SFM-CAB-RJTB provides the required grounding of shield | |
| Minimum cycle time<br>The minimum cycle time defines how far the bus cycle can be reduced without communication errors occurring. Note that very fast cycles decrease the idle time available for handling monitoring, diagnostics and acyclic commands. | 300 us | |
| **Contactor supply circuit SFM1 (X1)** | | |
| Rated control supply voltage $U_s$ | 24 V DC | |
| Rated control supply voltage $U_s$ tolerance | 22 … 31.2 V incl. ripple<br>It must be ensured that the minimum supply voltage is available at the last contactor in a supply chain. | |
| Typical current / power consumption (AF coil current not considered) | 20 mA / 480 mW (SCV40-10 module)<br>20 mA / 480 mW (SC40-10 module) | |
| Reverse polarity protection | no | |
| Short circuit protection of contactor control outputs | yes | |
| Max. load current for AF contactor | coordinated with supported AF contactor types | |
| Min. power failure buffering time | 10 ms | |
| **Digital Input (X3)** | | |
| Number of digital inputs | 1 | |
| Supply for digital inputs | internal | |
| Isolation | no | |
| Input signal bounce suppression | configurable (see module parameters) | |
| Typical input current at nominal supply | 7.5 mA | |
| Max. voltage loss at closed external auxiliary contact | max. 2 V | |
| Max. cable length | 10 m | |
| **General data** | | |
| MTBF | on request | |
| Duty time | 100 % | |
| Dimensions | see dimensional drawings | |
| Weight | 0.11 kg | |
| Mounting | Snapping on AF09 – AF96 | |
| | AF09(Z)...-nn | AF40...-11 |
| | AF12(Z)...-nn | AF52...-11 |
| | AF16(Z)...-nn | AF65...-11 |
| | AF26(Z)...-nn | AF80...-11 |
| | AF30(Z)...-nn | AF96...-11 |
| | AF38(Z)...-nn | |
| | nn = 11, 21, 30 | |
| Mounting position | on AF contactor. 1-4, 5: max. current = AC-3 current of contactor | |
| Minimum distance to other units | 0 mm for side to side mounting<br>5 mm to metal parts (e.g. control panel wall) | |
| Material of housing | UL 94 V0 | |
| Degree of protection | IP20 | |

| **Electrical connection X1, X3** | | X1 | X3 |
|---|---|---|---|
| Push-In | 1x | 0.2...2.5 mm²<br>24...12 AWG | 0.2...1.5 mm²<br>24...16 AWG |
| | 1x | 0.25...2.5 mm² | 0.2...1.5 mm² |
| | 1x | 0.25...2.5 mm² | 0.2...0.75 mm² |
| | 1x | 0.2...2.5 mm²<br>24...12 AWG | 0.2...1.5 mm²<br>24...16 AWG |
| Spring | 1x | 0.2...2.5 mm²<br>24...12 AWG | 0.2...1.5 mm²<br>24...16 AWG |
| | 1x | 0.25...2.5 mm² | 0.2...1.5 mm² |
| | 1x | 0.25...2.5 mm² | 0.2...0.75 mm² |
| Screwdriver type | | 0.6 x 3.5 mm | 0.4 x 2.5 mm |
| Tightening torque | | 10 mm | 8 mm |
| **Electrical connection X2** | | use ready-made cables, see accessories. | |
| Max cable length | | 0.5 m | |
| Basic insulation<br>Ensure safe distance from motor wires and other high voltage cables. | | 300 V | |

## 9.2 Smart voltage and current sensor module

| **Input circuit** | | **SCV10-40** | **SC10-40** |
|---|---|---|---|
| Nominal frequency | | 50/60 Hz (45 ... 65 Hz) | |
| Measurement method | | true RMS (up to 13th harmonics) | |
| Number of phases | | 1/3 | |
| Nominal measuring range current | | 0.2 to 40 A AC | |
| Measured current range | | 0.2 x $I_e$ ... 15 x $I_e$ | |
| Nominal voltage range | 3 phase | 150 to 690 V AC ± 10 % | - |
| | 1 phase | 90 to 400 V AC ±10 % | - |
| Measurement accuracy given at Ta=25 °C, 50/60 Hz | $I_{rms}$ (range 0.2 * $I_e$ ≤ 0.75*$I_e$) | ±3 % | |
| | $I_{rms}$ (range 0.75 * $I_e$ ≤ 2*$I_e$) | ±1,5 % | |
| | $I_{rms}$ (range >2 * $I_e$ ≤ 15*$I_e$) | ±3 % | |
| | $U_{rms}$ | ±1.5 % | - |
| | power factor ≥ 0.5 (inductive) | typ. ±1.5% ($I_{rms}$ > 3 A) | - |
| | apparent power | typ. ±3 % | - |
| | active power (cos phi > 0.5) | typ. ±5 % | - |
| | frequency (50/60 Hz) | ±1.5 % | - |
| | current imbalance | typ ±10 % (condition: $I_{mot}$ > 150 mA) | |
| | voltage imbalance | ±10 % | - |
| | voltage total harmonic distortion (THD) | ±5 % | - |
| | current total harmonic distortion (THD) | ±10 % (condition: $I_{mot}$ > 1A) | |
| Measurement range of earth fault current | | > 20% of $I_e$ | |
| Earth fault current | | $I_e$ < 1.0 A : ±25 % (condition: $I_{mot}$ > 100 mA and $I_{earth}$ > 80 mA)<br>$I_e$ >1.0 A : ±10 % (condition: $I_{mot}$ > 200 mA and $I_{earth}$ > 200 mA) | |
| Supported network types | | 1/3 phase, grounded networks | |
| Trip classes, selectable by parameter | | 5E, 10E, 20E, 30E | |
| Tripping time for phase loss | | determined by parameter CurrPhaseLossDelayPar.<br>adjustable from 0 ... 25.5 s | |
| Load per phase | | approx. 30 mΩ | |
| Short-circuit protection | | provided by external short-circuit protection device, e. g. MO, MCB, MCCB or fuse. Refer also to ABB coordination tables available here: www.lowvoltage-tools.abb.com/soc/ | |
| Max cross-section of wires. Use isolated wires only! | | 16 mm² | |

| Input circuit | | SCV10-40 | SC10-40 |
|---|---|---|---|
| Conductor holes in the current transformers | | 13 mm | |
| Performance under short-circuit conditions<br>Coordination type 2<br>$I_q$: Rated conditional short circuit current | Iq | 100 kA 80 kA | |
| | | 500 V AC 690 V AC | |
| | fuse | 200 A gG 200 A gG | |
| Additional information relating to cULus approval | | suitable for use on circuits capable of delivering not more than 100 kA rms, symmetrical, 600 V AC maximum, when protected by 100 A, class K5/RK5 fuses, use fuses only | |
| **Electrical connection X1** | | | |
| Connecting capacity | 1x | 0.2...2.5 mm²<br>24...12 AWG | |
| | 1x | 0.2...2.5 mm²<br>24...12 AWG | |
| | 1x | 0.2...2.5 mm² | |
| | 1x | 0.2...2.5 mm² | |
| Stripping length | | 8 mm | |
| Screwdriver type | | 0.6 x 3.5 mm | |
| Tightening torque | | 0.5...0.6 Nm | |
| **General data** | | | |
| MTBF | | on request | |
| Duty time | | 100 % | |
| Dimensions | | see dimensional drawings | |
| Weight | | 0.23 kg | |
| Mounting | | DIN rail (IEC/EN 60715), snap-on mounting without any tool<br>screw mounting with mounting clips<br>screw mounting with screws (M4) | |
| Mounting position | | any | |
| Minimum distance to other units | | - | |
| Material of housing | | UL 94 V2 | |
| Degree of protection | | IP20 | |

## 9.3 Common technical data

| Environmental data (common) | | | |
|---|---|---|---|
| | | SFM1 | SCV |
| Ambient temperature ranges | operation | -25 to +60°C | |
| | storage | -40 to +70°C | |
| Damp heat, cyclic<br>(IEC/EN 60068-2-30) | | 6 x 24 h cycle, 55 °C, 95 % RH | |
| Climatic class<br>IEC/EN 60721-3-3 | | 3K3 (no condensation, no ice formation)<br>Relative humidity 5 % - 95 %, no condensation | |
| Vibration, sinusoidal | | 4 g, 5-300 Hz | |
| Shock | | 15 g, 11 ms | |
| **Isolation data of contactor module in combination with contactor (and sensor module)** | | | |
| Rated insulation voltage $U_i$ | acc. to IEC 60947-4-1 | 690 V | |
| | acc. to UL / CSA | 600 V | |
| Rated impulse withstand voltage $U_{imp}$<br>SFM: Control supply, bus / mains contactor<br>SCN: X2 (voltage input) to control supply, bus | | 6 kV | |
| Basic insulation | | according to technical data of contactor | |
| Protective separation pollution degree 3 | | L/N: 277 V AC<br>L/L: 480 V AC | |
| Protective separation pollution degree 2 | | L/N: 400 V AC<br>L/L: 690 V AC | |
| Pollution degree | | 3 | |
| Overvoltage category | | III | |
| Installation altitude without derating | | max. 2000 m | |
| Deratings at high altitudes | | on request | |
| **Standards / Directives** | | | |
| Standards | | IEC/EN 60947-1:2020 (Ed. 6.0) / EN 60947-1:2007 + A1:2011 + A2:2014<br>IEC/EN 60947-4-1:2019<br>UL 60947-4-1:2014 (Ed. 3)<br>UL 60947-1:2013 (Ed. 5) | |
| Low Voltage Directive | | no. 2014/35/EU | |
| EMC directive | | no. 2014/30/EU | |
| RoHS directive | | no. 2011/65/EU incl. 2015/863/EU | |

| | | | | |
|---|---|---|---|---|
| **Electromagnetic compatibility** | | | | |
| Emission requirements | radio interference voltage | EN 61000-6-4 | X | |
| | | EN 61000-6-3 | | X |
| | radio interference field strength | CISPR 11 | class A | class B |
| Immunity requirements | electrostatic discharge | EN 61000-4-2 | 6 kV contact<br>8 kV air | |
| | radiated, radio frequency electromagnetic field amplitude modulated | EN 61000-4-3 | 10 V/m<br>(80-6000 MHz) | |
| | electrical fast transients (burst) | EN 61000-4-4 | 2 kV (power supply lines)<br>1 kV (signal lines) | |
| | surge, unsymmetrical / symmetrical | EN 61000-4-5 | 1 kV / 0.5 kV (DC-supply)<br>2 kV / 1 kV (measurement lines) | |
| | conducted disturbance, induced by radio frequency, common mode, amplitude modulated | EN 61000-4-6 | 10 V | |

| | |
|---|---|
| **Performance data** | |
| Cycle time in contactor module: “switch on signal” received via X2X until contactor control voltage set to 24 V DC | typ. 5 ms |
| Update rate of measurement values provided from sensor module and available for X2X communication | typ. 25 ms |

According to the current interpretation of applicable Chinese law the Novolink devices described in this manual are imported as industrial automation equipment (they cannot be used without a PLC) and do not need CCC certification.

## 9.4 Technical drawings

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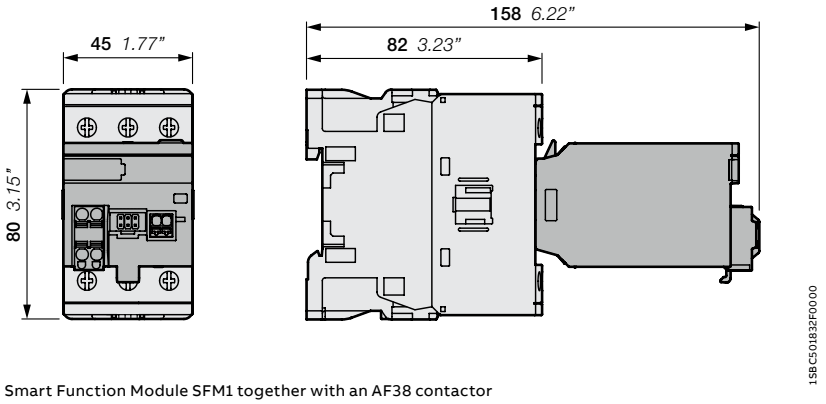
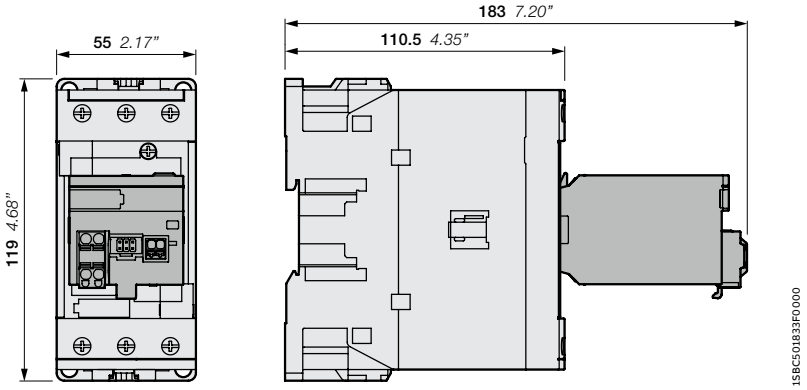
### Dimensional drawings

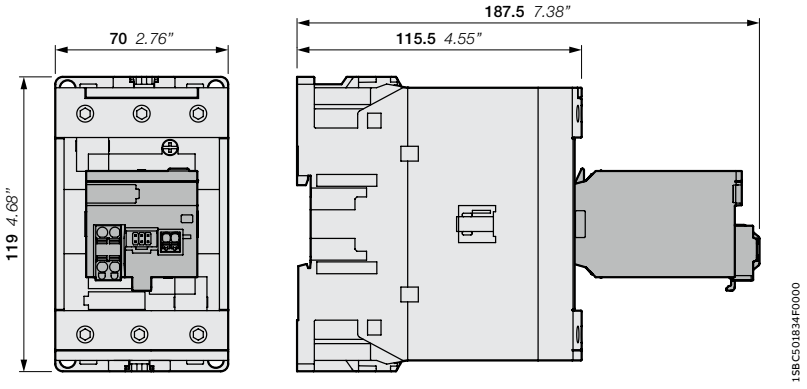
in **mm** and inches




Smart Function Module SFM1 together with an AF38 contactor




Smart Function Module SFM1 together with an AF40 contactor




Smart Function Module SFM1 together with an AF80 contactor

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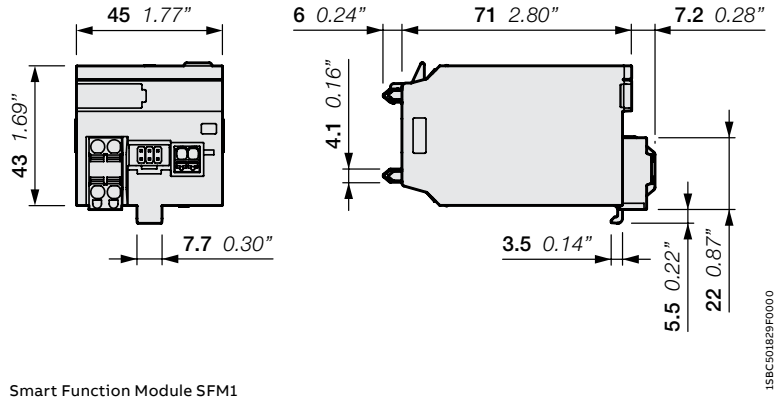
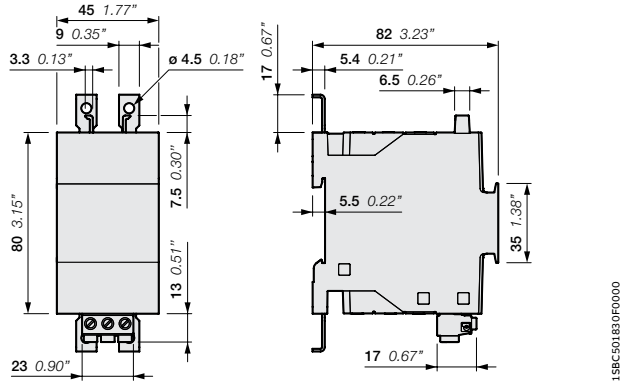
## Dimensional drawings

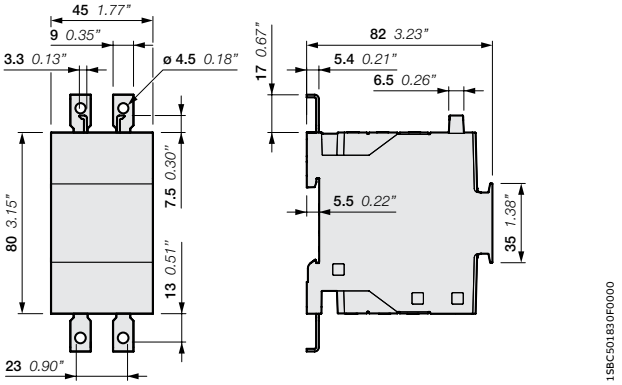
in **mm** and inches



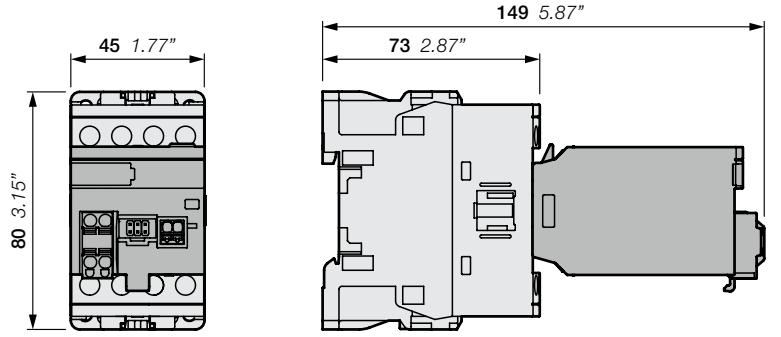

Smart Function Module SFM1




Smart Current and Voltage Sensor Module SCV10-40




Smart Current Sensor Module SC10-40




Smart Function Module SFM1 together with an AF09 contactor

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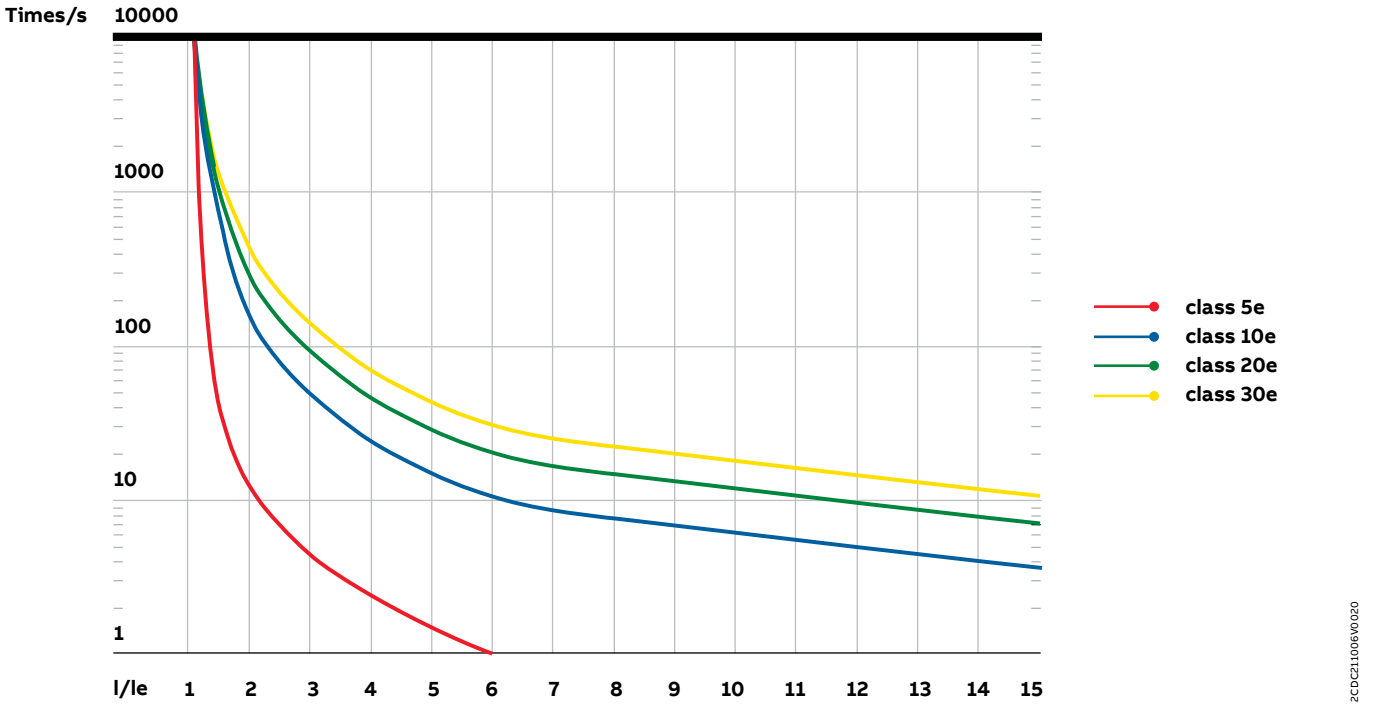
**Tripping curves for warm motor for three-phase and single-phase symmetrical loads**

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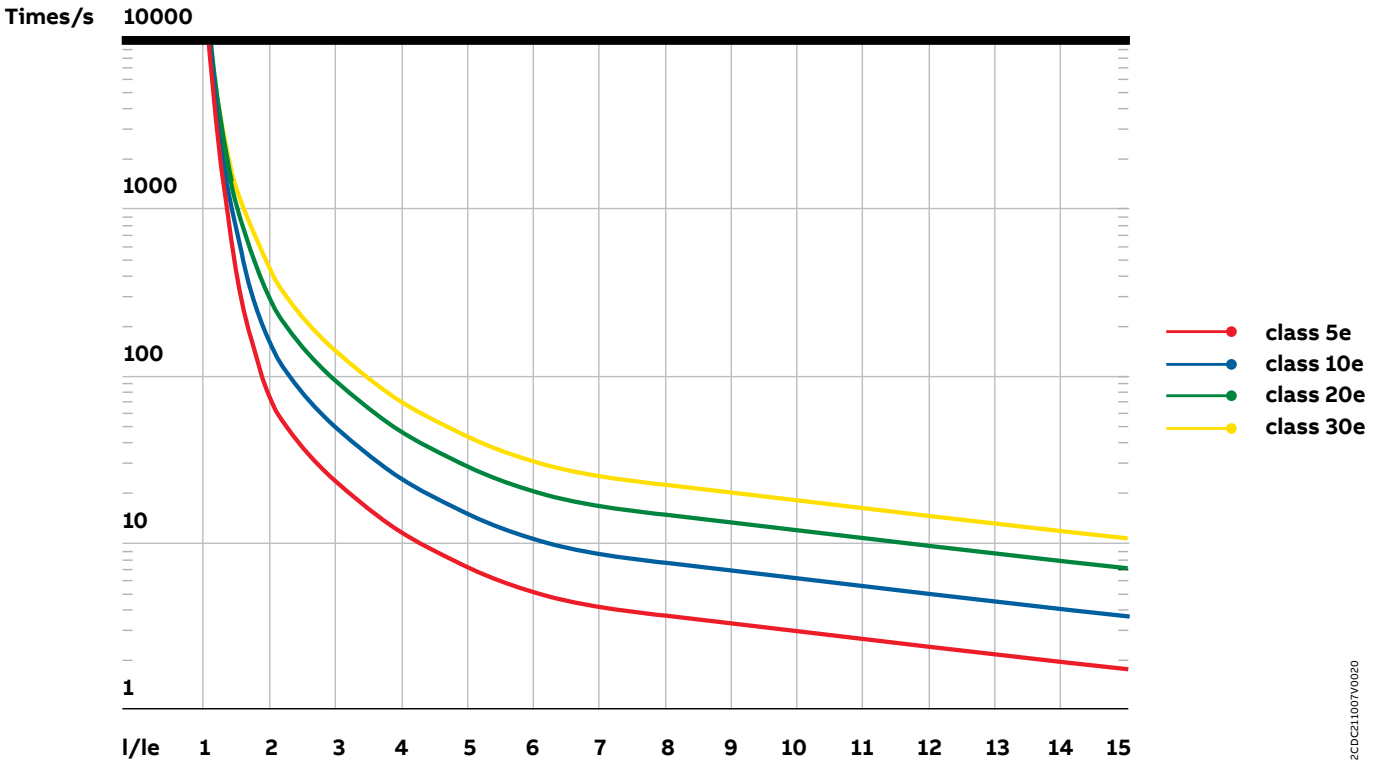
**Tripping curves for cold motor for three-phase and single-phase symmetrical loads**



# 10. Software license information

### 10.1 Free Modbus library

A portable Modbus implementation for Modbus ASCII/RTU.
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# 11. Revisions

| Rev. | Page (P) Chapt. I | Description | Date dept. / init. |
|---|---|---|---|
| 1.2 | All | Public version | 1.10.2020<br>DESTO/CPE |
| 1.3 | All | Update for SC10-40 | Dec/2021<br>DESTO/CPE |

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